

# Prospects for Whale Shark Conservation in Eastern Indonesia Through Bajo Traditional Ecological Knowledge and Community-based Monitoring

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## Abstract

The whale shark, *Rhincodon typus*, is a long-lived migratory species inhabiting tropical and warm-temperate waters worldwide. Seasonal aggregations of whale sharks in shallow coastal waters of many countries have led to the development of ecotourism industries. Whale sharks that aggregate seasonally at Ningaloo Reef in Western Australia have a migration range within Indonesian and Southeast Asian waters. However, very little is known about their behaviour, local migration patterns, or potential threats faced in this region. In this study, we investigated traditional ecological knowledge of whale sharks through interviews with Bajo and other fishers from five settlements in the Timor and Roti Islands in eastern Indonesia. We found that there are culturally driven prohibitions and customary beliefs concerning whale sharks among Bajo fishermen, who commonly sight sharks in the Timor Sea, in southern Indonesian and Timor Leste waters. Sightings are most common during the months of August to December. Interviews also indicate a low level of harvesting of whale sharks in the region. The results demonstrate the potential for combining traditional ecological knowledge and new technology to develop whale shark management strategies, and to determine the predictability of whale shark appearances as one vital factor in assessing the potential for development of small-scale whale shark ecotourism initiatives.

**Keywords:** whale shark, conservation, monitoring, traditional ecological knowledge, Bajo, Indonesia

## INTRODUCTION

The whale shark, *Rhincodon typus*, is a large (reputedly up to 18 m in length) migratory species that inhabits tropical and warm-temperate waters worldwide (Stevens 2007). Although they are principally oceanic, seasonal aggregations of these

sharks occur in the shallow coastal waters of many countries, probably in response to ephemeral, but predictable, increases in their planktonic prey (Jarman and Wilson 2004; Meekan et al. 2009). At many localities, this behaviour has led to the development of ecotourism industries that are based on snorkelers swimming with whale sharks (Meekan et al. 2006; Rowat 2007).

While these valuable industries exist in numerous countries, whale sharks have also been the subject of targeted fisheries for their fins and flesh, particularly in the Southeast and South Asian regions. Rapid declines in catches in these fisheries have created concerns over the status of whale shark populations, which in 2002, led to the listing of the species in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES 2002). This

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agreement strictly regulates the trade of the species based on quotas and permits, with the aim of preventing unsustainable exploitation. Many countries with aggregation sites for these sharks, including Australia, USA, Taiwan, Belize, Maldives, Philippines, Thailand, India and Mexico, have also now banned the harvesting and sale of whale shark products (NHT 2005; Camhi et al. 2009). However, these represent only a small portion of the 130 countries in whose waters whale sharks are known to occur.

One of the best-known aggregations of whale sharks occurs at Ningaloo Reef in Western Australia (Meekan et al. 2006) where there is a large ecotourism industry based on the occurrence of these sharks in near-reef waters from March to July (Bradshaw et al. 2008; Caitlin and Jones 2010). Evidence from photo-identification and eco-tourist sighting databases suggests that sharks visiting Ningaloo are declining in both size and number (Bradshaw et al. 2007, 2008), although the lack of reproductive data makes this hypothesis difficult to confirm. After leaving the aggregation site at Ningaloo, whale sharks migrate towards Indonesian and Southeast Asian waters to the north. Eckert et al. (2002), Wilson et al. (2006) and Bradshaw et al. (2008) suggest that the over-harvesting of whale sharks somewhere within this migration range may account for the potential declines witnessed at Ningaloo Reef.

It is difficult to confirm this idea since there is little published catch data on whale sharks (referred to as *ikan bodoh* or 'stupid fish' in Indonesian language, reflecting their status as an easy target) from targeted fisheries or as by-catch (Camhi et al. 2009) through most of Southeast Asia. A few published reports exist of whale sharks caught opportunistically using haul nets, gill nets and harpoons in Bali, Lombok and North Sulawesi, and the sale of whale shark fins and meat at local markets in eastern Indonesia was recorded by White and Cavanagh (2007). However, it is difficult, if not impossible, to use these records to extrapolate to total catches, due to the opportunistic nature of the trade and under-reporting (White and Cavanagh 2007). The fins are also valued as restaurant display items in Southeast Asia, but they do not fetch high prices when compared to other shark species (White and Cavanagh 2007). In Indonesia, there are no ecotourism enterprises focused on charismatic marine mega-fauna such as whale sharks, although the species is commonly encountered in broader marine ecotourism and diving tourism trips across the archipelago.

The best-documented harvest data are from Nusa Tenggara Timur (NTT), where villagers from Lamalera and Lamakera on Lembata and Solor Islands respectively have harvested whale sharks as part of a subsistence whaling fishery (that also takes toothed whales, manta rays and dolphins) since at least the 1970s (Hembree 1980; Barnes 1996, 2005; Mustika 2006). In 1995, Lamalera people are known to have taken 100 whale sharks during a year of exceptionally high catches (Barnes 2005), but anecdotal evidence suggests that up to 10 whale sharks per year have been harvested during the last decade or so (Dwyer pers. comm. 2007). Records on whale shark catches are sporadic and largely based on personal observations of visiting researchers and the staff of non-

government organisations (NGO) (Kahn pers. comm. 2008; Fowler pers. comm. 2009) and travel writers (e.g., Severin 1999). Furthermore, no information exists in the published literature regarding traditional ecological knowledge of whale sharks from Lamalera, and specifically, on indigenous beliefs and cosmology relating to whale sharks in Indonesia.

Wildlife ecotourism ventures have been established around the world to help in the conservation of threatened marine species, such as turtles, as well as provide economic benefits to local communities (Meletis and Harrison 2010; Pegas and Stronza 2010). Development of ecotourism operations based on interactions with whale sharks could provide a potential conservation and management strategy. Ecotourism could present an alternative to the opportunistic fisheries that could threaten the future of the species throughout the region, providing potential economic opportunities for local communities in eastern Indonesia. A wide range of social and economic factors would need to be explored before any ecotourism venture could be contemplated, but more fundamentally, such a venture first requires conditions where whale sharks can be accessed on a predictable basis and in sufficient numbers to accommodate the development of ecotourism industries. However, it is difficult to determine if such conditions exist, due to the lack of any formal surveying or reporting by governments.

