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Contextualising the coupled socio-ecological conditions of marine megafauna bycatch

Louise S.L. Teh [a, 1], Lydia C.L. Teh [a, *, 1], Ellen Hines [b], Chalatip Junchompoo [c], Rebecca L. Lewison [d]

[a] Fisheries Centre, University of British Columbia, 2202 Main Mall, Vancouver, British Columbia, V6T 1Z4, Canada
[b] Marine & Coastal Conservation and Spatial Planning Lab, Romberg Tiburon Center for Environmental Studies, Tiburon, CA 94920, USA
[c] Eastern Marine and Coastal Resources Research Center, Department of Marine and Coastal Resources, Rayong 21170, Thailand
[d] Department of Biology, San Diego State University, San Diego, CA 92182-4614, USA

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ABSTRACT

We apply an integrated and interdisciplinary conceptual framework to assess the potential for uptake of bycatch reduction measures by small-scale fisheries along the Andaman coast and eastern Gulf of Thailand, and in Sabah, Malaysia. Specifically, we characterize the current governance, socio-economic, ecological, and scientific context for marine megafauna bycatch, and identify the enabling and limiting factors to bycatch reduction at each location. Enabling factors are those that motivate or facilitate conservation actions among resource users, managers, and other stakeholders, while limiting factors are those that act as barriers to conservation. We conduct a comparative analysis of the strength of enabling and limiting factors at the two study locations by using a qualitative scoring system. Overall, conditions in Thailand appear to be relatively more supportive of bycatch reduction than Sabah. Many enabling factors, such as community based marine management and positive attitudes towards conservation, occur at the local scale, suggesting potential marine megafauna bycatch reduction approaches can be implemented successfully from the bottom-up. We show that intervention points for reducing marine megafauna bycatch lie within a much broader realm than conventionally considered in bycatch reduction schemes. Effective policies for reducing marine megafauna bycatch thus have to address multifaceted drivers of small-scale fishing behaviour in addition to ecological considerations.

1. Introduction

Bycatch of marine megafauna, large marine species such as marine mammals, sharks, and marine turtles, has been identified as a global conservation concern that needs to be addressed urgently because it threatens the viability of already depleted populations (Lewison et al., 2004, 2014; Peckham et al., 2007; Read, 2008; Mangel et al., 2010). Beyond the negative impact on population viability, declines in marine megafauna populations can also have cascading effects on marine ecosystems, and ultimately affect ecological and biogeochemical processes (Estes et al., 2011).

Directing conservation resources to megafauna bycatch hotspots is hampered by the scarcity of bycatch data. This is especially pronounced in areas with large coastal and small-scale fisheries, which tend to be minimally regulated and monitored in most places, particularly in developing countries. Not surprisingly, incidental megafauna catch by small-scale fisheries has been identified as a threat to coastal megafauna populations (D'Agrosa et al., 2000; Peckham et al., 2007; Gilman et al., 2010; Moore et al., 2010). Encounters between marine megafauna and small-scale fisheries arise due to spatial overlap between inshore fishing grounds and the coastal habitats and movement patterns of certain marine megafauna, particularly those that nest on land or reside in coastal waters. The vast number of small-scale fishers, who account for over 90% of all fishers worldwide (Béné, 2005) increases the likelihood of incidental encounters.

While successful marine megafauna bycatch mitigation efforts have been documented (e.g., reductions in marine turtle and shark captures in the Hawaii longline swordfish fishery (Gilman et al.,

* Corresponding author.
E-mail addresses: l.teh@fisheries.ubc.ca (L.S.L. Teh), lydia.teh@fisheries.ubc.ca (L.C.L. Teh), ehines@sfsu.edu (E. Hines), junchompoo@yahoo.com (C. Junchompoo), rlewision@mail.sdsu.edu (R.L. Lewison).
[1] Authors listed in alphabetical order.

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2007)), and protective legislation has been enacted in some countries (e.g., Moore et al., 2009; Allen et al., 2014), the problem of megafauna bycatch remains a particularly pressing one worldwide, and one which occurs under a cascading hierarchy of scales. It is an international and transboundary conservation issue due to the large spatial distribution and movement of marine megafauna such as turtles, whales, and sharks. At the same time, bycatch reduction is also ultimately a site specific problem which requires understanding how and why interactions between marine megafauna and humans occur. Thus, addressing marine megafauna bycatch involves asking questions about a specific place, which makes generalised approaches difficult. Rather, to address it we have to delve from the international scale to progressively finer regional, national, and community scales to tackle the problem locally.

To date, many megafauna bycatch reduction initiatives have tended to be sectoral in approach, i.e., addressing the problem as primarily an ecological one. The shortfall of this approach is that it does not provide an integrated perspective for addressing the multiple socio-economic, human, biological, and political drivers which influence fisheries and bycatch interactions at different scales. This is a particular problem for small-scale fisheries, which are highly context specific and challenging to manage (Brewer, 2013).

Recent research on small-scale fisheries has identified many factors that influence fishing pressure, and by extension megafauna bycatch, across a range of spatial hierarchies from regional, national, to local scales (Andrew et al., 2007). At the regional level, international trade and demand for certain marine animals and products have led to the depletion of vulnerable species such as humphead wrasse, sea cucumbers, and sharks (Clarke et al., 2013; Purcell et al., 2013; Sadovy de Mitcheson et al., 2013). At the national and community level, the prevailing socio-economic and governance environment may lead to marginalisation of fishing communities (Pauly, 1997), which can eventually result in Malthusian overfishing (Pauly, 1990). Other local socio-economic factors such as market access and population density have been associated with high fishing pressure and degraded environmental conditions (Brewer et al., 2012; Muallil et al., 2013). The type of alternative livelihoods available, fishers' demographics, e.g., age and fisher perception and motivations have also been identified as important local factors that influence fishing pressure in small-scale fisheries (Daw et al., 2012; Muallil et al., 2013).

Effective progress towards bycatch reduction necessitates contextualising the socio-ecological conditions under which small-scale fisheries and associated bycatch occur (Lewison et al., 2011; Senko et al., 2014), a task that requires bridging research perspectives from different disciplinary fields (Cinner, 2014). Although changes to fishing gear and practices can yield bycatch reduction in the short term, the long term efficacy of these single sectoral approaches are limited (Campbell and Cornwell, 2008).

We present an application of an integrated and interdisciplinary conceptual framework for marine megafauna bycatch reduction, first proposed by Lewison et al. (2011) (Fig. 1). We configure this framework to assess the potential for uptake of bycatch reduction measures for two coastal areas where small-scale fisheries are prevalent: The Andaman and eastern Gulf coasts of Thailand, and in Sabah, Malaysia. Our goal is to demonstrate how adopting a multisectoral approach, one that recognises interconnectedness and feedback loops among components, can help to identify entry points for addressing megafauna bycatch reduction. Using a case study approach, we conduct a comparative analysis of Thailand and Sabah with the specific objectives of: 1) characterizing the current legislative, socio-economic, and ecological context for marine megafauna bycatch at each location; and 2) identifying and quantifying enabling and limiting factors to marine megafauna bycatch reduction at each location.

Fig. 1. An integrated conceptual framework for bycatch reduction, showing interconnectedness among components. Figure is redrawn from Lewison et al. (2011).

2. Methods

2.1. Marine megafauna

The marine megafauna we focus on in this study include small cetaceans (dolphins and porpoises), dugongs, and turtles, as these are common bycatch species in the chosen case study sites. Among the marine megafauna found in Thailand and Sabah, the Irrawaddy dolphin (*Orcaella brevirostris*), Indo-Pacific finless porpoise (*Neophocaena phocaenoides)*, dugong (*Dugong dugon*), leatherback turtle (*Dermochelys coriacea*), and olive ridley turtle (*Lepidochelys olivacea*) are listed as 'Vulnerable' on the IUCN (International Conservation Union) Red List, while green turtles (*Chelonia mydas*) are listed as 'Endangered', and the hawksbill turtle (*Eretmochelys imbricata*) is 'Critically Endangered'. The Indo-Pacific humpback dolphin (*Sousa chinensis)* is classified as 'Near Threatened', spinner dolphins (*Stenella longirostris*) are 'Data deficient', and only the pantropical spotted dolphin (*Stenella attenuata*) has a status of "Least Concern" (IUCN, 2014). The Irrawaddy dolphin, Indo-Pacific humpback dolphin, Indo-Pacific finless porpoise, dugong, green turtle, hawksbill turtle, and olive ridley turtle are listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Species listed in Appendix I are considered to be the most threatened with extinction among CITES listed species, and international trade in these species is prohibited except for scientific purposes (CITES, 2015).

2.2. Study sites

2.2.1. Thailand

Study areas in Thailand include: i) six coastal provinces along the Andaman Coast of western Thailand, where dugong surveys and interviews with villagers have been conducted (Hines et al., 2005); and ii) Trat Province along the eastern Gulf coast of Thailand, where population studies of marine mammals are ongoing (Fig. 2). In this paper, 'Thailand' refers generally to the two study areas, unless where the specific study area is mentioned.

Bycatch in Thai waters is one of the major threats to all three types of megafauna considered in this study. Dugongs used to be regularly sighted along the Andaman Sea and Gulf of Thailand coasts,

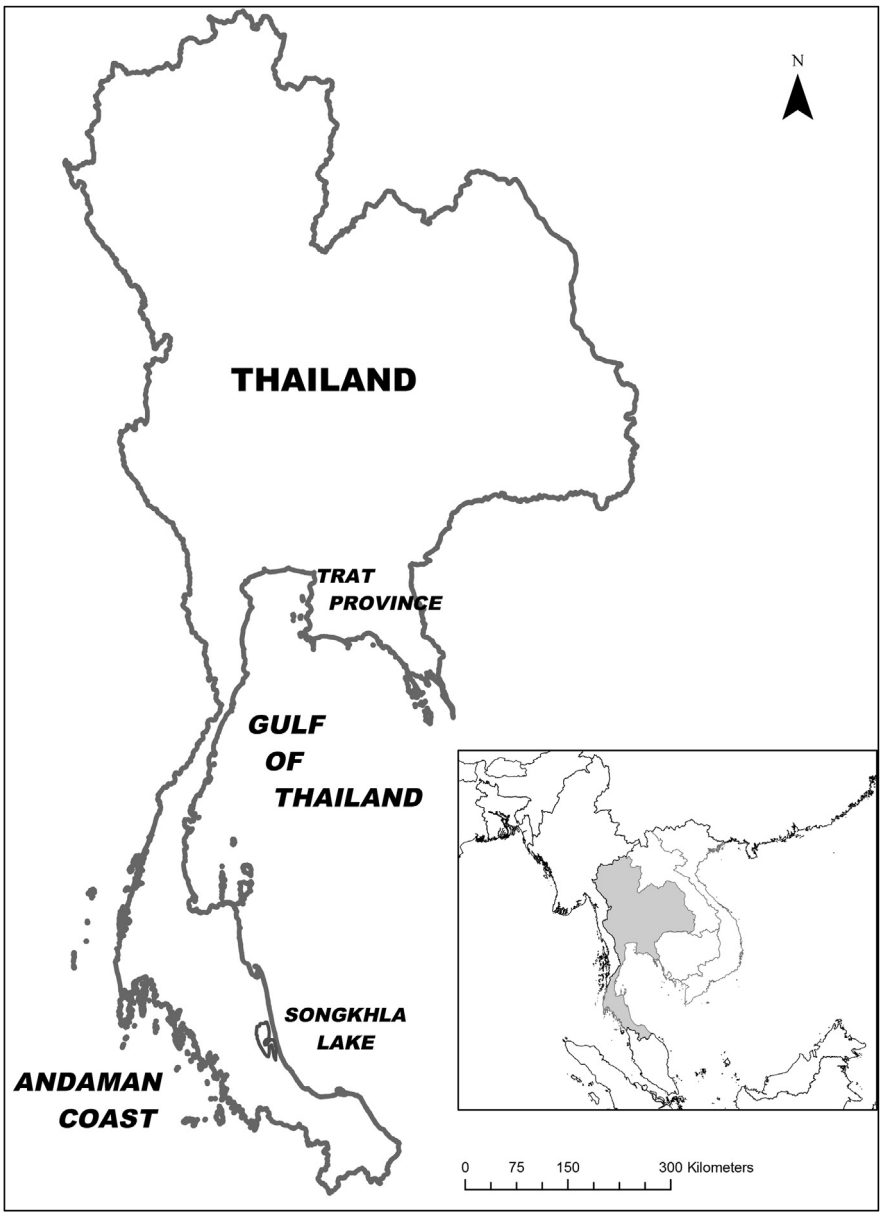

Fig. 2. Map of Thailand showing the Andaman and eastern Gulf coasts of Thailand. Map created by E. Hines.

but are now mainly confined to isolated population groups off the Andaman Sea (Hines et al., 2005). According to Hines et al. (2005), an estimated 200 dugongs were living in the Andaman Sea area around the early-2000s. Dugongs are at risk of being incidentally caught in fishing nets, especially those of large-scale commercial trawlers that encroach into shallow coastal waters and damage the seafloor habitat used by the animals. It is believed that there has been little dugong hunting since the introduction of the Fisheries Act B.E. 2490 (1947) (Adulyanukosol and Poovachiranon, 2006).

Dolphin mortality from fisheries in Thailand tends to be from accidental capture, as targeted killing of dolphins is not believed to have occurred for over 50 years (Adulyanukosol, 1999; Hines et al., 2005). Entanglement in gillnets is the primary threat to Irrawaddy dolphins throughout most of its range (Smith et al., 2007), and populations living in the Songkhla area of Thailand are identified as being among those most at risk (Consortium for Wildlife Bycatch Reduction, 2014). Interviews conducted along the eastern Gulf of Thailand between 2003 and 2014 indicate that the number of dolphins caught in nets was higher than sustainable relative to abundance estimates (Hines et al., 2013, 2014). Interviews in Trat province indicated the occurrence of dolphin bycatch by the following gears: commercial trawl boats, commercial floating seine boats, gillnets (crab, shrimp, and fish), ropes connecting fishing gears to buoys, and ropes of octopus traps (Hines et al., 2013). Similarly, the largest source of human-caused mortality of Indo-Pacific dolphins in Thailand is from accidental capture in gillnets and stake traps (Jaroensutasinee et al., 2010).

Bycatch is a serious concern for marine turtles due to intense fishing activity in the Gulf of Thailand, where trawling, drift gillnets and long-line hooks present the greatest threats to turtles (Chantrapornsyl, 1993). Further, turtle bycatch also occur in artisanal fisheries, where juvenile turtles are caught in squid or fish traps (Tsaros and Aureggi, 2007). In addition to the pressure they face from accidental capture, marine turtle populations in Thailand are also threatened by egg poaching, tourism development, and fisheries (Aureggi, 2009), while in the past, they were heavily

exploited for their eggs, meat, shells, and skin (Chantrapornsyl, 1993). Consequently, population levels of all marine turtle species in Thailand are substantially reduced from the past (Settle, 1995). On the positive side, one long term monitoring project in south Thailand showed a stable trend in nesting turtle numbers over 13 years, and community education had almost reduced all incidences of egg poaching (Aureggi, 2009), although it is not clear whether this is applicable to all areas of Thailand.

2.2.2. Sabah, Malaysia

Sabah is a Malaysian state situated on the northeast portion of Borneo Island (Fig. 3). The two study sites in Sabah are Pulau Banggi in north Sabah, and the Semporna islands off the southeastern coast of the state. Similar to Thailand, marine megafauna populations in Sabah have declined from the past, and incidental capture in fisheries is among the main threats to dugongs, dolphins, and marine turtles. Marine mammals in Sabah are protected under the federal Fisheries Act 1985 and the International Trade in Endangered Species of 2008 (Act 686), while marine turtles are protected under Sabah's Wildlife Conservation Enactment 1997. Two studies have estimated marine megafauna bycatch levels in Sabah (Jaaman et al., 2009; Pilcher et al., 2008), but are not comparable due to the different study methods that were utilised.

Dugongs used to be common in shallow coastal waters of East Malaysia, which includes the states of Sabah and Sarawak (Pilcher et al., 2008). Current dugong numbers in Sabah are substantially reduced from the past (Rajamani et al., 2006, 2013; Pilcher et al., 2008). Between 1996 and 2001, dugongs were the most commonly recorded marine mammal species to be stranded in the coastal waters of East Malaysia (Jaaman et al., 2009). Dugongs were reportedly hunted in the past, and targeted hunting is potentially occurring to the present time (Jaaman et al., 2008). Dugong parts are still traded in some parts of Sabah for ornamental or medicinal uses (Rajamani et al., 2006).

Based on fisher interviews, a rapid assessment study found that dugong bycatch was relatively rare, and that they were mainly caught by gillnets. All caught dugongs were reportedly released alive (Pilcher et al., 2008). Other threats to dugongs include vessel collisions, disease, destructive fishing, pollution and sedimentation from coastal development and palm oil plantations, and degradation of seagrass beds (Rajamani et al., 2006; Pilcher et al., 2008).

Dolphin mortality from fisheries in Sabah is from incidental capture and targeted hunting. Dolphins are caught incidentally by gillnets and trawlers, with Irrawaddy and Asian bottlenose dolphins (*Tursiops aduncus*) being the most frequently bycaught species in gillnets (Jaaman et al., 2009). The meat of incidentally caught dugongs, Asian bottlenose dolphins, and finless porpoises are typically used for home consumption, trade, or as shark bait. In contrast, almost all fishers who reported bycatch of Indo-Pacific humpback and Irrawaddy dolphins released or discarded the cetaceans. Although decreased since the 1980s, dolphin hunting still occurs in Sabah, particularly in Semporna (Jaaman et al., 2008; Lajiun undated). Spinner dolphins were reportedly the most commonly hunted species, followed by bottlenose and spotted dolphins. In contrast, Irrawaddy and Indo-Pacific humpback dolphins are not targeted by fishers (Jaaman et al., 2008). Similarly, whales are encountered but not hunted in Sabah (Jaaman et al., 2008).

Marine turtles are unintentionally caught in trawl and gill nets or hooked in hook and line operations. Although sightings of marine turtles are common by small-scale fishers in Pulau Banggi and Semporna Islands, accidental capture of these animals is apparently low at the study sites (Teh and Teh, unpublished data). In contrast, commercial shrimp trawl fisheries are thought to contribute to the deaths of 3000 to 4000 marine turtles annually in Sabah from net drownings (Anonymous, 2014). Additional direct threats to marine turtles in Sabah include illegal trade in turtle products, including their eggs and meat, the continued widespread practice of bomb fishing, which destroys coral habitat, and rapid tourism and coastal development (Jolis and Kassem, 2011).

2.3. Data collection and analysis

We first conducted a review of published and grey literature to characterise the extent of marine megafauna bycatch, and the local

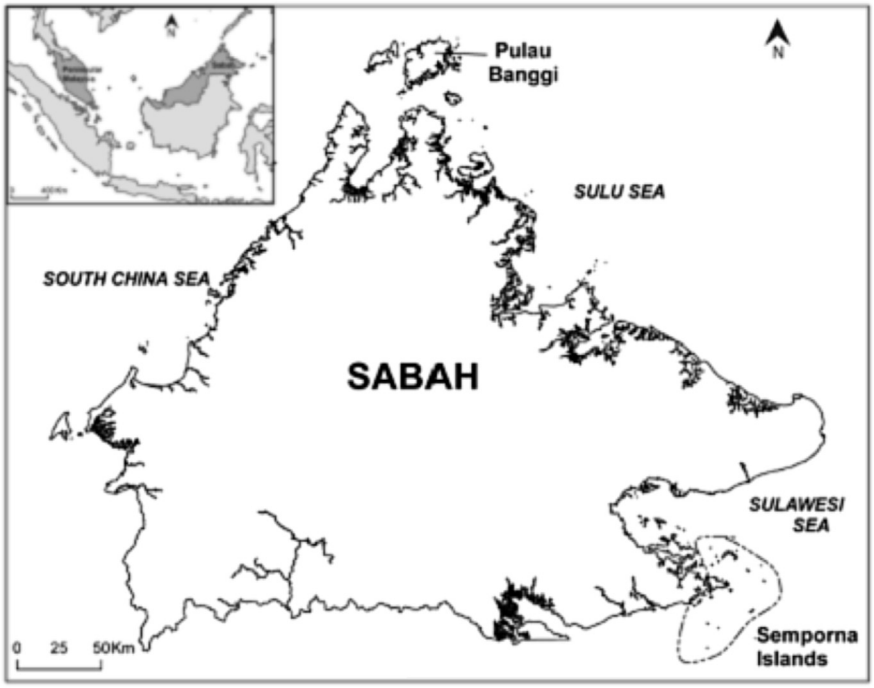

Fig. 3. Map of Sabah showing the study sites of Pulau Banggi and Semporna Islands. The inset map shows Peninsular and East Malaysia, with Sabah located on the north eastern part of Borneo. Source: ESRI World Basemap.

context under which bycatch occurs at each study site. The level of marine megafauna bycatch was assessed qualitatively, as quantitative assessment was not possible due to the absence of data and variable methodologies used to estimate bycatch within and across the two study areas. The frequency of bycatch at each site was categorised as 'low', 'medium', or 'high'. Thailand data were primarily based on studies on the status and distribution of dugongs and dolphins carried out by Hines and colleagues from the Thai Department of Marine and Coastal Resources (DMCR) starting in 2000 (Hines et al., 2009, 2012; 2014). These studies consisted of line transect surveys conducted at sea, as well as interviews with local villagers. Additional unpublished bycatch data used in this study were collected by DMCR (Eastern Centre) staff in Rayong Province, in co-operation with local fishermen networks from 2004 to 2014. The level of bycatch in Sabah was estimated on the basis of a rapid assessment of marine bycatch (Pilcher et al., 2008; Jaaman et al., 2009; Moore et al., 2010), as well as from unpublished interview data on the frequency of small-scale fishers' catch of marine megafauna (Teh and Teh, unpublished data). These interview data were collected while conducting a separate study on marine turtles in the Semporna Islands in May 2014. A total of 60 interviews with small-scale fishers in 3 fishing communities were conducted by LCLT and LSLT. Part of the study questionnaire consisted of questions on the frequency of sightings and bycatch of marine turtles, dolphins, and whales. The responses to these questions were used for this study.

The local context for bycatch reduction was assessed in terms of enabling and limiting situational factors under four categories 1) governance; 2) socio-economics; 3) ecology; and 4) research and education. Enabling factors are those that facilitate or improve opportunities for bycatch reduction, where 'bycatch reduction' behaviour was framed within the broader context of marine conservation oriented behaviour. Limiting factors are those that inhibit or act as a disincentive to engage in such behaviour. The potential for bycatch reduction was inferred by scoring the strength of enabling and limiting factors in Thailand and Sabah. We then conducted a comparative analysis to gain insight on situational factors that encourage or restrain opportunities for reducing bycatch at the study sties.

2.3.1. Identification of enabling and limiting factors

We identified situational factors associated with governance, socio-economic and ecological context, and marine conservation related research and education that are assumed to lead towards (enabling) or away from (limiting) conservation oriented behaviour. The directional effect of situational factors on behaviour was determined based on literature. However, we recognise that in some cases, the relationship between situational factors and behaviour can be ambiguous. As such, by directional effect we do not mean to imply any direct or linear relationship. In the next section we describe the rationale behind the selected enabling and limiting factors, and list the specific factors in Table 1.

2.3.1.1. Governance. The presence of national legislation and policies for protecting marine biodiversity and regulating fisheries bycatch and fishing effort (e.g., marine protected areas, ban on destructive fishing gears, catch restrictions, prohibited sale and trade in endangered species) are essential for providing the legal and institutional framework for undertaking marine megafauna protection. As well, national ratification or participation in regional biodiversity initiatives that address bycatch issues benefits local efforts through the provision of funding or research and monitoring capabilities (e.g., Coral Triangle Initiative). The presence of these legislation, regulations, and management tools were considered to be enabling factors. However, many small-scale fisheries in Thailand and Sabah remain essentially open access, which was considered to be a limiting factor. In the past two decades, there has been a general shift away from top-down fisheries management to a governance model that devolves management to local resource users, i.e., community or co-management arrangements in which resource users and government collaborate to manage marine resource use (Pomeroy, 1995; Cinner et al., 2012).

Implementation of co-management models at the community level was found to be associated with successful fisheries (Gutiérrez et al., 2011). Therefore, the presence of fisheries co-management or aspects related to facilitating the formation of co-management arrangements was viewed as an enabling factor. Despite the existence of rules and regulations, illegal, unreported, and unrecorded (IUU) fishing may still occur due to weak management capacity for monitoring and enforcement. IUU fishing is a worldwide problem. It distorts the level of fishing effort and status of marine resources, thereby inhibiting informed decisions on sustainable fisheries management (Agnew et al., 2009; Österblom et al., 2011). This has negative consequences for marine megafauna, as the likelihood of being caught incidentally increases with the presence of higher, non-detected IUU fishing pressure. The presence of IUU fishing and other non-compliant behaviour, as well as the lack of monitoring and enforcement capacity, were therefore listed as limiting factors.

2.3.1.2. Socio-economic. An important step towards reducing marine megafauna bycatch is to decrease the level of fishing effort. The presence of alternative income sources for fishers, or having a portfolio of livelihood options can help alleviate fishing pressure (Allison and Ellis, 2001). Economic assistance to encourage fishers to switch to bycatch minimising gear, or to engage in non-extractive activities (e.g., tourism) presents incentives for conservation behaviour. Social capital, as defined in this paper, refers to a community's ability to self-organise and collectively implement rules and regulations (Pretty, 2003). The presence of social capital is an important institutional factor at the community level that facilitates management of fisheries resources (Jentoft et al., 1998; Grafton, 2005). We thus consider it to be an enabling factor. Similarly, social norms and peer pressure from community members have been found to encourage compliance with fisheries and other conservation regulations, and are considered enabling factors (Kuperan and Sutinen, 1998; Madrigal et al., 2013).

On the other hand, drivers that motivate increased levels of fishing pressure can be viewed as limiting factors. For instance, fisheries subsidies which encourage increased fishing effort, such as fuel and boat subsidies (Sumaila et al., 2010) are considered to be limiting factors. Other limiting factors include high market demand for, or local use of, marine megafauna (e.g., Robards and Reeves, 2011). The link between high poverty rates, social marginalisation, and overexploitation of marine resources is widely acknowledged (Pauly and Chua, 1988; Béné, 2003; Cinner, 2011). Related to this are social issues such as population growth and the arrival of migrant fishers or illegal coastal settlers, which increase demand and hence, pressure, on marine resources (Teh and Sumaila, 2007; WIOMSA, 2011). In particular, the dependence on fish for income and food security in many poor, rural coastal communities provides another motivation for continued fishing effort (Kronen et al., 2010). The intrusion of commercial fishing vessels into inshore, small-scale fishing grounds has been recorded in Thailand and Sabah (Flaherty and Karnjanakesorn, 1993; Nissapa et al., 2004; Hines et al., 2005; Teh and Sumaila, 2007). The resulting increase in competition for fisheries resources is another driver of fishing effort, and thus a limiting factor.