Investigating the traditional ecological knowledge (TEK)<sup>1</sup> of whale sharks held by local people provides an alternative means of accessing this information. It is now generally accepted that any conservation initiative is more likely to succeed if a multi-disciplinary approach involving social and natural science knowledge are considered and evaluated (Drew and Henne 2006; Fraser et al. 2006; Risen and Tilt 2010). The application of TEK has been acknowledged for its contribution to the management and conservation of marine species, where knowledge from local fishers can be evaluated and combined with western scientific knowledge and management approaches for enhancing biodiversity conservation and management of fisheries or threatened species (Johannes 1981; Johannes et al. 2000; Aswani and Hamilton 2004; Moller et al. 2004; Drew and Henne 2006; Fraser et al. 2006; Mallory et al. 2006; Lauer and Aswani 2008; Lavides et al. 2010).

In this paper, we have chosen to use the term TEK, despite potential negative connotations associated with the word 'traditional' implying knowledge being frozen in time (Stacey 2007; Heckler 2009). Furthermore, the term 'ecological' tends to separate the social and spiritual aspects from the biological, whereas indigenous peoples do not regard these as separate knowledge forms (Berkes 1999)<sup>2</sup>. Irrespective of these problems of nomenclature, here we adopt a definition of traditional ecological knowledge as "a cumulative body of knowledge and beliefs, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship between living beings (including humans) with one another and their environment" (Berkes 1999: 8). This knowledge comprises four interrelated elements: local knowledge of the environment (e.g., fish); systems of

resource management; social institutions; and world view—spiritual and cultural components that give rise to the ‘sacred knowledge’ construct (Berkes 1999: 13).

Documentation of TEK can provide valuable ecological information on marine species and incorporate important wildlife-human interactions that may not otherwise be revealed in published scientific descriptions of marine species (Johannes and Yeeting 2001). Indigenous communities are often highly dependent on local natural resources and may therefore know about natural fluctuations in population size, habitat specificity, aggregation, and migration patterns that are not yet recorded in scientific literature (Huntington et al. 2004; Drew 2005; Mallory et al. 2006). It can be argued that TEK can provide a cheaper and more holistic method of detecting changes in fish populations and that a precautionary approach based on this information may be more prudent than waiting for expensive, slow-coming scientific proof (Calamia 1999; Fraser et al. 2006).

Despite the well-documented benefits of TEK, there are numerous challenges researchers must be cognisant of when conducting TEK research and its application within western conservation approaches. Embedded in these research processes are issues of power, ethical dilemmas and difficulties in combining TEK research and science in conservation and management. There is also the potential for a situation to arise where the end use of TEK research may negatively affect the TEK holders, such as through the loss of access to livelihoods activities. Researchers should also be wary of TEK being translated into data that fits neatly into western scientific knowledge systems and is then used to benefit the researchers, scientists and conservationists, with little or no benefit to local people involved in the research, from removal of TEK from its wider epistemological context (Drew and Henne 2006; Shackeroff and Campbell 2007).

Nonetheless, despite these challenges, complexities and the assumption of ‘best practice’ approaches being followed by all researchers with TEK holders, it can be highly beneficial to work closely with fishermen to document knowledge on whale sharks. Small-scale fishers spend more time on the water and therefore have a higher chance of encountering whale sharks (Rowat and Engelhardt 2007) than scientists who carry out infrequent and expensive field expeditions.

In this study, we investigated TEK of whale sharks through interviews with Bajo and other fishers from five settlements in the Timor and Roti Islands in eastern Indonesia. We documented customary practices and beliefs concerning whale sharks (e.g., taboo, ritual and cosmology); actual geographic locations where whale sharks have been sighted, where they were believed to aggregate or migrate, and their seasonal patterns; and information relating to human-induced threats faced by whale sharks in Indonesia (e.g., subsistence or commercial fishing and trade of products). Additionally, we reported the results of a pilot study of techniques for community-based whale shark monitoring programmes in these communities. The primary aim of this research was to determine the presence of whale sharks in eastern Indonesia

and their predictability, and local migration routes using traditional ecological knowledge, and thus, whether biological conditions exist for the potential consideration of a whale shark ecotourism initiative. The second aim was to explore prospects for community-based whale shark monitoring and ecotourism potential in this region of the Indonesian archipelago. When using the term ‘biological conditions’ in this paper, we are broadly referring to the presence and frequency of appearance of sharks. We also emphasise that for the purposes of this paper, we address only one factor in determining ecotourism viability; notably, whether suitable biological conditions exist to support this industry.

## SITES AND METHODS

Field research for this study was conducted in eastern Indonesia in early July 2007 (through semi-structured interviews) and the months of August to November in 2007 and 2009 (through community-based documentation activities) with fishermen from five villages.

### Bajo of eastern Indonesia

The Bajo of eastern Indonesia (also referred to in the literature as Bajau or Bajau Laut, and who refer to themselves as Sama people)<sup>3</sup> belong, ethno-linguistically, to a larger Sama-Bajau subgroup that migrated to Indonesia at the beginning of the nineteenth century and dispersed throughout eastern Indonesia over the following centuries (Stacey 2007). The number of ethnic Bajo in Indonesia is estimated to be somewhere in the range of 90,000–150,000 (Mead and Lee 2007). Bajo inhabit widespread social and economic domains through mobile livelihood strategies, which has given rise to the application of the label ‘sea nomads’ in both academic and popular literature. Although most Bajo live in settlements in areas with high marine biodiversity—in particular, in all five provinces of Sulawesi, and provinces of Nusa Tenggara Barat (NTB) and NTT—they are generally landless. As such, the marine environment constitutes culturally defined living spaces (Chou 1997; Lowe 2003); Bajo spend their entire life in the vicinity of the sea and are heavily dependent on marine resources and associated livelihoods as hunters and gatherers, fishers, sailors, boat builders, and traders. In the words of the Bajo “*Laut merupakan dasar hidup*” (The sea forms the basis of our life) and “*Kita punya kebun di laut*” (Our garden is the sea) (Stacey 2007).

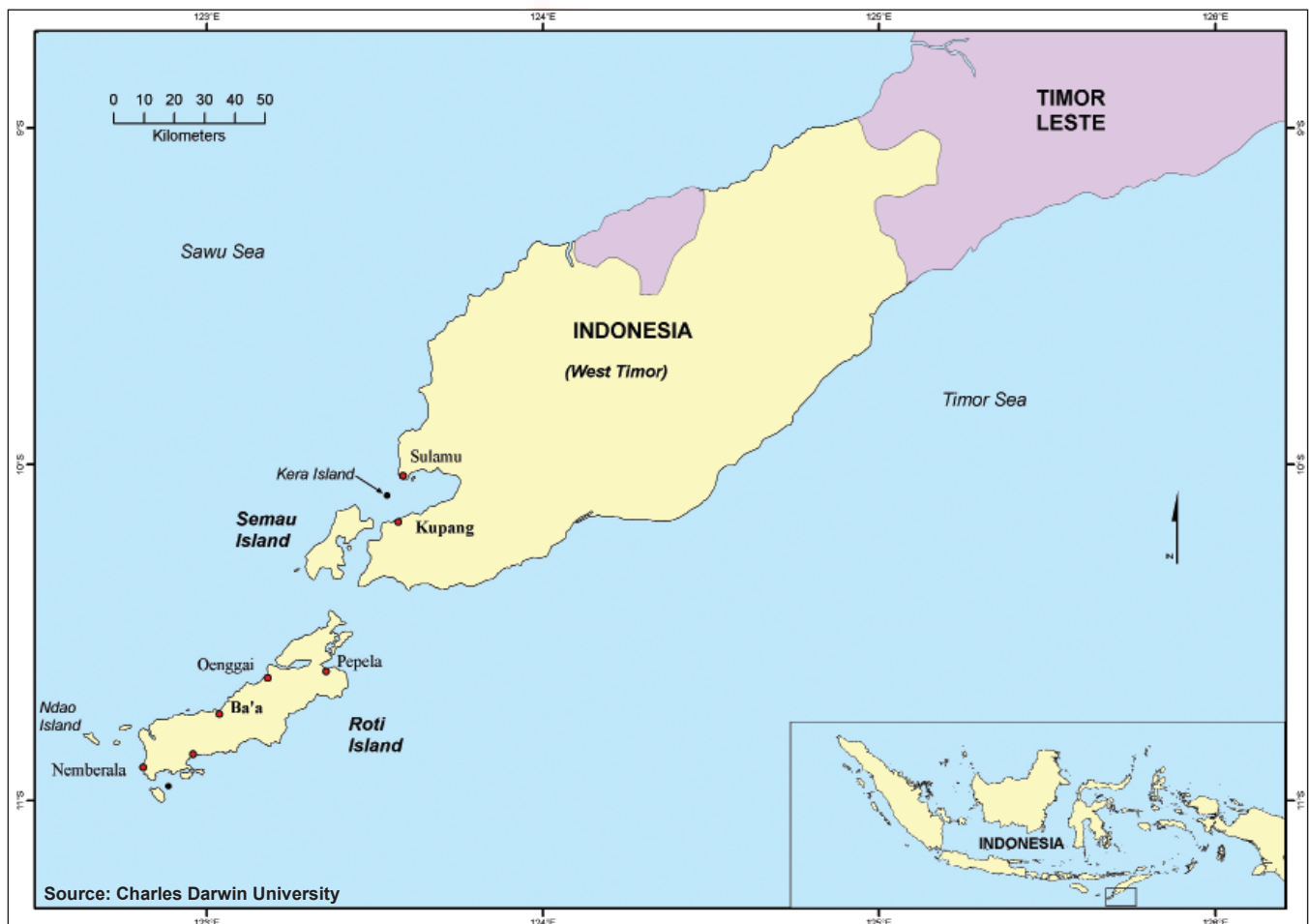
Despite being increasingly recognised for their rich marine wisdom, the Bajo’s migratory fishing strategies are often considered a threat to the environment and conservation. As non-resident fishers, the Bajo in many locations are considered responsible for overfishing and using destructive fishing techniques resulting in negative environmental impacts (Lowe 2003, 2006; Majors 2008; Clifton 2010)<sup>4</sup>. This is in contrast to perceptions by conservationists of ‘fixed’ stationary coastal communities (Lowe 2006) whose strategies are often viewed as having a positive impact on the marine environment (Clifton

2010). As Lowe (2006) explains, habitation in stilt houses over the sea and mobile livelihood strategies are regarded as ‘uncivilised’ and ‘threatening’ by Indonesian government and conservation organisations (Lowe 2006). A lifestyle which involves seasonal short or long-term migratory fishing activities suggests that “...they can’t possibly care about the particular location they happen to find themselves in at a given moment” (Lowe 2006: 86), and that protection of the environment and concern for overharvesting of particular species is of no concern to them as they move on.

The Bajo possess a rich marine cosmology and ritual practice, with belief in supernatural beings—ancestors of the sea who control the universe of the sea and all the creatures in it for Bajo people—and a causal relationship with spirits who inhabit the sea. This cosmology and causal relationship with spirits that inhabit the seas is governed by customary law (*adat*), and interactions with this spirit world and ritual activity require the services of someone with specialised knowledge (*ilmu*); holders and teachers of specialised ritual and maritime knowledge which is passed down through generations. Bajo religious beliefs are syncretic, whereby elements of Islam (Sunni) are fused with Bajo cosmology and ritual practice. This syncretism can be observed in various manifestations of

Bajo practical religion—in their cosmology, life cycle rituals, and other rituals concerned with boats, fishing, housing, and health (Stacey 2007).

Of all maritime populations in eastern Indonesia, the Bajo are the most mobile and have the largest ranging geographical coverage; there are settlements of Bajo communities scattered across eastern Indonesia, from north Maluku across to Sulawesi, in the south in the Flores Sea and along the Lesser Sunda Islands. For centuries, the Bajo have engaged in various forms of long-distance fishing voyages (referred to as *lama* in Sama language) around what is now the Indonesian archipelago, including fishing voyages to north and northwestern Australian waters (Stacey 2000, 2007). Bajo communities that originated from settlements in the Wakatobi (Tukang Besi) Islands in the province of Southeast Sulawesi currently reside at the villages of Pepela and Oenggai in Roti Island, Kera Island, and Sulamu and Kupang Bay in West Timor (see Figure 1). Given this migratory fishing behaviour, they presented a logical group to be involved in this study of migratory species. Moreover, Bajo and other coastal communities in the east Nusa Tenggara region have themselves expressed interest in accessing alternative or supplementary livelihoods (Fox et al. 2009), and have also been identified as priority beneficiaries for the development of



**Figure 1**  
Location of five communities visited in Nusa Tenggara Barat, Indonesia



new livelihood activities as part of the larger conservation and development agenda in the region (ATSEA 2011).