Factors influencing one's willingness to comply with fisheries regulations or otherwise engage in conservation-oriented behaviour include individuals' perceptions about legitimacy and benefits derived from conservation, morality (personal norms), intrinsic

Table 1
Factors, both enabling and limiting, that characterize the governance, socio-economic, ecological, and research & education context of marine megafauna bycatch.

	Enabling	Limiting
Governance	1. Legislation protecting marine megafauna and their associated habitat 2. Presence and practice of traditional management system and resource use rights 3. Legislation for decentralisation/community management 4. Community based fisheries management 5. Coordination and cooperation between government agencies responsible for marine resource management 6. Participation in regional marine and fisheries conservation initiatives 7. Inter-sectoral management and enforcement of MPAs 8. Presence of non-extractive MPAs	1. Lack of, or ineffective enforcement of conservation and fisheries regulations, e.g., occurrence of IUU fishing, illegal wildlife trade, non-compliance with MPA zones 2. Open access fisheries
Social and Economic	1. Coastal communities have alternate income sources that are not dependent on marine resources 2. Economic incentive or assistance to adopt gears that prevent/minimise bycatch 3. Presence of social capital 4. Sense of stewardship 5. Perceived benefits from conservation 6. Traditional practices or beliefs about not harming marine megafauna	1. Market demand for marine megafauna bycatch 2. Marine megafauna used by coastal communities 3. Presence of capacity enhancing fisheries subsidies 4. Presence of illegal settlers 5. High dependence on fish for food security 6. High poverty rate and marginalisation of fishing communities 7. Conflict between small-scale and commercial fishing 8. Distrust of authorities 9. Presence of high discount rates among fishers
Ecological	1. Local ecological knowledge 2. Minimal overlap in species' spatial distribution and marine resource use patterns 3. Introduction/use of bycatch reduction gear	1. Use of destructive and/or unsustainable fishing techniques
Research and education	1. Conservation awareness about marine conservation and/or marine megafauna 2. Presence and involvement of NGOs, academic institutions and other economic sectors (e.g., tourism) in raising conservation awareness or participating in monitoring and research 3. Presence of marine megafauna stranding network 4. Scientific knowledge of species' distribution, abundance, vulnerability to fishing gears	1. Lack of access and exposure to schools, social media

motivations and attitudes, and emotional or customary beliefs (McClanahan et al., 1997; Neilsen and Mathiesen, 2003; Piovano et al., 2012; Madrigal-Ballestero et al., 2013; Bennett and Dearden, 2014). Time discounting indicates one's willingness to wait for future benefits. Small-scale fishers have been found to have high discount rates (Teh et al., 2014), which have been linked with resource overexploitation (Clark, 1973), and are therefore considered a limiting factor.

2.3.1.3. Ecological. Marine megafauna bycatch can be reduced if there is minimal overlap of their spatial distribution with fishing grounds. Local ecological knowledge was considered an enabling factor because it can play an important role in marine spatial planning by identifying where and when certain species occur (Aswani and Hamilton, 2004; Lauer and Aswani, 2008). The availability of bycatch reduction gears was considered an enabling factor, as was fishers' adaptive capacity to change their fishing behaviour, while unsustainable fishing techniques was a limiting factor because of the potential for harming the megafauna species or their habitat. We note that bio-physical conditions that affect food availability and habitat suitability also influence the distribution of marine megafauna, and hence their chances of being caught by fishing gear (Briscoe et al., 2014). For instance, hunting pressure for dugongs in the Torres Strait (Australia) was correlated with environmental conditions (Kwan et al., 2006). However, due to the ambiguity of this parameter, we have not included it as either a limiting or enabling factor.

2.3.1.4. Research & education. The presence of research and monitoring projects, networks, and/or environmental non-governmental organisations (NGOs) can improve knowledge about megafauna populations and raise the profile of issues related to their management and conservation. Often, NGOs step up to fulfil tasks in which the state or other sectors have been ineffective. This may include conducting research, engaging with policy makers and communities, or monitoring progress and compliance (Genmill and Bamidele-Izu, 2002). These were considered enabling factors for generating knowledge, facilitating policy decisions, and supporting training and awareness geared towards conservation.

2.3.2. Scoring the strength of situational factors

We characterised the situational context (governance, socio-economic, ecological, research and education) for marine megafauna bycatch at each location based on literature and the authors' (LCLT, LSLT, EH, CJ) field experience. This allowed for a qualitative comparison of the relevant enabling and limiting factors outlined in Table 1 for Thailand and Sabah. We then scored the strength of enabling and limiting factors at study sites on a scale from 1 (weak) to 4 (strong). Strength was assessed based on evidence from literature (see Appendix A) and the authors' combined experience interacting with fishing communities at the study sites. For example, in Sabah the level of fisheries and wildlife enforcement tends to be sporadic and limited by manpower and funds. Thus, as an enabling factor 'enforcement level' scores 'weak'; at the same time, the low level of enforcement is scored as being a 'strong' limiting factor for reducing bycatch. Enabling and limiting factor scores were then aggregated and averaged under each of the four broad categories. We gave additional weight to stronger scores on the assumption that all things being equal, the presence of a strong enabling factor at a particular site imparts a positive synergistic effect. Likewise, the presence of a strong limiting factor suggests that greater cumulative effort is required to overcome the barrier compared to a weak limiting factor. Thus, factor scores of three were weighted higher by 25% and factor scores of four were weighted higher by 50%.

3. Results and discussion

3.1. Bycatch level comparison

The qualitative assessment undertaken here suggests that bycatch occurrences may be higher in Thailand compared to Sabah, particularly those of cetaceans, while dugongs are rarely bycaught in Sabah and the Andaman and Gulf coasts of Thailand. Less than 1% of respondents in a rapid assessment of marine mammal bycatch in Sabah stated that they had caught dugongs (Pilcher et al., 2008), while most (88%) fishers in villages along the Andaman coast of Thailand said that dugongs were not caught in fishing nets (Hines and Junchumpoo, unpublished data) (Fig. 4).

Accidental catch of cetaceans was more common in Thailand, where 12% of interviewed fishers along the eastern Gulf of Thailand reported cetaceans as a bycaught species (Hines et al., 2013, 2014). The percentage of fishers who reported cetacean bycatch rose to 30% when both the Andaman Sea and Gulf of Thailand were considered (Hines et al., 2014). Despite dolphins being common in Sabah waters, cetaceans were an uncommon bycaught species (6% of interviewed fishers (Pilcher et al., 2008)), and most fishers claimed to have caught a dolphin only once in their lives. The majority of small-scale fishers interviewed in Semporna said they regularly saw dolphins on their fishing trips (Teh and Teh, unpublished data), yet few were incidentally caught (although dolphins are targeted by a small group of fishers in Semporna), suggesting that gear, spatial use patterns, or ecological conditions in Sabah may play a role in minimizing cetacean bycatch.

Marine turtles were the most common bycaught species in both Sabah and Thailand. Thirty percent of respondents in the eastern Gulf of Thailand reported that marine turtles were the most common bycaught species (DMCR, unpublished data), while 25% of respondents in Sabah reported accidental catch of marine turtles (Pilcher et al., 2008) (Fig. 3). Along the eastern Gulf of Thailand turtle mortality from entanglement with fishing gears is common due to widespread use of bottom gillnets and longlines by artisanal fishers (Chanrachkij et al., 2010). Fishing related mortalities accounted for almost a quarter of all necropsied stranded marine turtles in the past decade (EMCOR, 2015). In Sabah, commercial (large-scale) trawlers are responsible for a high number of marine turtle mortalities every year, in contrast to small-scale fisheries where the incidence of bycaught marine turtles is apparently low.

3.2. Comparison of enabling and limiting factors in Thailand and Sabah, Malaysia

The potential for reducing megafauna bycatch in the future relies on the integration of multiple context-dependent situational factors (detailed in Appendix A). We compared the presence and relative strength of each situational factor, as detailed below and summarised in Table 2.

3.2.1. Governance

Of the eight enabling factors under the governance category, four were present in Thailand and five in Sabah. Overall, the two locations share largely similar governance environments at all scales (Table 2). On the positive side, there are existing legislative frameworks at the national scale for megafauna protection and fisheries regulation in both locations, as well as spatial delineation of inshore fishing grounds. Both Thailand and Malaysia are parties in international initiatives and conventions which aim to protect marine megafauna (e.g., CITES). Importantly, Malaysia is part of the Coral Triangle Initiative, for which improving the status of threatened and endangered marine species is one of its national targets.

However, these legislative instruments are not implemented effectively at state and local levels. Many regulations, such as those pertaining to fisheries and Marine Protected Areas (MPAs), are generally not effectively enforced or implemented. In particular, fisheries remain essentially open access at both locations, and there is poor enforcement of spatial boundaries and fishing gear regulations (Teh and Sumaila, 2007; Bennett and Dearden, 2013). This gives rise to common occurrences of illegal, unrecorded and unreported (IUU) and destructive fishing practices, thereby intensifying the direct threat of fisheries to marine megafauna populations.

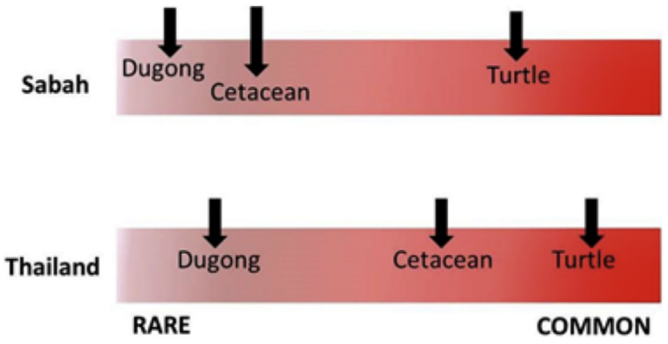

Fig. 4. Relative bycatch level (indicated by arrows) of dugongs, cetaceans, and marine turtles in Sabah and Thailand. Bycatch levels in Thailand are estimated based on Hines et al. (2009, 2013; 2014), while Sabah levels are based on Pilcher et al. (2008), Jaaman et al. (2009), and Moore et al. (2010). Unpublished data from the Thai Department of Marine and Coastal Resources, E. Hines and L. Teh were also used in conducting the bycatch assessment.

The presence of community based management of marine resources is an enabling factor that can potentially mitigate ineffective management by state agencies. Though present at both locations, community based management has a stronger (longer) presence in Thailand relative to Sabah. The Thai government has supported fisheries co-management with local communities since the early 1990s to counter fisheries over-exploitation. In contrast, active participation by Sabah fishing communities in marine resource management only started in the past decade.

3.2.2. Social and economic

Four socio-economic factors were considered to be enabling, while another six were limiting. Three out of four enabling factors were present in both Thailand and Sabah, while almost all limiting factors were present at both locations. The exception was fishers' discount rates, for which there was no study available for Thailand. The three national scale factors (presence of social problems, rural poverty, fisheries subsidies) were all limiting, while all the enabling factors occurred at the local level. In general, Thailand and Sabah have similar national and local level limiting factors which drive fishing pressure.

Capacity enhancing fisheries subsidies are present in both Thailand and Sabah (Appendix A). These subsidies are a limiting factor because they potentially increase fishing effort by reducing the cost of fishing, for instance, through government funded fuel or boat subsidies (Sumaila et al., 2010). Fishing effort is further intensified by the arrival of illegal migrants to coastal villages in both Thailand and Sabah, which increases competition for fisheries resources. For many illegal fishers, their need to make a living, which is exacerbated by a lack of alternative livelihoods, outweighs the low risk of being apprehended by authorities.

The rural poverty rate in Sabah and Thailand is comparatively low relative to developing countries worldwide (60%) (IFAD, 2011), and is lower in Sabah (13% vs. 17% in Thailand) (see Appendix A). Nonetheless, socio-economic dependence on fishing in both Thailand and Sabah is high (Bennett and Dearden, 2014; Teh et al.,

Table 2
Presence of enabling and limiting factors in Thailand and Sabah, and the scale at which they occur. √ = Presence, X = absent or not sufficient, ● = relatively stronger presence or higher degree of factor. Supporting rationale for each factor is provided in Appendix A.

	Enabling (+) or limiting (−) factor	Thailand	Sabah	Scale
GOVERNANCE				
Legislation protecting marine megafauna	+	√	√	National
Spatial zoning for delineation of traditional (small-scale) fishing grounds	+	X	X	National
Effective enforcement of fisheries regulations	+	X	X	State/Province
Effectively managed MPAs for fisheries	+	X	X	State/Province
Effective management of fishing capacity	+	X	X	National State/Province
Presence of community based marine resource management	+	√●	√	Local
Presence of marine conservation NGOs	+	√	√	Local
Inter-sectoral management of marine megafauna issues	+	√	√	Local
Participation in regional marine and fisheries conservation initiatives	+	√	√	National
SOCIAL AND ECONOMIC				
Presence of social problems (illegal migrants, low education, poverty) at coastal communities	−	√	√	National Local
Presence of social capital in marine resource management	+	√	√	Local
Poverty rate	−	●		National State/Province
Perceived benefits from marine tourism sector	+	X	X	Local
Presence of capacity enhancing fisheries subsidies	−	√	√	National
Dependence on fishing for income and food	−	√	√●	Local
Positive attitude towards marine conservation	+	√●	√	Local
High discount rate among fishers	−		√	Local
Legends and/or taboos against using marine megafauna	+	√	√	Local
Local use and market demand for marine megafauna	−	√	√	Local
ECOLOGICAL				
Degradation or loss of coastal habitats used by marine megafauna	−	√	√	State/Province Local
Encounters with megafauna	−	√	√●	Local
Flexibility to change fishing gear (switch to gear that is less likely to catch marine megafauna)	+	**X**	X	Local
Fishers' knowledge of megafauna (spatial distribution/ecology etc.)	+	√	√	Local
RESEARCH AND EDUCATION				
Conservation awareness about marine conservation and/or marine megafauna	+	√●	√	Local
Presence of stranding network	+	√	X	National Local
Existing research on marine megafauna ecology, distribution, bycatch	+	√●	√	National Local

2014), and when compounded by other limiting factors such as low education levels in fishing communities at both locations, can inhibit opportunities for fishers to diversify economically and gain formal employment. Thailand's relatively more advanced tourism development may offer better opportunities for non-marine employment relative to Sabah. On the other hand, many community members do not perceive benefits from the marine tourism sector (Teh and Cabanban, 2007; Bennett and Dearden, 2014).

In general, small-scale fishers in Pulau Banggi and Semporna were found to have high discount rates, which imply an unwillingness to wait for future benefits. This attitude does not reflect an optimistic outlook for fishers' willingness to adopt conservation measures. Moreover, a survey about marine protected area awareness conducted with the general public in Sabah indicated that only 37% of respondents were interested in playing a more active conservation role (Cham, 2012). In comparison, attitudes towards marine conservation are potentially higher in Thai fishing villages, where interviews on both coasts showed that almost all respondents thought that it was important to conserve dugongs (Hines et al., 2005). Local socio-economic conditions in Thailand therefore appear to be more favourable for enabling bycatch reduction.

3.2.3. Ecological

Thailand and Sabah share similar ecological context, although the degree to which the individual factors are present differs. The two limiting factors span in scale from local to state level. These are equally prevalent at both locations, although a global assessment of coral reef status indicated that the level of anthropogenic threats such as coastal development, pollution, and destructive fishing was lower in Thailand than in Malaysia (Wilkinson, 2008). The potential for encounters with marine megafauna may be higher in Sabah as fishers report regular sightings of turtles and dolphins during their fishing trips, while fishers' flexibility to change fishing gear is considered low in both Thailand and Sabah.

Fishers' ability to adapt to change is influenced by a range of socio-economic and cultural variables, including their cognitive maps of marine space, fishing knowledge, family relationships, and access to non-fishing jobs (Teh et al., 2012). In Sabah, a large number of small-scale fishers in Pulau Banggi were inflexible in their ability and willingness to change fishing grounds; this may pose a challenge to potential bycatch reduction measures. Similarly, Bennett and Dearden (2013) found that many coastal villagers felt powerless to do anything about the decline in fisheries resources. Both these examples indicate a general inability to respond to, and overcome future changes, which is not positive for adapting to bycatch reduction measures. Overall, the ecological context for megafauna bycatch reduction seems to be slightly more favourable in Thailand due to a comparatively lower level of anthropogenic pressure.

3.2.4. Research and education

All education and research factors are considered to be enabling. Of these three factors, two span in scale from local to national levels. While all three factors are present in Thailand, only two are relevant to Sabah (there is no established stranding network in Sabah). There is relatively more research on marine megafauna (dolphins and dugongs) as well as application of this scientific knowledge to conservation in Thailand, as evidenced by the development of a stranding network for marine cetaceans. In contrast, the depth of research on marine megafauna and their bycatch is lower in Sabah, whereby knowledge on marine mammal bycatch is largely based on two rapid assessment studies (Jaaman et al., 2009; Pilcher et al., 2008) conducted more than 5 years ago. Encouragingly, the bycatch issue has received recent attention in a study that used habitat modelling to assess bycatch risk for dugongs in Sabah (Briscoe et al., 2014).

Another positive sign for Sabah is that the Sabah Fisheries Department has been directing efforts to introduce the use of turtle exclusion devices aboard trawlers (N. Pilcher, pers comm.). Moreover, in February 2015 state agencies and a NGO held the first awareness training programme for fishers about marine mammal strandings (Anonymous, 2015). Thus, there is progress towards developing greater awareness about marine megafauna in Sabah. Nevertheless, current conservation awareness and existing scientific research on megafauna appear to be stronger in Thailand. This suggests that community education and research about megafauna and marine conservation is generally more developed in Thailand, putting it in a comparatively better position to advance marine megafauna bycatch reduction programmes.

3.3. Potential for bycatch reduction

The aggregated factor strength scores are presented in Fig. 5. Factors that fall in the upper left quadrant can be considered to exert a strong positive effect while those that fall in the lower right quadrant tend to be barriers for bycatch reduction. Research and education factors in Thailand have the highest potential for encouraging bycatch reduction behaviour out of all situational factors in both study sites. None of the situational factors in Sabah are strong drivers for bycatch reduction. Among them, governance factors are most conducive, while ecological factors are least supportive of bycatch reduction in Sabah.

Comparatively stronger enabling factors for governance and research and education situate Thailand in a better position for implementing bycatch reduction measures than Sabah (Fig. 5). Central to an integrated approach to bycatch management is to engage and involve communities from the outset (Lewison et al., 2011). In this aspect, community based fisheries management has a longer history in Thailand – Decentralisation was made into country policy in 1992, and community based management started in 1995 (Mangroves for the Future, 2015). In Trang province, local fishers and villagers have collaborated with government sectors to conserve dugongs and seagrass beds, including collecting scientific information and being involved in the stranding network (Adulyanukosol et al., 2010). However, a top-down management structure was still considered a barrier towards the development of local institutions for managing marine resources in communities along the Andaman Coast (Bennett and Dearden, 2014).

In comparison, community based marine management is just beginning in Sabah. While community based management was included in Malaysia's 9th National Plan (2006–2010), the government has lacked capacity to sufficiently support communities at the local level (Nasuchon and Charles, 2010). Instead, community involvement in marine management in Sabah has mainly been led by NGOs. At the national level, Malaysia is a signatory to the Coral Triangle Initiative (CTI). Addressing fisheries bycatch of threatened and endangered species is one of the actions under the Malaysian CTI Plan of Action (CTI, 2009). Therefore, Malaysia's participation in the CTI provides a platform for pushing the bycatch reduction agenda at the international level. As well, it facilitates the provision of funding and expertise for further research and action on reducing marine megafauna bycatch.

A positive indicator in both Thailand and Sabah is the active presence and involvement of NGOs (albeit stronger in Thailand) in conducting marine conservation and delivering education and awareness programmes (see Appendix A). This can lead to willingness to report marine animal strandings even when there is no established stranding network, as was the case in Pulau Banggi, Sabah (Anonymous, 2009). In addition, tourism resorts in Sabah actively co-operate with NGOs in monitoring turtle landings and nestings. Similarly, tourist resorts in Thailand have been involved in monitoring whale sharks (Theberge and Dearden, 2006). As outlined in Lewison et al.'s (2011) framework, these partnerships underscore the importance of building inter-sectoral co-operation and trust among marine managers, users and scientists.

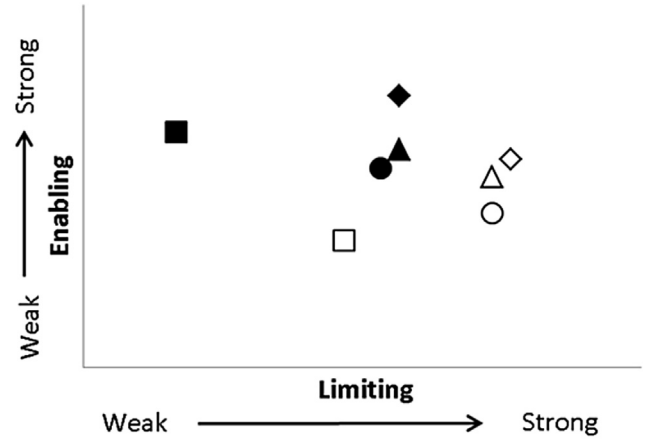

Fig. 5. The strength of situational factors in Thailand (filled shapes) and Sabah (open shapes). ◇ Governance; Δ Socio-economic; ○ Ecological; □ Research and education.

The presence of illegal migrants is a limiting social factor which is not usually considered within the context of bycatch reduction. However, illegal settlers impose additional pressure on already scarce fisheries resources by increasing demand and competition for fish. The subsequent intensification of fishing activity increases the potential for fisheries–megafauna interactions. Migrant fishers, many of whom enter the country illegally, are prevalent along the Andaman Coast as well as throughout Sabah (Corpuz, 2008; Panjarat, 2008; Vignoli et al., 2010). Related to this is the issue of stateless people. In Sabah, the Bajau Laut, a formerly nomadic group of seafaring people, have no Malaysian citizenship. Consequently, they have no access to education or social services that may potentially decrease their reliance on fishing. At the same time, their worldview of conservation is different from conventional western perspective, and they are socially marginalised from local Sabah society as well as from participatory marine conservation planning (Brunt, 2013). Therefore, the potential for Bajau Laut to participate in bycatch reduction is not high. Yet, they have high likelihood of encountering megafauna because they have a history of hunting dolphins, and live on house-boats within the Semporna area (Sather, 1997), which is a turtle migration corridor and hotspot for turtles within Sabah (Jolis and Kassem, 2011). The Moken, a semi-nomadic group who travel along the Andaman coast of Thailand, face similar issues with statelessness, social marginalisation, and inability to access basic social services.

Stakeholders are more likely to support conservation when they perceive benefits from the proposed action. In Thailand, little support was given to a network of MPAs along the Andaman Coast due to the perceived negligible benefits and negative impacts of MPAs on fishing livelihoods, as well as negative perceptions of the MPA governance process (Bennett and Dearden, 2014). Nonetheless, there seemed to be overall more positive attitudes towards conservation in Thai study sites compared to Sabah. For example, more than half of Thai respondents had positive attitudes towards the need to conserve dolphins along the Gulf coast of Thailand (Hines et al., 2014). In contrast, in Sabah only about one-third of survey participants[2] indicated interest in being involved in

[2] Survey respondents included members from the private and public sector, and the general public.

conservation (Cham 2013). This difference could be partly driven by the longer period that Thai respondents had been interacting with researchers and NGOs, which can lead to an increased awareness of the need for conservation. Another factor could be the different worldview held by different ethnic groups towards conservation. For instance, many Muslim fishers in Sabah have faith that God will provide for them, hence do not worry about the future state of the environment (Teh and Teh, unpublished data).

4. Conclusion

This paper applies Lewison et al.'s (2011) integrated and interdisciplinary conceptual framework for bycatch reduction to Thailand and Sabah to assess the potential for uptake of conservation measures by small-scale fishers. This differs from how the global issue of marine megafauna bycatch has largely been approached, i.e., as an ecological problem. However, empirical data from areas where megafauna bycatch and small-scale fisheries overlap highlights the complex, multi-dimensional context for effective megafauna bycatch reduction, and a need for direct understanding and integration of social, cultural, ecological and governance elements (Whitty, 2015).

Our analysis shows that enabling factors for reducing marine megafauna bycatch in small-scale fisheries are present in both Sabah and the Andaman and eastern Gulf coasts of Thailand. Many enabling factors occur at the local scale, suggesting potential marine megafauna bycatch reduction approaches can be implemented successfully from the bottom-up. We show that intervention points for reducing marine megafauna bycatch lie within a much broader realm than conventionally considered in bycatch reduction schemes. As such, bycatch reduction becomes not only a fisheries problem, but also a trigger to tackle underlying socio-cultural, economic, governance, and environmental issues affecting coastal communities. Effective policies for reducing marine megafauna bycatch have to therefore simultaneously address the multifaceted drivers of small-scale fishing behaviour, such as maintaining access to fisheries for food security and livelihoods. Lastly, our analysis highlights that there is much scope for improvement in all aspects of governance, socio-economics, ecology, human perspectives, and scientific knowledge in both Thailand and Sabah to move towards a position that is more supportive of marine megafauna bycatch reduction.

Acknowledgements

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Appendix A. Summary of ecological, socio-economic, and governance context relevant to fisheries conservation and marine megafauna bycatch reduction in Thailand and Sabah.