### Research sites

The islands of Timor and Roti are located in the Province of NTT in the southeastern region of Indonesia. We visited two villages in West Timor—the Bajo settlement on Kera Island located in Kupang Bay, and the village of Sulamu located to the north of Kupang, the capital of West Timor. The Bajo community on Kera Island originates from many Bajo villages in eastern Indonesia, but the majority of members come from Sulamu. It is only in the past four years that the Bajo have re-settled on Kera Island, although the island has been inhabited by other ethnic groups in the past. At the time of our visit in 2007, there were 52 households. There are no facilities on the island: no school, water, or electricity and children that do attend school commute to Sulamu.

In Roti, the team visited three villages: the Butonese/Rotinese village of Pepela and Bajo hamlet at Tanjung Pasir (approximately 60 households) (see Stacey 2007); Oenggai village, with a mixed Rotinese/Bajo population of approximately 300, located in east Roti; and Nemberala, a Rotinese village and popular surfing/beach destination. A group of fishermen from neighbouring Ndao Island were interviewed on the beach (Figure 1).

There are already some small-scale ecotourism activities in the region, based in Kupang, Ba'a and Nemberala. In this paper, we do not include any detailed analysis of demand or feasibility of tourism activities, considering only low-scale, seasonal, marine-based ecotourism such as surfing and diving in a region that is identified for further marine conservation initiatives (CTI 2009) and development of associated enterprises.

### Interviews

We developed a series of semi-structured interview questions that were translated into Indonesian. All fishers are relatively fluent in the Indonesian language. These were used as a guide for semi-structured interviews undertaken during a week-long field trip in 2007 (June, 30 to July, 7). Topics and questions related broadly to themes of: customary practices and beliefs concerning whale sharks (e.g., taboo, ritual and cosmology); actual geographic locations where whale sharks have been sighted, or where they are believed to aggregate or migrate, and their seasonal patterns; and information relating to threats faced by whale sharks in the region (e.g., subsistence or commercial fishing and trade of products). A literature review helped to establish a framework for the study as well as define the field survey design and interview questions. The interviews focussed on information about whale sharks in the northwestern region of the Timor Sea and southeastern Indonesian region; in particular, around the waters of Roti Island, and West and East Timor. However, given that the Bajo are active across the Indonesian archipelago, information relating to a wider geographical coverage was obtained.

In 2007, seven key informant interviews (lasting between 15–30 minutes and 1–2 hours) with respected Bajo elders and holders of traditional knowledge were conducted, as well as ten informal group discussions with other groups of fishermen living in the villages of Tanjung Pasir, Pepela, Oenggai, Nemberala and Kera Island. The selection of key informants was based on one of the author's (Stacey) past long-term ethnographic field experience in most of these communities, and contacts and availability of these informants. The interviews were largely conducted in Bahasa Indonesian. During all visits to villages in 2007, the team also approached as many fishers as possible to ask about whale sharks. These discussions were much more informal and opportunistic, based on whoever was present/available at the time. Approximately 15 fishers were interviewed regarding reported whale shark sightings in 2009.

To assist with discussions with fishermen, three whale shark photographic books were prepared and made available to fishers and their families to peruse. Cartographic maps of eastern Indonesia and northern Australia were also used to aid in identifying locations and migration patterns of whale sharks.

### Visual sightings and photographic documentation of whale sharks

Photo-identification of individual whale sharks has been used successfully by Meekan et al. (2006), Graham and Roberts (2007), Speed et al. (2007), and Rowat et al. (2009), to identify individuals, as well as provide information on population structure and survival estimates at different locations. During two seasons (August to November), the first following the field survey in 2007 and again in mid-2009, we attempted to confirm the presence of whale sharks in the NTT region by recording visual sightings by fishermen and through photographic documentation and identification.

In 2007, the research team worked with members of the Bajo community at Namusein village in Kupang, who host a local non-governmental organisation (NGO)—*Sama Turo*, established to facilitate the education of Bajo children in NTT. The NGO is represented by Bajo members from five villages in Kupang and Roti Island (Namusein, Sulamu, Kera Island, Tanjung Pasir, Oenggai). The NGO coordinator decided on the terms of their engagement and the resources required to support the monitoring activities. Through personal networks, 15 disposable Kodak underwater cameras and information sheets (in Indonesian) on how to use the cameras and correct positioning for photographing a whale shark, were delivered to the coordinator in August and September. The cameras were then distributed to members of the Bajo community in Kera Island, Oenggai and Tanjung Pasir, and the Rotinese community at Batu Tua in West Roti. Some funds were provided to help with the costs of camera distribution and boat fuel. Fishermen were informed that if they were successful in photographing a whale shark, they would be rewarded financially. One of the authors visited Kupang to collect the one camera returned in late 2007.

In 2009, a different approach was used, whereby we contracted Nusa Cendana University (UNDANA) staff to visit communities, identify fishermen for camera distribution, undertake briefings and training on how to use cameras to take photographs of whale sharks, and collect cameras. Four visits were undertaken by the UNDANA team between late August and November to Kera Island and Sulamu in West Timor and Tanjung Pasir, Pepela, Oenggai and Nemberala in Roti Island: 13 cameras and snorkelling equipment were distributed during the first field visit, and fishermen were given a small amount of money to help cover the costs of fuel. One camera was returned in late 2009.

The photographs were developed and compared, using the pattern recognition programme I3S (Speed et al. 2007), with a database photo library of 1,000 individual whale sharks [collected between 1992 and 2006 from localities including Ningaloo Reef in Western Australia (WA), Christmas Island, the Maldives, Seychelles, and Mozambique], held by the Australian Institute of Marine Science (Speed et al. 2007).

### Analysis

The results of field interviews were analysed qualitatively and written up as records of conversations, as well as literal translations of recorded interviews. Within the limitations of the brief pilot study, the information was cross-checked between Bajo from various settlements, and information and identification of emerging common themes developed into summary results.

## RESULTS

### Bajo customary practices and beliefs concerning whale sharks

The Bajo hold specialised customary practices (*adat*) concerning whale sharks (*kareo dede* in Sama-Bajo language). One Bajo fishermen interviewed in Tanjung Pasir stated “*Nenek moyang dilarang dapat hiu kareo*” (Our ancestors forbid us to catch whale sharks) and “*Kalau dapat harus lepas*” (If you do catch one [e.g., by accident in a net], you must release it). Customary law prohibits the hunting of whale sharks and the Bajo therefore do not hunt the species. This fits within the overall framework of Bajo cosmology (see Stacey 2007).

According to a Bajo elder from Sulamu village “*Ikan dijaga oleh dewa*” (The fish [whale shark] is guarded by a spirit). Other large marine creatures, such as whales, are also considered to be guarded by spirits, and these can protect or come to the aid of fishermen in times of need or misfortune at sea. For example, one of the fishermen from Kera Island recounted a story about a boat which sank near Savu Island. The crew were saved from drowning by a whale shark; they held onto its fin and it took them to safety. As a result of such beliefs, the killing of whale sharks (and whales) is considered taboo (*pemali* in Sama-Bajau language).