Governance	Thailand	Sabah
Spatial zoning (delineated traditional fishing zone)	**Yes** (up to 3 km from shore) In 2011 10 out of 22 coastal provinces expanded their conservation zone to 5.4 km (OECD, 2013). As well, in Trat Province, the local municipality and DOF are holding a public hearing for closing Trat Bay during the mackerel season.	**Yes** (up to 5 nm from shore)
Enforcement of spatial fishing regulations	**No** - Restrictions on small-scale fishing within marine national parks have never been enforced (Lunn and Dearden, 2006). - Some local communities have taken enforcement responsibility upon themselves (Johnson, 2001).	**Partly** - Inshore fishing areas are not enforced at the state level, leading to an essentially open access situation. - Some communities (Kudat) have been enforcing their own fishing grounds. - Sabah Parks and other NGOs e.g. Reef Guardian enforce marine reserve boundaries.
Presence of unlicensed/illegal fishing	**Yes** - IUU fishing by Thai vessels in neighbouring countries occurs regularly (Sea Resources Management, 2008). Illegal fishing by local Thai commercial trawlers in the inshore area also leads to conflict with the small-scale fishers (Nissapa et al., 2004; Nasuchon and Charles, 2010).	**Yes** - Illegal poaching inside no-take reserves by locals as well as foreign vessels (Teh and Teh, 2009). - Large population of unlicensed fishermen (Biusing, 2001; Corpuz, 2008; Teh et al., 2009).
Legislation protecting marine megafauna	**Yes** i) Federal Fisheries Act BE 2490 (1994). Prohibits any type of fisheries for turtles & tortoises or their eggs, sea cow, coral, and porpoises; ii) Wildlife Conservation and Protection Act 1992; iii) National Park Act 1961	**Yes** Federal: i) Wildlife Conservation Act 2010; ii) Fisheries Act 1985; iii) Fisheries Regulations 1999; iv) National Parks Act 1980 State: i) Sabah Wildlife Conservation Enactment 1997; ii) Sabah Biodiversity Enactment 2000; iii) Parks Enactment 1984
Effectiveness of fisheries management	**Weak** (Panjarat, 2008; Pitcher et al., 2009) - Thailand marine waters are overfished; the total marine annual catch is double the estimated maximum sustainable yield (Henocque and Tandavanitj, 2011). - Overcapacity still a problem (Morgan et al., 2007; Salayo et al., 2008; Funge-Smith et al., 2012), especially for small-scale fisheries (Pomeroy, 2012) - Presence of IUU fishing – Thai vessels fishing outside EEz and IUU fishing within Thailand (trawlers operating near	**Moderately weak** (Saad et al., 2013) - Regular incidences of blast fishing and high presence of IUU fishing indicate weak enforcement of fisheries regulations. - Similar to the Southeast Asia region, - overcapacity remains a problem, especially for small-scale fisheries (Morgan et al., 2007; Funge-Smith et al., 2012; Pomeroy, 2012) - Declining catch rates (SEAFDEC, 2012; Teh and Sumaila, 2007) indicate that fisheries management has not been effective.

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Governance	Thailand	Sabah
	shore – conflict with small-scale fishers. Lack of government control over Thai fishing fleet outside EEZ (IUU) (De Young, 2006) - Poor fishing practices and overexploited fisheries still a problem (SEAFDEC, 2012; OECD, 2013) - DOF had development agenda, not conservation/sustainable use (although national legislation has/is being? Updated to be consistent with sustainable fisheries principles). - Motion to amend Fisheries Act to include string resource based management is opposed by industries (Komatsu, 2013) - State lacks capacity to monitor and enforce fisheries regulations (Johnson, 1998). Interviews with fishers along the Andaman Coast indicated that lack of monitoring capacity by the Department of Fisheries (staff and boats), lack of political will, and corruption contributed to the ongoing intrusion of commercial fishing vessels into inshore waters (Bennett and Dearden, 2014).	- Lack of clear vision and direction for conservation and sustainable use of biodiversity. - Fisheries emphasis is still on maximising production based on maximum sustainable yield (MSY). - Ad hoc decisions made on licensing and resource allocation; there is a need for a masterplan (Saad et al., 2013) - Malaysia has an adequate leg al framework to support fisheries management (De Young, 2006). However, the main challenge is that there is no single government body that has sole responsibility for management of the coastal and marine realm (Saad et al., 2013). There is a lack of encompassing legislation that sets clear rules for conservation and sustainable use of biodiversity. Currently several laws are enforced sectorally, leading to conflict, overlaps, and gap in implementation. - In Sabah 3 agencies split up duties for management and conservation of marine resources and biodiversity: a) Sabah Parks has custodial duty, and carries out management and conservation of national parks (both marine and terrestrial); b) Sabah Wildlife Department is in charge of wildlife beyond park boundaries, including marine turtles; c) The main focus of Sabah Department of Fisheries is on fisheries production and conservation. It also deals with the conservation and management of selected cetaceans, elasmobranchs and marine reptiles in Sabah waters (Saad et al., 2013). - Authorities tend to be lenient with fishermen caught hunting marine mammals or possessing meat or parts of marine mammals (Jaaman et al., 2008).
Presence of multiple use MPAs	Good coverage (>12% of marine and coastal areas protected) but restrictive in terms of multiple use to accommodate local communities. See IUCN 2013 report for evaluation of management effectiveness of Thailand's marine and coastal protected areas	Existing marine parks are mainly managed for tourism and do not allow multiple use (except for a small fishing area in Tun Sakaran Park)
Presence of traditional/customary marine management systems	No evidence found	No evidence for marine, although there is a traditional system for freshwater fisheries. - A leader in one coastal village has set up *adat* (traditional) rules that are recognized by the Native Courts (Vaz, 2012, p.78).
Presence of community based fisheries management	**Yes, widespread** - Fisheries co-management with local communities has been supported by the Thai government since the early 1990s to counter the problem of fisheries over-exploitation. - The large scale Coastal Habitats and Resources Management (CHARM) project (2002–2007) introduced fisheries co-management in six provinces on both the Andaman and Gulf of Thailand coasts in southern Thailand. - Positive: Formal adoption of community based fisheries management approach by government – DOF set up CBFM project. Previously Fisheries Act did not have provisions that empower local government nor support public participation in fisheries resource management. It did not support a system of fishing rights. - Constitutional changes in 2007 resulted in more emphasis put on participation of local authorities and stakeholders in establishing and implementing fisheries policies.	**Yes, limited** - Starting up in Kudat/Banggi and Semporna areas[1]. - In multi-use Tun Sakaran Marine Park, Sabah Parks and a local NGO engaged with local communities to develop alternative livelihood programmes for fishing households, but local communities do not make decisions or take part in the actual management process. - In Banggi, the Maliangin Island Community Association (MICA) is a relatively new registered society comprised of local villagers who actively take part in fisheries enforcement and participate in meetings with government agencies and NGOs regarding fisheries management. - In Kudat, two villages have set up monitoring systems to prevent encroachers into traditional fishing grounds and to prevent bomb and cyanide fishing (Vaz, 2012 p.78) - 85% of respondents support partnership between government and fishing community to enforce fishery rules and regulations (Vaz, 2012 p. 78) - There is ongoing work by WWF to work with communities to engage in developing local conservation enterprise, and undertaking collaborative monitoring and enforcement of fisheries[2].
How developed/mature is community based management?	**Established** - Decentralisation was made into country policy in 1992, and community-based fisheries management started in 1995. - Constitutional changes in 2007 resulted in more emphasis on participation of local authorities and stakeholders in establishing and implementing fisheries policies. - Fisher groups have been effective at solving issues related to fishing grounds and gear use. At Bang Saphan Bay, 9 fishers' groups were formed to manage fisheries resources. Fishers resolved fishing ground conflict between different user groups, and jointly agreed to ban certain gears (Nasuchon and Charles, 2010). - In Phang Nga Bay, community based management was successful in reducing social conflicts between push nets and gill net fishers. Village committees regularly take part in	**Initial phase** Overall Malaysia is slow in developing community-based fisheries management. Although community-based management was included in the 9th National Plan, the government has lacked capacity to sufficiently support communities at the local level (Nasuchon and Charles, 2010). Therefore, community based management has a relatively recent history in Sabah. - Tun Sakaran Marine Park (TSMP), gazetted in 2004, was the first marine park established in Sabah where resource users live within park boundaries. The Marine Conservation Society and Sabah parks engaged with local communities to develop alternative livelihood programmes, but local communities do not make decisions or take part in the actual management process. Further, the Bajau Laut, a semi-nomadic maritime

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Governance	Thailand	Sabah
	meetings to discuss and monitor management activities with DoF[3].	group of people who have traditionally lived and fished in the TSMP area, were not meaningfully involved in the stakeholder participatory process (Brunt, 2013). - At Tun Mustapha Park, which is in the process of being gazetted, the WWF has been actively working with fishing communities since 2007. Activities include developing handicrafts as additional income and training youth in conservation, e.g. to conduct reef check surveys and monitor fish catches. The fishing community is formally represented by a registered society known as MICA. MICA jointly decided with WWF on the zoning of a no-take marine sanctuary. Enforcement of the no-take zone is carried out by local villagers who have been trained as Honorary Wildlife Wardens by Sabah Wildlife Department and Sabah Parks (Teh and Teh, pers. obs.)
Presence of NGOs for marine conservation, education and scientific research	**Yes** - Fisheries and coastal community based management projects are mainly supported by NGOs, especially in southern Thailand (Toksrina et al., 1998). - WWF - Wild Animal Rescue Foundation of Thailand (sea turtle and dugong conservation project) - CORE Sea (Marine conservation and research association) - Naucrates Sea Turtle Conservation Project - Yadfon (grassroots organisation, small-scale fishery)	**Yes** - WWF has largest presence in marine conservation - Marine Conservation Society - Reef Guardian (local conservation organisation that manages the Sugud Islands Marine Conservation Area) - Marine Research Foundation - Local youth groups have branched out from NGOs, e.g. Banggi Youth Club, Green Semporna Youth Club
Participation in, and funding from large regional marine and fisheries conservation initiatives	**Yes** - Mangroves for the Future - European Union funded CHARM	**Yes** - Coral Triangle Initiative
Social-economic		
Social problems and issues facing fishing communities	**Many social issues** - Low education level locks fishers into fishing - Spatial conflict between small-scale and commercial fishers - Large proportion of commercial vessels are crewed by illegal migrant fishers who work under substandard conditions	**Many social issues** - Poverty and substandard living standards in water villages (lack of basic sanitary facilities) - Low literacy rates among fishers - Illegal migrants from southern Philippines and Indonesia exert additional pressure on local fisheries and coastal resources as many of these migrants engage in small-scale fishing as well as work as crew on commercial vessels.
Presence of social capital (examples of self-organisation)	**Yes** - Fishers have established volunteer networks for monitoring, controlling, and reporting illegal fisheries (OECD, 2010) - Since 1990s fishing communities throughout southern Thailand have been implementing community based management of their own (Johnson, 2001). - In Trang province, fishers work with government officers to protect seagrass beds from illegal fishing.	**Yes** - At least 3 villages in Pulau Banggi have taken the initiative to protect their village fishing grounds (Teh et al., 2014)
Poverty line income	USD 190–237 per household in Trat Province (2008)[4].	USD 230 (RM808 @RM3.52/USD) per household in Sabah (2009)
Poverty rate	16.7% (2011) - % of rural population below poverty line (World Bank, 2014).	12.7% (2012) Incidence of rural poverty in Sabah (Department of Statistics, (2012)).
Access to credit (by fishing communities)	**Moderate** - Loans obtained from middleman, bank, or village fund - Majority of villagers (77% of interviewees) borrow to meet daily expenses (Vignoli et al., 2010).	**Low, need to rely on informal sources** - Island communities lack access to banks - Credit generally obtained from fish buyer
Tourism as alternative employment	**Moderate prospects** - Fishers did not perceive benefits from tourism arising from the placement of MPAs near their communities (Bennett and Dearden, 2013).	**Poor to moderate prospects** - In the Semporna Islands Priority Conservation Area where there is a high concentration of dive resorts, 27% of fisher respondents indicated that at least one person in the household was employed as a resort worker (Teh and Teh, 2014). - Majority (>60%) of those employed at resorts were in low paying wage jobs such as housekeeping and landscaping. None were in managerial positions. - Access to tourism jobs is restricted by many fishers' non-resident status, which prevents them from gaining legal employment. Tourism employment prospects are further hampered by fishers' poor skills level (e.g., in language, customer service, administration).
Dependence on fishing income (Fishing income as % of total income OR % of fishers with alternate jobs)	**High** - Small-scale fishing communities are highly dependent on local fisheries resources (Boonchuwongse and Dechboon, 2003; Panjarat, 2008; Bennett and Dearden, 2014). - About 34% of fishers have other jobs, mostly in agriculture or small retail businesses (Panjarat, 2008).	**High** - Fishing is the main source of income for small-scale fishers in coastal villages (Teh et al., 2014). - Majority of fishers in Pulau Banggi, Sabah had no other employment in 2004. Since 2009 a growing number of fishers are working part-time in recently developed oil palm and rubber plantations on the island (Teh, pers. obs.).
Fisheries subsidies	**Yes** Total estimated fisheries subsidies of USD 553 million for 2003. Capacity enhancing subsidies account for 90% of total subsidies (Sumaila et al., 2010).	**Yes** Total estimated fisheries subsidies of USD 317 million for 2003. Capacity enhancing subsidies account for 89% of total subsidies (Sumaila et al., 2010).

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Governance	Thailand	Sabah
Fish consumption (importance of fish for food security)	**High** - Fish provides on average 10–14 g of protein per capita per day, making up 40.5% of animal protein and 17.6% of total protein intake (Panjarat, 2008). - Apparent per capita national fish consumption was 42 kg in 2004 and 36 kg in 2012[5]. In 2011, fish made up 33% of total animal protein intake[6].	**High** - Fish and other seafood make up 21% of per capita consumption of protein intake (Hajeb and Jinap, 2011) - National per capita fish consumption increased from 39 kg in 1995 to 49 kg in 2000, 60 kg in 2005 and is predicted to rise up to 65 kg in 2010 (Hajeb and Jinap, 2011) - Fish made up 39% of total animal protein intake in 2011[7].
Attitude towards conservation	**Mixed (negative and positive)** - On the Andaman Coast, local people in rural communities living near marine parks perceived the MPAs to have negative impacts on fisheries livelihoods (Bennett and Dearden, 2013). - In Trat province, over 90% of interviewees felt moderately to extremely positive towards the 'Need to conserve' (Hines et al., 2013, 2014). - In Trat, Phang-Nga, and Krabi provinces almost 100% of interviewees thought that it was important or very important to conserve dugongs (Hines et al., 2005). - At Bang Saphan Bay Thai fishers seemed broadly willing to participate in monitoring activities (Nasuchon and Charles, 2010).	**Neutral to positive** - In an awareness survey of the Tun Mustapha Park (TMP) in Sabah, 37% of respondents (comprised of the general public) indicated an interest to play a more active role in the conservation of TMP, 14% were not interested and 49% were non-committal (Cham, 2012). - Fishers and villagers demonstrate positive attitudes towards marine megafauna through their willingness to help save stranded or entangled dolphins, whales, and dugongs[7,8].
Time discounting	**N/A**	**High** (Teh et al., 2014) Average annual discount rate of small-scale fishers in Sabah was 265%.
Degree of conservation awareness among coastal communities	**Increasing** - Coastal communities are growing more aware of the significance of conservation (E. Hines, personal observation). - In Trang province conservation awareness is high. Local fishers help to promote dugong conservation by constructing an observation platform for dugongs and protecting seagrass beds (Abdulyanukosol et al. 2010). - Awareness of the importance of conserving dugongs and seagrass is higher among communities along the Andaman Sea than those along the Gulf of Thailand (Adulyanukosol et al., 2010).	**Improving** - There has been ongoing effort by government agencies and NGOs to raise awareness about marine conservation and bycatch of marine megafauna among fishermen, school children, and the public. - Local fishermen are willing to report strandings. E.g., in 2009, fishermen in Pulau Banggi reported a dugong caught in fishing net to the NGO (WWF) and Department of Fisheries. In the past 2 years, fishermen have also reported stranded dolphins, whales, and incidentally caught whale sharks to the Department of Fisheries and resorts[8]. - Higher awareness appears to be localised in communities where NGOs have a heavier presence. - In February 2015, state agencies (Sabah Wildlife Department, Department of Fisheries Sabah) and WWF held an awareness training programme for fishermen about marine mammal strandings. Many fishers were unaware that marine mammals were protected by law (Anonymous, 2015).
Marine mammal sightings (what about encounters?)	**High** Average % of fishermen who reported sighting marine mammals in Trat Province (DMCR, 2014): Dugong-1.3% Whale shark – 0.3% S. chinensis – 30.1% O. brevirostris – 55.6% T.aduncus – 6.0% N.phoceanoides – 1.7% Unknown species – 5.0%	**High** Average % of fishermen who reported sighting marine mammals in Sabah (Jaaman et al., 2009): Dugong – 12.3% Whales – 16.7% Open water dolphins – 72.3% S. chinensis – 26% O. brevirostris – 57%
Knowledge of species	**Fair** - Fishers are aware of the dolphin's role in nearshore ecosystems and ecotourism (Hines et al., 2014). - Coastal villagers in Trang province demonstrated clear knowledge on the swimming, breathing, feeding, and communication behaviour or dugongs (Rojchanaprasart et al., 2014).	**Fair** - Almost all fishers could differentiate between dugongs and cetaceans, and differentiate Irrawaddy dolphin, Indo-Pacific humpback dolphin, and finless porpoise from other cetaceans (Jaaman et al., 2009). - Fishers are familiar with dolphin and dugong behaviour (e.g. dolphins follow trawlers, dugongs avoid humans)
Traditional use	**Yes, for dugongs** - Dugong meat is consumed and various body parts are believed by the older generation to have protective and curative properties (Adulyanukosol et al., 2010). - Bone and tusk are used to make rings and charms/amulets (Adulyanukosol et al., 2010).	**Yes, for dugongs** - Targeted hunting of dugongs and dolphins was practiced in the past (Rajamani et al., 2006; Jaaman et al., 2008), although most fishers report that they stopped doing this in the 1980s. At the same time, folklore liken dugongs to humans because they shed tears, therefore dugongs are not eaten. Differences in use patterns may be due to the many different ethnic background of fishing communities in Sabah.
Marine bycatch used?	**Yes** - In Trat, Phang Nga and Krabi provinces, most fishers said that they would help a dugong back into the water if one were found alive (Hines et al., 2005). - If a dugong is found dead, the meat would be consumed while its teeth, tusk, bones and skin would be collected (Hines et al., 2005).	**Yes** - Incidentally caught dugongs, Indo-Pacific bottlenose dolphins, finless porpoise are sold to fish traders (Jaaman et al., 2008). - The meat of bycaught dugongs, open water dolphins and finless porpoises is used for home consumption or in some cases as shark bait (Jaaman et al., 2009).

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Governance	Thailand	Sabah
	- Muslim fishers do not eat dugong meat (Hines et al., 2005).	- A dugong that was caught in a net in Pulau Banggi was released alive. - A dugong that was caught in net in Kuala Penyu and died was eaten (Shaiddin, 2012).
Compliance with regulations (overall)	**Low** - Fisheries regulations: Thai trawlers regularly fish illegally in the EEZ of neighbouring countries. - MPA compliance – Fishers living close to marine parks knowingly continued to fish inside the protected area because they did not think that the marine park benefited fisheries (Bennett and Dearden, 2013).	**Low** - Fisheries regulations: bomb fishing is still widely practiced despite a ban under the *Fisheries Act* and past education and awareness campaigns. - MPA compliance – commercial fishing boats and small-scale fishers regularly enter Sugud Islands Marine Conservation Area (SIMCA) to fish in spite of frequent patrolling by SIMCA enforcement personnel.
Ecological		
Gear technology in coastal communities	**Mainly small-scale, gillnets** Gear type used by coastal communities along the eastern Gulf of Thailand (Hines et al., 2013, 2014): Traditional – 33% (longline, bamboo stake traps, push nets, traps) Gillnets (crab, fish, and shrimp) – 61% Trawl nets – 6% Purse seine – 1% Note that the above figures do not capture the large Thai industrial trawl fleet.	**Mainly small-scale** Gear type used by registered fishers in northeastern and eastern Sabah (%) (Jaaman et al., 2009): Traditional – 38% (hook and line, bag nets, lift nets, fish stakes, traps, barrier nets, scoop nets) Gillnets – 27% Trawl nets – 27% Purse seine – 7% Note that there is a large population of unregistered small-scale fishers in Sabah (Teh et al., 2011), hence the actual proportion of fishers who use traditional gear is higher than indicated above.
Bycatch species (gear)	**Cetaceans, dugongs, marine turtles** Dolphins (rope of octopus trap, anchovy purse seines) Dugongs (rope of shrimp net, set trap) Porpoise (pair-trawlers)	**Cetaceans, dugongs, marine turtles** - About 41% of boats sampled in Sabah reported incidental catches of marine mammals (Jaaman et al., 2009). Of these boats, 61% caught dugongs, 13% caught cetaceans, and 26% caught both. - Cetaceans were incidentally caught by all gears (gillnet, fish stake, trawl net, purse seine) and dugongs by all gears except purse seine (Jamman et al., 2009). - Bycatch was highest in gillnets (Jaaman et al., 2009). - Irrawaddy dolphins and open water dolphins were the most frequently reported cetacean species caught by gillnets (Jaaman et al., 2009).
Occurrence or frequency of bycatch	**Moderate** Along the Andaman coast one of the biggest problems for dugong is being caught in stationary nets, gill nets, and push net trawlers (Hines et al., 2005). - On the eastern Gulf, fishing gear entanglement was identified as the cause of death in 30% of necropsied stranded cetaceans (n = 662) from 2003 to 2013 and 23% of necropsied stranded marine turtles from 2004 to 2014 (n = 294) (EMCOR, 2015). - In the Andaman Coast fishing gear entanglement and other human activities were the cause of death for 89% of necropsied stranded dugongs (n = 133) from 2003 to 2013 (DMCR unpublished report 2014). - The fishing gear mostly responsible for bycatch of Irrawaddy dolphins was gillnets. The accidental catch of Irrawaddy dolphins is on average more than 10 animals per year from the Eastern Gulf of Thailand (DMCR unpublished report 2014).	**Low to moderate** - Bycatch of dugongs and cetaceans is reported to be rare by fishers. Only 4 dugongs and 65 cetaceans were accidentally caught in a year in a survey of 161 fishing communities across Sabah (Pilcher et al., 2008).
Presence of non-extractive MPAs	**Yes** There are 18 National Marine Parks (NMPs) along the Andaman coast which are technically "no-take" MPAs.	**Yes** 1) Sugud Islands Marine Conservation Area (est. 2001, 46,300 ha) 2) Tunku Abdul Rahman Park (est. 1974, 4930 ha km^2) 3) Turtle Islands Park (est. 1977, 1740 ha)
Anthropogenic threats to nearshore habitat	**Low to moderate** - Between 2004 and 2008 Thailand exhibited slight improvement in coral reef conditions (Wilkinson, 2008). - The loss of seagrass habitat is between 30 and 60% in Thailand (Wilkinson, 2008). - Out of 5 anthropogenic threat indicators, ranked low in 3 and low-medium in 2 (Wilkinson, 2008).	**Moderate to high** - Between 2004 and 2008 there was an overall decline in coral reef conditions in Malaysia (Wilkinson, 2008). - Out of 5 anthropogenic threat indicators, ranked low in 2; medium–high in 2; and high in 1 (Wilkinson, 2008).
Research and education		
Presence of stranding network	**Yes**	**No** - Universiti Malaysia Sabah (UMS) announced a task force for developing an operating manual to handle stranding cases (Anon, 2012).
Existing research on marine mammals and bycatch issues	**Moderate** - Long term dolphin population studies have been carried out since 2003 by academic institutions and Thai government agencies (San Francisco State University, Phuket Marine Biological Center, Department of Coastal and Marine	**Low** - Research on marine mammal ecology, biology, and bycatch have mainly been carried out by academic institutions and NGOs (Universiti Malaysia Sabah, Universiti Malaysia Terengganu, Marine Research Foundation, WWF) (e.g., Jaaman

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Governance	Thailand	Sabah
	Resources, Department of Fisheries) (e.g., Ponnampalam et al., 2013; Hines et al., 2013, 2014). - Research on dugongs, including cultural significance, have been done since the 1980s (Chantraporsyl and Adulyanukosol, 1994; Hines et al., 2005; Adulyanukosol et al., 2010)	et al., 2008, 2009; Pilcher et al., 2008; Rajamani et al., 2006, 2013; Kamaruzzan and Jaaman, 2013; Teoh et al., 2013; Briscoe et al., 2014). There is limited to no research carried out by state agencies. - Compared to Thailand, there is no long term population studies.
Stranding occurrences	**Moderate to high** - From 2002 to 3013, the stranding record of the Eastern Gulf of Thailand is 228 cases, of which Irrawaddy dolphins comprised the largest proportion at 37%, followed by finless porpoises (29%) and bottlenose dolphins (17%) (DMCR report 2014).	**Moderate** - Sabah has the highest number of cases of whale strandings and sightings compared to other states in Malaysia (Anonymous, 2012).

[1] WWF Marine Programme http://www.wwf.org.my/about_wwf/what_we_do/marine/sulu_sulawesi_marine_ecoregion_programme/. Accessed 14 Aug 2015.
[2] UNDP GEF Small Grants Programme. https://sgp.undp.org/index.php?option=com_countrypages&view=stories&country=71&Itemid=205. Accessed 14 Aug 2015.
[3] United Nations Sustainable Development Knowledge Platform. URL: https://sustainabledevelopment.un.org/content/dsd/dsd_aofw_mg/mg_success_stories/csd7/os2.htm. Accessed 14 Aug 2015.
[4] Calculated from 2576 Baht/person/month in Trat Province (http://knoema.com/wtxids/thailand-regional-dataset-october-2013?region=1000160-trat-province) @ 33.31 baht/USD exchange rate in 2008), average 4-5 persons per household (Panjarat 2008)
[5] Thailand Department of Fisheries (undated) Thailand seafood market and potentials for Peruvian products. Prepared by INFOFISH for Peru Export and Tourism Promotion Board.
[6] FAOSTAT. 2014. http://faostat3.fao.org/download/FB/CL/E. Accessed 14 Aug 2015.
[7] WWF Malaysia. URL: http://www.wwf.org.my/?10060/Rare-Dugong-saved-in-Maliangin-Community-Marine-Sanctuary. Accessed 14 Aug 2015.
[8] Borneo Colours. URL: www.borneocolours.com/2014/compassion-marine-wildlife/. Accessed 14 Aug 2015.

References

Adulyanukosol, K., Hines, E., Boonyanate, P., 2010. Cultural significance of dugong to Thai villagers: implications for conservation. In: Proceedings of the 5th International Symposium on SEASTAR2000 and Asian Bio-logging Science (The 9th SEASTAR2000 Workshop): 43–49. http://hdl.handle.net/2433/107337. Accessed 14 Aug 2015.

Adulyanukosol, K., 1999. Dugong, dolphin and whale in Thai waters. In: Proceedings of the 1st Korea-Thailand Joint Workshop on Comparison of Coastal Environment. 9-10 Sept 1999, Seoul, Korea, pp. 5–15.