Interviews with Rotinese and Butonese fishermen from

Pepela did not indicate any customary beliefs specific to whale sharks.

### Whale shark sightings, migration, and seasonal patterns

Most of the Bajo and other fishermen interviewed reported that they usually saw whale sharks swimming alone or in pairs when they were near the surface, in particular, in locations in northern Australia, eastern Indonesia, and in the seas that are now part of Timor Leste. Whale sharks were constantly moving, following the currents on a seasonal basis in search of food. They were most often sighted during the Indonesian east monsoon period beginning in August, through to the early west monsoon of November or December.

Fishermen rarely saw whale sharks aggregate. Based on this, they believed that the sharks bred infrequently and only ever produced one or two offspring. One fisherman from Tanjung Pasir, Pepela, who had over 20 years of experience fishing in the Timor and Arafura Seas, reported that he had seen five or more sharks together in offshore waters south of Sumbawa Island, a group in deeper waters towards Lombok Island, and eight sharks north of Darwin, while shark fishing in the Arafura Sea in the 1980s.

The Bajo and other fishermen we spoke to in Tanjung Pasir, who had also fished in the Timor Sea and northwest region of Australia for decades, had regularly sighted whale sharks in Australian waters, in particular, around the vicinity of Ashmore Reef, and further south towards Scott Reef. These same fishermen had sighted whale sharks in the NTT region—in the waters south of Roti Island, in the straits between Timor (Kupang) and Semaui Island, and in the waters around Kera Island (Figure 2). To the north, sharks were sighted in the Mako Straits (between Adonara and Lomblem Islands) and Lambardi Straits (between Lomblem and Pantar Islands), and in the Savu Sea between Timor and Flores Islands. Whale sharks were also sighted in the region of southeast Sulawesi—around the Wakatobi Islands and in the Buton Straits, and in the Arafura Sea close to the West Papuan coast.

Rotinese fishermen from Pepela reported that when it was windy, whale sharks came to the surface of the sea and chased schools of small fish (*ikan halus*). Fishermen reported that, when sighted, whale sharks were most commonly engaged in ram filter-feeding, where the sharks would swim slowly at the surface with their mouths open (Taylor 2007).

The Bajo from Kera Island and Sulamu village reported that the whale sharks they saw in the region targeted pelagic fish (fingerlings). These were not identified, but may include mackerel and tuna. Fishermen noted that around the time of our visit (July, 2007), the pelagic fish were just starting to spawn, coming in from deep waters into Kupang Bay and travelling north along the Timor coast. As small fish developed in the shallow coastal waters during August to October, the whale sharks came in to feed on them. As pelagic fish grew bigger they moved offshore and the whale sharks also moved away, perhaps following the prey fish.

Fishermen stated that whale sharks usually travelled in deep

water and were therefore only seen when they came to the surface, usually when chasing small fish. The most common time to see whale sharks was during the months of August to December, which coincided with departures of sharks from Ningaloo Reef in WA. Generally, the sharks were not sighted during the early period of the east monsoon when waters were still choppy, but were seen with the onset of lighter wind conditions in late August and September.

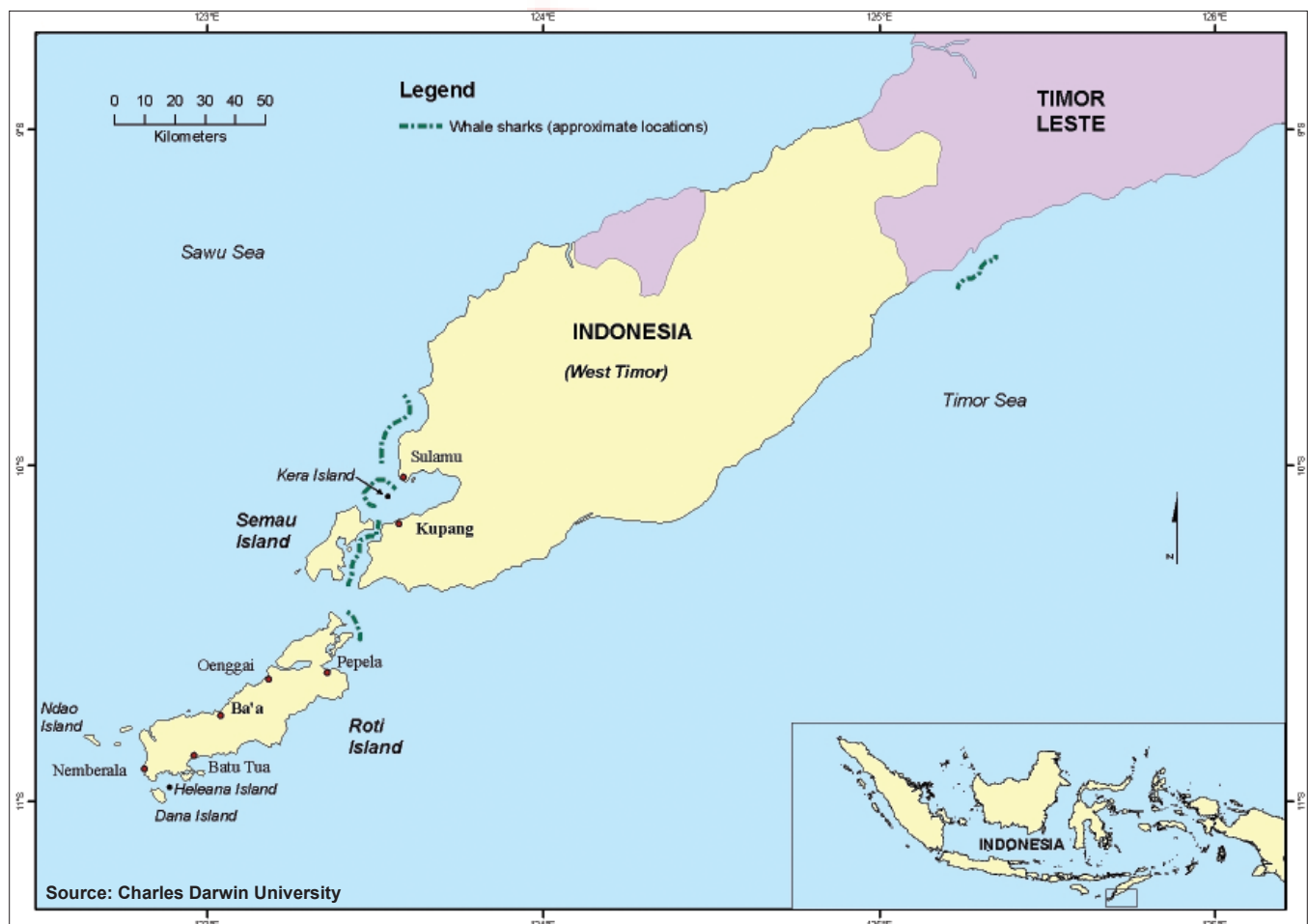
Bajo fishermen from Oenggai village on Roti Island saw whale sharks in deeper waters directly offshore from the village and in the region to the northeast (Figure 2). Whale sharks were often seen when bait fish were present, and often at the same time as manta rays (*Manta* spp). The fishermen usually saw sharks in August, but also at other times, and knew that the whale sharks were not dangerous as they only ate small fish and shrimp-like crustaceans. Bajo fishermen did not harm whale sharks, for reasons outlined above.

Pepelan fishermen reported that they often saw large whale sharks in the region of West Roti, between Dana Island and the mainland, especially at Batu Heleana (a popular tuna fishing area that is protected from strong wind during the west monsoon), Landau Island and the village of Batu Tua (Figure 2). During the months of November and December, particularly once the

rains began, whale sharks came to the surface to eat small bait fish (*ikan halus* - 'neri'). Fishermen also stated that if the wind was strong, sometimes the whale sharks came to the surface in protected areas, especially near coral reefs. One fisherman stated he believed whale sharks were in the area all year round, but he only saw them when they came to the surface with the rains at the start of the west monsoon and in the presence of smaller fish. Geographical features that may support the presence of whale sharks and their food sources included the presence of a strait where strong currents create uplifts of nutrients that attract small fish. Additionally, according to fishermen, during the west monsoon, the area is protected from westerly winds. However, whale sharks were also sighted in the area during the later east monsoon months. One fisherman had reported seeing up to five whale sharks together in the West Roti area.

Fishermen from Pepela also stated that they regularly saw whale sharks around Rotinese waters, off Pantai Roti, Tanjung Usu and Kambing Island, (northeast Roti), in waters close to Tobololong village, at the southern tip of West Timor coast, in the straits between Sulamu and Kera Island, and in deep waters to the south of Sumbawa Island.

The crew of a boat from Ndao Island at Nemberala reported that they saw whale sharks during the months of August to



**Figure 2**  
*Approximate locations where whale sharks were sighted by fishermen in Timor, Roti and Timor Leste waters*

September in waters between West Roti and Ndao Island. A fisherman from Sulamu reported that he had often seen whale sharks in waters off the south coast of Timor Leste—south of Covalima District, prior to 1999 when a Bajo community existed at Hera village in Dili (Figure 2). In this area, whale sharks visited to feed on small fish (*ikan tembong*).

Whale sharks are present and regularly sighted in the West Timor-Roti area during the months of July to November. Reported whale shark sightings by fishermen during the period from early August to late November 2007 and August to November 2009 are shown in Figure 3. However, this is not indicative of actual numbers of whale sharks in the region during this time of year, and the time of year relates only to the actual times the project teams were active and visiting villages (late August to early November in 2009). The results are consistent with the information provided by fishermen relating to knowledge on whale shark locations and behaviour collected during July 2007 (Figure 3). In 2007, 13 whale sharks were sighted, and in 2009, 16 whale sharks were sighted by fishermen from the five villages. Whale sharks were most commonly sighted in waters between Kera Island and Sulamu village on West Timor, and the north of Kupang Bay; around Pepela and Oenggai waters, Roti Island, but were also seen

in waters southwest of Roti near Nemberala village and small offshore islands (Figure 3).

### Anthropogenic threats faced by whale sharks

With the price of whale shark fins, meat and skin generally low in NTT and Indonesia (White and Cavanagh 2007), whale sharks are not as attractive a target species compared to other areas in Southeast and South Asia. In addition, most of the small boat or artisanal fishermen do not have the technology to hunt such a large fish. However, there were some occasional accidental catches while fishermen were targeting predatory sharks or netting for fish. We were informed by fishermen in Kera Island, Sulamu and Pepela in 2007 that two to three whale sharks had been caught in the past 12 months. One shark was caught by a Pepelan fisherman about three months before our visit in waters south of Roti Island while the crew were shark fishing (for fins) from a small motorised boat using longline gear. The whale shark, approximately three metres in length, was lashed to the side of the boat and landed in Pepela. The skin and meat (of a total weight of 320 kg) were salted, dried and sold to a local trader in Pepela and shipped to Surabaya. The meat sold for USD 0.32 per kg and the skin for USD 0.27