Adulyanukosool, K., Poovachiranon, S., 2006. Dugong (Dugong dugon) and seagrass in Thailand: present status and future challenges. In: Arai, N. (Ed.), Proceedings of the 3rd International Symposium on SEASTAR2000 and Asian Bio-logging Science, Dec 13-14 2006, Bangkok, Thailand.

Agnew, D.J., Pearce, J., Pramod, G., Peatman, T., Watson, R., Beddington, J.R., Pitcher, T.J., 2009. Estimating the worldwide extent of illegal fishing. PLoS One 4 (2), e4570. http://dx.doi.org/10.1371/journal.pone.0004570.

Allen, S.J., Tyne, J.A., Kobryn, H.T., Bejder, L., Pollock, K.H., Loneragan, N.R., 2014. Patterns of dolphin bycatch in a north-western Australian trawl fishery. PLoS One 9 (4), e93178. http://dx.doi.org/10.1371/journal.pone.0093178.

Allison, E.H., Ellis, F., 2001. The livelihoods approach and management of small-scale fisheries. Mar. Policy 25, 377–388.

Andrew, N.L., Béné, C., Hall, S.J., Allison, E.H., Heck, S., Ratner, B.D., 2007. Diagnosis and management of small-scale fisheries in developing countries. Fish Fish. 8, 227–240.

Anonymous, 2009. Bajau Fishermen Save Rare Dugong. The Star Online, 17 December 2009. http://www.thestar.com.my/story/?file=%2F2009%2F12%2F17%2Fnation%2F5319917&. Accessed 14 Aug 2015.

Anonymous, 2014. TED Technology Helps Save Our Turtles. Daily Express online. December 17, 2014. http://www.dailyexpress.com.my/news.cfm?NewsID=95187. Accessed 14 Aug 2015.

Aswani, S., Hamilton, R.J., 2004. Integrating indigenous ecological knowledge and customary sea tenure with marine and social science for conservation of bumphead parrotfish (*Bolbometopon muricatum*) in the Roviana Lagoon, Solomon Islands. Environ. Conserv. 31, 69–83.

Aureggi, M., 2009. Thirteen years of sea turtle conservation in South Thailand: are we avoiding extinction?. In: Proceedings of the 5th International Symposium on SEASTAR2000 and Asia Bio-logging Science, March 5-6 2009 Bangkok, Thailand.

Béné, C., 2003. When fishery rhymes with poverty: a first step beyond the old paradigm on poverty in small-scale fisheries. World Dev. 31, 949–975.

Béné, C., 2005. Small-scale Fisheries: Assessing Their Contribution to Rural Livelihoods in Developing Countries. FAO Fisheries Circular No. 1008. FAO, Rome.

Bennett, N.J., Dearden, P., 2013. A picture of change: using photovoice to explore social and environmental change in coastal communities on the Andaman Coast of Thailand. Local Environ. Int. J. Justice Sustain. 18, 983–1001.

Bennett, N.J., Dearden, P., 2014. Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. Mar. Policy 44, 107–116.

Brewer, T.D., 2013. Dominant discourses, among fishers and middlemen, of the factors affecting coral reef fish distributions in Solomon Islands. Mar. Policy 37, 245–253.

Brewer, T.D., Cinner, J.E., Fisher, R., Green, A., Wilson, S.K., 2012. Market access, population density, and socioeconomic development explain diversity and functional group biomass of coral reef fish assemblages. Glob. Environ. Chang. 22, 399–406.

Briscoe, D.K., Hiatt, S., Lewison, R., Hines, E., 2014. Modeling habitat and bycatch risk for dugongs in Sabah, Malaysia. Endanger. Species Res. 24, 237–247.

Brunt, H., 2013. Stateless Stakeholders: Seen but Not Heard? the Case of the Sama Dilaut in Sabah, Malaysia. Anthropology of Development and Social Transformation, University of Sussex, UK. MA dissertation.

Campbell, L.M., Cornwell, M.L., 2008. Human dimensions of bycatch reduction technology: current assumptions and directions for future research. Endanger. Species Res. 5, 325–334.

Cham, M., WWF Malaysia, 2012. Survey on Awareness and Public Support for the Proposed Tun Mustapha Park (CTI-CFF Report, Malaysia).

Chantrapornsyl, S., 1993. Status of marine turtles in Thailand. In: Proc. First ASEAN Symposium - Workshop on Marine Turtle Conservation. WWF & USAID, Manila, pp. 123–131.

Cinner, J.E., 2011. Social-ecological traps in reef fisheries. Glob. Environ. Chang. 21, 835–839.

Cinner, J., 2014. Coral reef livelihoods. Curr. Opin. Environ. Sustain. 7, 65–71.

Cinner, J.E., McClanahan, T.R., MacNeil, M.A., et al., 2012. Comanagement of coral reef social-ecological systems. Proc. Natl. Acad. Sci. 109, 5219–5222.

CITES, 2015. Convention on International Trade in Endangered Species of Wild Fauna and Flora. http://www.cites.org/eng/app/index.php. Accessed 14 Aug 2015.

Clark, C.W., 1973. The economics of overexploitation. Science 181, 630–634.

Clarke, S.C., Harley, S.J., Hoyle, S.D., Rice, J.S., 2013. Population trends in Pacific Oceanic sharks and the utility of regulations on shark finning. Conserv. Biol. 27, 197–209.

Consortium for Wildlife Bycatch Reduction, 2014. Irrawaddy Dolphin. bycatch.org/node/740. Accessed 14 Aug 2015.

Corpuz, R.C., 2008. Assessment of Current Livelihood Options Semporna Islands (WWF Malaysia Report).

CTI, 2009. Malaysia Draft National Plan of Action. Coral Triangle Initiative on Coral Reefs. Fisheries and Food Security, MOSTI, Malaysia.

Daw, T.M., Cinner, J.E., McClanahan, T.R., Brown, K., Stead, S.M., et al., 2012. To fish or not to fish: factors at multiple scale affecting artisanal fishers' readiness to exit a declining fishery. PLoS One 7 (2), e31460. http://dx.doi.org/10.1371/journal.pone.0031460.

D'Agrosa, C., Lennert-Cody, C.E., Vidal, O., 2000. Vaquita bycatch in Mexico's artisanal gillnet fishery: driving a small population to extinction. Conserv. Biol. 14, 110–119.

Estes, J.A., Terborgh, J., Brashares, J.S., et al., 2011. Trophic downgrading of planet Earth. Science 333, 301–306.

Flaherty, M., Karnjanakesorn, C., 1993. Commercial and subsistence fisheries conflicts in the Gulf of Thailand: the case of squid trap fishers. Appl. Geogr. 13, 243–258.

Funge-Smith, S., Briggs, M., Miao, W., 2012. Regional Overview of Fisheries and Aquaculture in Asia and the Pacific 2012 (RAP Publication 2012/26). Asia-Pacific Fishery Commission, FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.

Gemmill, B., Bamidele-Izu, A., 2002. The role of NGOs and civil society in global environmental governance. In: Esty, D.C., Ivanova, M.H. (Eds.), Global Environmental Governance: Options and Opportunities. Yale Center for Environmental Law and Policy, New Haven, CT, pp. 1–24.

Gilman, E., Kobayashi, D., Swenarton, T., Brother, N., Dalzell, P., Kinan-Kelly, I., 2007.