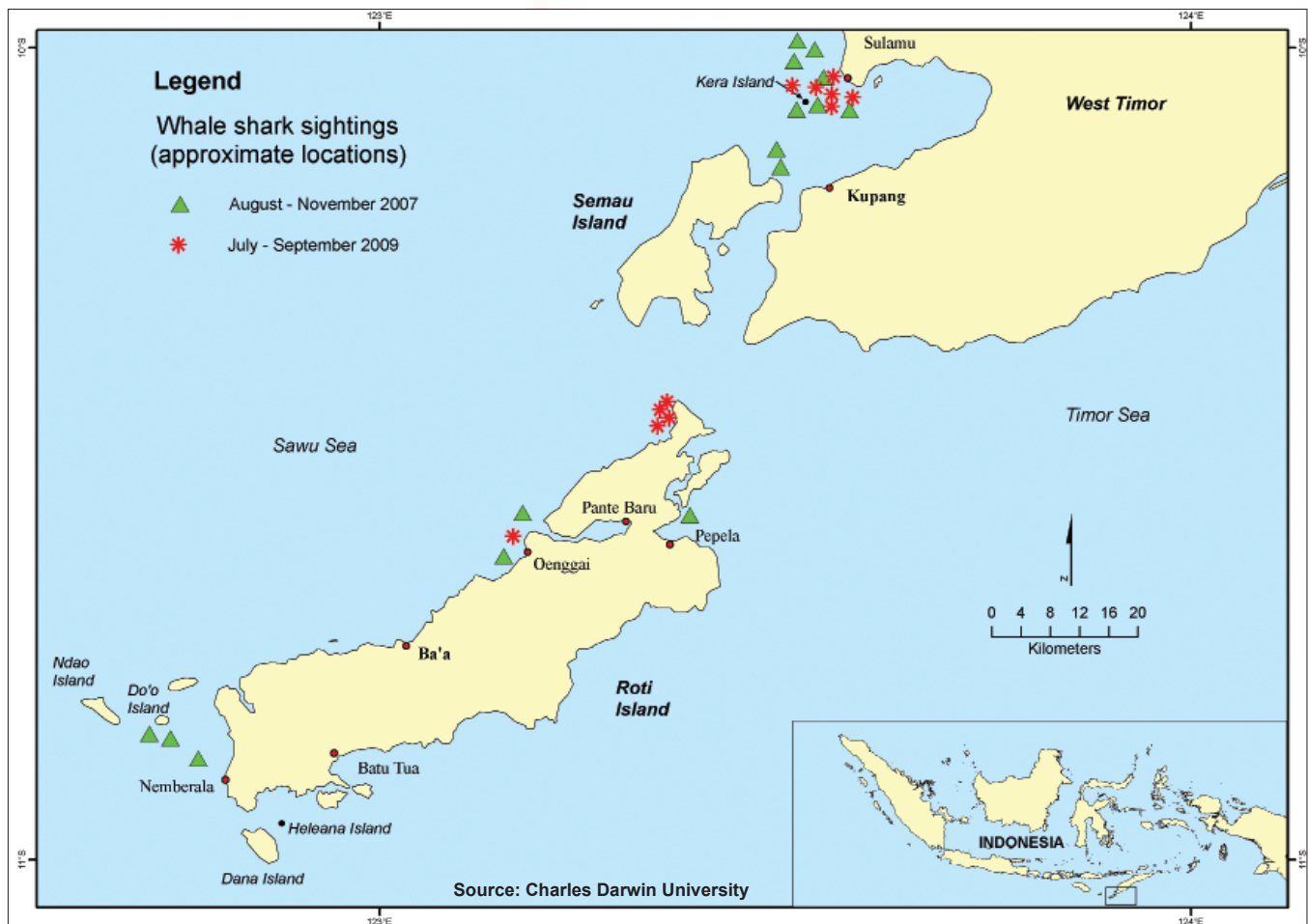


Figure 3  
Approximate locations of whale sharks sighted by fishermen in Timor-Roti waters during August–November 2007 and July–September 2009



per kg. The fin was sold to a trader in Kupang for USD 8.55 per kg (a total of 23 kg). The skin was said to have been used to make purses and bags.

Fishermen from Kera Island and Pepela reported that in 2005 or 2006, a whale shark was caught accidentally by Namusein fishermen while net fishing for tuna (*lamparang*) in Kupang Bay. The 11 m whale shark was landed on the beach at Namusein. The Department of Fisheries staff were alerted and they instructed the fishermen to tow the whale shark out into the bay and release it.

A fisherman from Oenggai village on Roti Island had heard a story of a whale shark being landed in Sulamu (Kupang area). But after this, there was sickness in the village and since then, no whale sharks have been caught.

### Photographic documentation for monitoring

Of the 15 cameras distributed in 2007, only one was returned. The developed film revealed good quality photos of one shark (see Figure 4) which were analysed in order to determine whether a match could be made in the photo-library of the whale sharks visiting Ningaloo Reef. To date, no match has been made for this particular individual in the AIMS database

In 2009, 14 cameras were distributed, but only one Bajo fishermen from Kera Island managed to photograph a whale shark successfully—the same fishermen who successfully photographed a whale shark in 2007. The images were processed and spot-checked in the AIMS database, but no match was found with any whale sharks on the existing database for Ningaloo Reef.

## DISCUSSION

Our research determined the presence and location of whale sharks in the East Nusa Tenggara region of eastern Indonesia using traditional ecological knowledge, explored Bajo relationships with whale sharks, and tested approaches for community-based monitoring. Our goal was to determine



Photo credit: Charles Darwin University

Figure 4

A photograph taken by a Bajo fisherman from Sulamu village, Kupang Bay, in late October 2007, of a whale shark sighted approximately 3 nm north of Kera Island

whether suitable biological conditions exist to support ecotourism based on whale sharks in this region of the Indonesian Archipelago.

The longevity and migratory behaviour of whale sharks makes it very difficult and expensive to collect long-term data (Theberge and Dearden 2006). Our study provides an example of the potential for combining traditional ecological knowledge and new technology to effectively monitor rarely-sighted migratory species such as whale sharks. We documented customary beliefs and law (*adat*) of the Bajo that prohibit them from harming or hunting whale sharks. These systems are part of a wider marine cosmology based on belief in, and causal relationship with, spirits who inhabit the sea (Lowe 2003; Stacey 2007). However, it is not known whether Bajo in all villages adhere strictly to these customary practices. Regardless of how closely these practices are followed, their very existence provides a useful basis for discussion regarding conservation of the species.

Bajo and Rotinese fishermen from settlements in NTT commonly sight whale sharks in various locations in the Timor Sea, around islands in NTT and beyond to other parts of Indonesia, and Timor Leste waters. Sightings are most common during the months of August to December. Whale sharks are typically seen alone or in pairs at the surface of the water feeding on small fish, and shark migration patterns may be related to the timing and location of fish spawning. While our work suggests a seasonal presence, more information is still required. Further research is needed over 2–3 consecutive years to determine, more precisely, how many sharks visit the area, and the links between sightings and food sources. Knowledge of the predictability of visitations is essential if ecotourism industries are to be developed. Our study shows that ecotourism and community-based monitoring could provide a means to supply this information.

It appears that there is no commercial fishery or well-established commercial market for whale shark products in NTT. Incidental and/or opportunistic harvesting of whale sharks by local fishermen occurs both in this area and in the wider region of the Indonesian Archipelago, but information on the extent and scale of this harvest is poor. Reasons for a lack of markets include customary beliefs of some fishing groups, lack of available local technology to harvest these large animals, lack of post-harvesting equipment such as freezers, as well as low prices for whale shark products such as flesh and skin. Even without a market within Indonesia, external demand for whale shark products could stimulate harvest of the species (Fowler 2000; Camhi et al. 2009) as occurred in the Indian state of Gujarat (Hanfee 2001). Given the extensive subsistence and artisanal fisheries that operate in Kupang Bay and the NTT area, overfishing of whale shark food sources may pose a greater potential threat to whale shark populations in NTT than actual harvesting, whether incidental or targeted.

Although whale sharks have been harvested as part of the traditional whaling fishery in Lembata since at least the 1970s, it is also not known what impact the harvest has on the population size. The villages of Lamalera have not supported

attempts by non-government conservation organisations, including the World Wide Fund for Nature, or the Government of Indonesia to introduce conservation measures and limit traditional harvests of whales and other mega-fauna in the region (Toohey 2010). For this reason, it appears unlikely that villagers would be interested in ecotourism based on whale sharks (Barnes 2005). In fact, tourism ventures already exist at Lamalera, based on participation in traditional hunting activities, with 40–50 fee-paying tourists a year involved in whale hunting in 1999 (Severin 1999).

Our research also suggests that certain ethno-linguistic groups are more culturally predisposed to undertake conservation monitoring than others. Bajo are maritime-orientated, both economically and culturally, and are more confident regarding close encounters with whale sharks than some other groups such as Rotinese (even though all fishermen report that they are not harmful). However, it is physically and mentally challenging to dive into the ocean and swim with a whale shark that may be more than 7 m in length, manoeuvre into the correct position and take a photograph. Although our returns of cameras were very low, with only one person from a group of 15 fishermen photographing a whale shark in two separate years, considering the minimal time and resources that were available to the project to monitor this activity, we do believe that this return reveals an opportunity for involvement of some individual Bajo to participate in training and receive remuneration for photographic identification of sharks, and shows promise for prospects of monitoring and conservation of whale sharks in the Timor-Roti region.

However, the low returns may illustrate some of these challenges and issues associated with TEK application in conservation research (Drew and Henne 2006; Shackeroff and Campbell 2007). The goals of our research—using Bajo TEK for whale shark documentation—may not equate with how Bajo believe TEK should be used in new ways and outside of customary contexts. Other practical issues that might limit monitoring by Bajo involve the difficulties of requiring fishermen to do this work while they are on fishing trips (inshore or distant shore) that earn income. Fishermen from some of these communities are often engaged in long-distance fishing trips, especially during the east monsoon season (Stacey 2007) when the seas are calm and potentially during times when whale sharks are most likely to be present in the area. Consequently, scheduling of monitoring with income-earning activities is an important consideration. Any future work will need to address issues of cultural, and even individual, suitability, as well as dealing with the trade-offs in employing fishermen full-time on whale shark monitoring for short periods (i.e., a few weeks at a time) with the attendant impacts on regular fishing activities.

Our research challenges the commonly-held perception in the conservation literature that the Bajo have only negative environmental impacts through the use of damaging fishing techniques and do not concern themselves with sustainable practices (Lowe 2003, 2006). At least for whale sharks, our work shows that the mobility of this group, their knowledge,

beliefs and conservation-orientated ethic could be of value to the management of this migratory species. There are culturally-driven prohibitions on the exploitation of whale sharks among the Bajo, who are one of the most widespread maritime-adapted ethnic groups in eastern Indonesia. Bajo world views and beliefs about whale sharks broadly align with conservation goals, which is not always the case as TEK can sometimes conflict with conservation of a species (Shackeroff and Campbell 2007). These cultural constraints could be encouraged through development of economic incentives, including paid involvement in activities such as whale shark photo-identification and environmental monitoring. The former could provide a cost-effective means of helping to further investigate the links between whale sharks visiting Western Australia and those found moving seasonally through eastern Indonesia (and Timor Leste) using whale shark photo-identification techniques and database searches. Engaging the fishers in the conservation and protection of whale sharks could have added pay-offs in developing supplementary income opportunities for Bajo and other fishers who have operated in the now disrupted traditional Indonesian fishery of the Timor Sea (Stacey 2007).

Examples of ecotourism based on whale sharks or other mega-fauna from other parts of the world suggest that consideration of any such venture should proceed with caution and consider the broader social, cultural, economic and political context in which they may operate (Campbell 2010). Just as there are culturally driven prohibitions on whale shark exploitation, there may be community cultural beliefs that do not align with ecotourism interests (such as inappropriate tourist apparel and behaviour, or the creation of community dependence on the enterprise to the detriment of other livelihood strategies) (Cárdenas-Torres et al. 2007). It is necessary to determine if real benefits will flow to local communities and whether these benefits are distributed equitably (Bookbinder et al. 1998; Diaz-Amador 2005; Quiros 2005; Cárdenas-Torres et al. 2007). Community dependence on tourism activities may be risky as the number of visitors can also be affected by factors outside the control of the industry (Cárdenas-Torres et al. 2007), such as political instability. Finally, others researchers argue that the evidence is slim with regard to the contribution or add-on benefits of ecotourism to the conservation agenda (Ballantyne et al. 2009; Meletis and Harrison 2010). Such ventures could cause harm or disturbance to whale sharks and their habitats (Diaz-Amador 2005; Quiros 2005, 2007).

Biologists and marine scientists argue that multiple approaches are critical for the conservation of whale sharks through determining migratory pathways by satellite tagging, international collaboration for management across political boundaries and monitoring of population abundance using capture-mark-recapture at aggregation sites (Fowler 2000; Speed et al. 2007; Bradshaw et al. 2008). Our study shows that research involving both social and natural science knowledge (Drew and Henne 2006; Fraser et al. 2006) is another tool that could be used to better equip managers to develop appropriate conservation strategies. As well as international instruments

to promote multilateral management and conservation of the species, ultimately, the best outcomes for the preservation of migratory megafauna such as whale sharks in this region of Indonesia will be achieved through a combination of western science, traditional ecological knowledge, community-based monitoring and small-scale ecotourism businesses that provide real economic and social benefits to local peoples.

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### Notes

1. Traditional ecological knowledge (TEK) is commonly referred to in the literature by a multitude of terms such as indigenous knowledge, indigenous ecological knowledge, traditional knowledge, local ecological knowledge or traditional environmental knowledge (see for example, Agrawal 1995; Berkes 1999; Ellen and Harris 2003; Heckler 2009).
2. We have not adopted the term 'local knowledge' as this tends to lack historical continuity and a sense of cultural transmission (Berkes 1999) among other issues [see Heckler (2009) for a discussion of these].
3. In this paper, we prefer to use the term 'Bajo' rather than 'Bajau' or 'Sama' as it is still the more commonly used exonym for Sama-speaking peoples in eastern Indonesia, in particular, in Sulawesi and East Nusa Tenggara provinces.
4. See also the recent article in *The Guardian* newspaper (<http://www.guardian.co.uk/environment/2010/sep/18/last-sea-nomads>) where the Bajo are blamed for negative ecological impact on coral reefs in Indonesia through destructive fishing technologies.

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