Reducing sea turtle interactions in the Hawaii-based longline swordfish fishery. Biol. Conserv. 139, 19–28.
Gilman, E., Gearhart, J., Price, B., et al., 2010. Mitigating sea turtle by-catch in coastal passive net fisheries. Fish Fish. 11, 57–88. http://dx.doi.org/10.1111/j.1467-2979.2009.00342.x.
Grafton, R.Q., 2005. Social capital and fisheries governance. Ocean Coast. Manag. 48, 753–766.
Gutiérrez, N.L., Hilborn, R., Defeo, O., 2011. Leadership, social capital and incentives promote successful fisheries. Nature 470, 386–389.
Hajeb, P., Jinap, S., 2011. Mercury exposure through fish and seafood consumption in the rural and urban coastal communities of Peninsular Malaysia. World J. Fish Mar. Sci. 3, 217–226.
Hines, E., Abdulyanukosol, K., Duffus, D., Dearden, P., 2005. Community perspectives and conservation needs for dugongs (*Dugong dugon*) along the andaman coast of Thailand. Environ. Manag. 36, 654–664.
Hines, E., Manananansap, S., Ilangakoon, A., Ponnampalam, L., Morse, L., 2009. Coastal Cetaceans in Trat Province, Eastern Thailand (Final Report to Ocean Park Conservation Foundation, Hong Kong).
Hines, E., Junchompoo, C., Ilangakoon, A., Ponnampalam, L., Jackson-Ricketts, J., 2013. Coastal Cetaceans in Trat Province, Eastern Thailand. Final Report to Ocean Park Conservation Foundation. Hong Kong and Indo-Pacific Cetacean Foundation, Australia.
Hines, E., Junchompoo, C., Ilangakoon, A., Ponnampalam, L., Jackson-Ricketts, J., 2014. Coastal Cetaceans in Trat Province, Eastern Thailand (2012-2014) (Final Report to Indo-Pacific Cetacean Foundation, Australia).
IFAD, 2011. Rural Poverty Report 2011. International Fund for Agricultural Development, Rome, p. 317.
IUCN, 2014. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org. Accessed 14 Aug 2015.
Jaaman, S., Lah-Anyi, Y.U., Pierce, G.J., 2008. Directed fisheries for dolphins and dugong in Sabah, East Malaysia: past and present. Borneo Sci. 23, 1–20.
Jaaman, S., Lah-Anyi, Y., Pierce, G.J., 2009. The magnitude and sustainability of marine mammal by-catch in fisheries in East Malaysia. J. Mar. Biol. Assoc. U. K. 89, 907–920.
Jaroensutasinee, M., Jutapruet, S., Jaroensutasinee, K., 2010. Population size of Indo-Pacific humpback dolphins (*Sousa chinensis*) at Khanom, Thailand. Walailak J. Sci. Technol. 7, 115–126.
Jentoft, S., McCay, B.J., Wilson, D.C., 1998. Social theory and fisheries co-management. Mar. Policy 22, 423–436.
Johnson, C., 2001. Community formation and fisheries conservation in Southern Thailand. Dev. Change 32, 951–974.
Jolis, G., Kassem, K., 2011. Marine Turtle Status in Northeast Semporna Priority Conservation Area. Kota Kinabalu. WWF-Malaysia, Malaysia.
Kronen, M., Vunisea, A., Magron, F., McArdle, B., 2010. Socio-economic drivers and indicators for artisanal coastal fisheries in Pacific island countries and territories and their use for fisheries management strategies. Mar. Policy 34, 1135–1143.
Kuperan, K., Sutinen, J.G., 1998. Blue water crime: deterrence, legitimacy, and compliance in fisheries. Law Soc. Rev. 32, 309–338.
Kwan, D., Marsh, H., Delean, S., 2006. Factors influencing the sustainability of customary dugong hunting by a remote indigenous community. Environ. Conserv. 33, 164–171.
Lajiun, J., 2015. Concerted Efforts Needed to Halt Dwindling Population of Marine Mammals in Malaysia. New SabHinesah Times undated. www.newsabahtimes.com.my/nstweb/print/43719. Accessed 14 Aug 2015.
Lauer, M., Aswani, S., 2008. Integrating indigenous ecological knowledge and multispectral image classification for marine habitat mapping in Oceania. Ocean. Coast Manage 51, 495–504.
Lewison, R.L., Crowder, L.B., Read, A.J., Freeman, S.A., 2004. Understanding impacts of fisheries bycatch on marine megafauna. Trends Ecol. Evol. 19, 598–604.
Lewison, R.L., Soykan, C.U., Cox, T., Peckham, H., Pilcher, N., LeBoeuf, N., McDonald, S., Moore, J., Safina, C., Crowder, L.B., 2011. Ingredients for addressing the challenges of fisheries bycatch. Bull. Mar. Sci. 87, 235–250.
Lewison, R.L., Crowder, L.B., Wallace, B.P., et al., 2014. Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots. Proc. Natl. Acad. Sci. 111, 5271–5276.
Madrigal-Ballestero, R., Schluter, A., Lopez, M.C., 2013. What makes them follow the rules? Empirical evidence from turtle egg harvesters in Costa Rica. Mar. Policy 37, 270–277.
Mangel, J.C., Alfaro-Shigueto, J., Van Waerebeek, K., Caceres, C., Bearhop, S., Witt, M.J., Godley, G.J., 2010. Small cetacean captures in Peruvian artisanal fisheries: high despite protective legislation. Biol. Conserv. 143, 136–143.
Mangroves for the Future, 2015. http://www.mangrovesforthefuture.org/countries/members/thailand/. Accessed 14 Aug 2015.
McClanahan, T., Glaesel, H., Rubens, J., Kiambo, R., 1997. The effects of traditional fisheries management on fisheries yields and the coral-reef ecosystems of southern Kenya. Environ. Conserv. 24, 105–120.
Moore, J.E., Wallace, B.P., Lewison, R.L., Zydelis, R., Cox, T.M., Crowder, L.B., 2009. A review of marine mammal, sea turtle and seabird bycatch in USA fisheries and the role of policy in shaping management. Mar. Policy 33, 435–451.
Moore, J.E., Cox, T.M., Lewison, R.L., et al., 2010. An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. Biol. Conserv. 143, 795–805.
Muallil, R.N., Cleland, D., Alino, P.M., 2013. Socioeconomic factors associated with fishing pressure in small-scale fisheries along the West Philippine Sea biogeographic region. Ocean. Coast Manage 82, 27–33.
Nasuchon, N., Charles, A., 2010. Community involvement in fisheries management: experience in the Gulf of Thailand countries. Mar. Policy 34, 163–169.
Nielsen, J.R., Mathiesen, C., 2003. Important factors influencing rule compliance in fisheries lessons from Denmark. Mar. Policy 27, 409–416.
Nissapa, A., Masae, A., Khemakorn, P., Kongpro, A., Sanitmatjaro, W., Salaemae, S., 2004. Fish Fights over Fish Rights: Report of a Case Study on Conflicts between Anchovy and Small-scale Fishers in Thailand. Worldfish Center, Penang, Malaysia.
Österblom, H., Constable, A., Fukumi, S., 2011. Illegal fishing and the organized crime analogy. Trends Ecol. Evol. 26, 261–262.
Panjarat, S., 2008. Sustainable Fisheries in the Andaman Sea Coast of Thailand. http://www.un.org/depts/los/nippon/unnff_programme_home/fellows_pages/fellows_papers/panjarat_0708_thailand.pdf. Accessed 14 Aug 2015.
Pauly, D., 1990. On malthusian overfishing. Naga, ICLARM Q. 13, 3–4.
Pauly, D., 1997. Small-scale fisheries in the tropics: marginality, marginalization, and some implications for fisheries management. In: Pikitch, E., Huppert, D., Sissenwine, M. (Eds.), Global Trends: Fisheries Management. American Fisheries Society, Bethesda, pp. 40–49.
Pauly, D., Chua, T.E., 1988. The overfishing of marine resources: socioeconomic background in Southeast Asia. AMBIO 17, 200–206.
Peckham, S.H., Maldonado Diaz, D., Walli, A., Ruiz, G., Crowder, L.B., Nichols, W.J., 2007. Small-scale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. PLoS One 2 (10), e1041.
Pilcher, N., Ramachandran, T., Tan, C.D., et al., 2008. Rapid Bycatch Survey, Malaysia. Marine Research Foundation Sabah and Universiti Malaysia Sabah. Unpublished report.
Piovano, S., Basciano, G., Swimmer, Y., Giacoma, C., 2012. Evaluation of a bycatch reduction technology by fishermen: a case study from Sicily. Mar. Policy 36, 272–277.
Pomeroy, R., 1995. Community-based and co-management institutions for sustainable coastal fisheries management in Southeast Asia. Ocean. Coast Manage 27, 143–162.
Pretty, J., 2003. Social capital and the collective management of resources. Science 302, 1912–1914.
Purcell, S.W., Mercier, A., Conand, C., Hamel, J.F., Toral-Grnada, M.V., Lovatelli, A., Uthicke, S., 2013. Sea cucumber fisheries: a global analysis of stocks, management measures and drivers of overfishing. Fish Fish. 14, 34–59.
Rajamani, L., 2013. Using community knowledge in data-deficient regions: conserving the Vulnerable dugong *Dugong dugon* in the Sulu Sea, Malaysia. Oryx 47, 173–176.
Rajamani, L., Cabanban, A.S., Abdul Rahman, R., 2006. Indigenous use and trade of Dugon (*Dugong dugon*) in Sabah, Malaysia. Ambio 35, 266–268.
Read, A.J., 2008. The looming crisis: interactions between marine mammals and fisheries. J. Mammal. 89, 541–548.
Robards, M.D., Reeves, R.R., 2011. The global extent and character of marine mammal consumption by humans: 1970-2009. Biol. Conserv. 144, 2770–2786.
Sadovy de Mitcheson, Y., Craig, M.T., Bertoncini, A.A., et al., 2013. Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery. Fish Fish. 14, 119–136.
Sather, C., 1997. The Bajau Laut: Adaptation, History, and Fate in a Maritime Fishing Society of South-eastern Sabah. Oxford University Press, Kuala Lumpur, p. 359.
Senko, J., White, E.R., Heppell, S.S., Gerber, L.R., 2014. Comparing bycatch mitigation strategies for vulnerable marine megafauna. Anim. Conserv. 17, 5–18.
Settle, S., 1995. Status of nesting populations of sea turtles in Thailand and their conservation. Mar. Turt. Newsl. 68, 9.
Smith, B.D., Shore, R.G., Lopez, A., 2007. Status and Conservation of Freshwater Populations of Irrawaddy Dolphins. WCS Working Papers No. 31. http://www.iucn-csg.org/wp-content/uploads/2010/03/wcswp31.pdf. Accessed 14 Aug 2015.
Sumaila, U.R., Khan, A.S., Dyck, A.J., Watson, R., Munro, G., Tydemers, P., Pauly, D., 2010. A bottom-up re-estimation of global fisheries subsidies. J. Bioecon 12, 201–225.
Teh, L., Cabanban, A.S., 2007. Planning for sustainable tourism in southern Pulau Banggi: an assessment of biophysical conditions and their implications for future tourism development. J. Environ. Manage 85, 999–1008.
Teh, L., Sumaila, U.R., 2007. Malthusian overfishing in Pulau Banggi? Mar. Policy 31, 451–457.
Teh, L.C.L., Teh, L.S.L., Starkhouse, B., Sumaila, U.R., 2009. An overview of socio-economic and ecological perspectives of Fiji's inshore reef fisheries. Mar. Policy 33, 807–817.
Teh, L.C.L., Teh, L.S.L., Meitner, M., 2012. Preferred resource spaces and fisher flexibility: implications for spatial management of small-scale fisheries. Hum. Ecol. 40, 213–226.
Teh, L.S.L., Teh, L.C.L., Sumaila, U.R., 2014. Time preference of small-scale fishers in open access and traditionally managed reef fisheries. Mar. Policy 44, 222–231.
Theberge, M.M., Dearden, P., 2006. Detecting a decline in whale shark Rhincodon typus sightings in the Andaman Sea, Thailand, using ecotourist operator-collected data. Oryx 40, 337–342.
Tsaros, P., Aureggi, M., 2007. Interaction between Sea Turtles and Artisan Fisheries at Phra Thong Island (Naucrates Final Report).
Vignoli, S.M., Rojas, M.F., Zazo, A.M., Friis, M., 2010. Characterization of the Fishing Livelihood in Ban Hadsaikao and the Effect of the Limitations on the Fishermen's Livelihood. University of Copenhagen, Denmark. ILUNRM-SLUSE Field Course Report.
Whitty, T.S., 2015. Governance potential for cetacean bycatch mitigation in small-

scale fisheries: a comparative assessment of four sites in Southeast Asia. Appl. Geogr. http://dx.doi.org/10.1016/j.apgeog.2015.01.003.
Wilkinson, C., 2008. Status of Coral Reefs of the World: 2008 Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre. Townsville, Australia, p. 296.
WIOMSA, 2011. Migrant Fishers and Fishing in the Western Indian Ocean: Socio-economic Dynamics and Implications for Management. Final Report of Commissioned Research Project MASMA/CR/2008/02.

References

Anonymous, 2012. Government Welcomes Research on Whale Stranding Cases in Sabah, 10 August 2012. Borneo Post online. http://www.theborneopost.com/2012/08/10/govt-welcomes-research-on-whale-stranding-cases-in-sabah/. Accessed 14 Aug 2015.
Anonymous, 2015. Stakeholders Get Training on Stranded Marine Mammals. Daily Express online. Feb 2, 2015. http://dailyexpress.com.my/news.cfm?NewsID=96812. Accessed 14 Aug 2015.
Biusing, R.E., 2001. Assessment of Coastal Fisheries in the Malaysian Sabah Portion of the Sulu-sulawesi Marine Ecoregion (SSME). WWF Malaysia, Sabah, p. 719.
Boonchuwongse, P., Dechboon, W., 2003. Socioeconomic assessment of marine fisheries of Thailand. p. 577–628. In: Silvestre, G., Garces, L., Stobutzki, I., Ahmed, M., Valmonte-Santos, R.A., Luna, C., Lachica-Aliño, L., Munro, P., Christensen, V., Pauly, D. (Eds.), Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries, 67. WorldFish Center Conference Proceedings, pp. 577–628.
Chanrachkij, I., Yasook, N., Anantapongsuk, S., Petrasatien, P., Wanchana, W., 2010. Survey of Small-scale Fishing Gear and Practices Contributing to Sea Turtle Mortalities along the Coast of Rayong Province, Eastern Gulf of Thailand, p. 55. SEAFDEC TD/SP/38.
Chatrapornsyl, S., Adulyanukosol, K., 1994. Occurrence of dugongs (*Dugong dugon*) and the status of the dugong in Thailand. In: Proceedings of the Seminar of the Department of Fisheries in 1994, Bangkok, Thailand, pp. 380–385.
DMCR, 2014. Annual Report for 2013 (In Thai). Department of Marine and Coastal Resources. http://dmcr2014.dmcr.go.th/detailLibrary.php?WP=oH93xRl5orOaL3DznGO4ZKN4oGS3G0lDooya4UERnHy4Ljo7o3Qo7o3Q. Accessed 14 Aug 2015.
FAO Fisheries Technical Paper. No. 488. In: De Young, C. (Ed.), 2006. Review of the State of World Marine Capture Fisheries Management: Indian Ocean. FAO, Rome, p. 458. http://www.fao.org/docrep/009/a0477e/a0477e0c.htm. Accessed 14 Aug 2015.
Department of Statistics, 2012. Household Income and Basic Amenities Survey Report. Malaysia Department of Statistics, Putrajaya.
EMCOR, 2015. The Stranding Report of Eastern Gulf of Thailand from the Last 10 Years (2004-2014). Eastern Marine and Coastal Research and Development Center, Rayong Province. Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment, Thailand. February, 2015.
Henocque, Y., Tandavanitj, S., 2011. Fisheries and co-management in practice, Thailand, p102–103. In: Misdorp, R. (Ed.), Climate of Coastal Cooperation. Coastal & Marine Union, EUCC, The Netherlands. http://www.coastalcooperation.net/part-II/II-7-2.pdf. Accessed 14 Aug 2015.
Hines, E., Junchompoo, C., Ilangakoon, A., Ponnampalam, L., Jackson-Ricketts, J., 2012. Coastal Cetaceans in Trat Province, Eastern Thailand (Final Report to Ocean Park Conservation Foundation, Hong Kong and Indo-Pacific Cetacean Foundation, Australia).
Hines, E., Abdulyanukosol, K., Duffus, D., Dearden, P., 2005. Community perspectives and conservation needs for Dugongs (*Dugong dugon*) along the Andaman coast of Thailand. Environ. Manag. 36, 654–664.
Johnson, C., 1998. Beyond community rights: small-scale fisheries management in southern Thailand. TDRI Q. Rev. 13, 25–31. http://www.tdri.or.th/library/quarterly/text/j98_3.htm. Accessed 14 Aug 2015.
Kamaruzzan, A.S., Jaaman, S.A., 2013. Interactions between Indo-Pacific humpback and Irrawaddy dolphins in Cowie Bay, Sabah, Malaysia. Malay Nat. J. 64, 185–191.
Komatsu, M., 2013. Special Study on Sustainable Fisheries Management and International Trade in the Southeast Asia and Pacific Region. ADBI Working Paper 438. Asian Development Bank Institute, Tokyo. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2340967. Accessed 14 Aug 2015.
Lunn, K.E., Dearden, P., 2006. Monitoring small-scale marine fisheries: an example from Thailand's Ko chang archipelago. Fish. Res. 77, 60–71.
Morgan, G., Staples, D., Funge-Smith, S., 2007. Fishing Capacity Management and IUU Fishing in Asia. Asia-Pacific Fishery Commission Food and Agriculture Organization of the United Nations, Bangkok.
OECD, 2010. Review of Fisheries in OECD Countries 2009: Policies and Summary Statistics. OECD Publishing.
OECD, 2013. OECD Review of Fisheries: Policies and Summary Statistics 2013. OECD Publishing. http://dx.doi.org/10.1787/rev_fish-2013-en. Accessed 14 Aug 2015.
Pitcher, T.J., Kalikoski, D., Short, K., Varkey, D., Pramod, G., 2009. An evaluation of progress in implementing ecosystem-based management in 33 countries. Mar. Policy 33, 223–232.
Pomeroy, R., 2012. Managing overcapacity in small-scale fisheries in Southeast Asia. Mar. Policy 36, 520–527.
Ponnampalam, L.S., Hines, E.M., Monanunsap, S., Ilangakoon, A.D., Junchompoo, C., Adulyanukosol, K., Morse, L., 2013. Behavioral observations of coastal Irrawaddy dolphins (Orcaella brevirostris) in Trat province, eastern Gulf of Thailand. Aquat. Mamm. 39, 401.
Rojchanaprasart, N., Tongnunui, P., Tinnungwattana, W., 2014. Comparison between traditional ecological knowledge of coastal villagers in Thailand and scientific ecological knowledge regarding Dugong. Kasetsart J. Soc. Sci. 35, 368–377.
Saad, J., Hiew, K., Gopinath, N., 2013. Review of Malaysian Laws and Policies in Relation to the Implementation of Ecosystem Approach to Fisheries Management in Malaysia. The USAID Coral Triangle Support Partnership, Honolulu, Hawaii.
Shaiddin, A.N., 2012. Menyingkap Permasalahan Nelayan Kuala Penyu. Utusan Borneo, 16 Jun 2012.
Salayo, N., Garces, L., Pido, M., Viswanathan, K., et al., 2008. Managing excess capacity in small-scale fisheries: perspectives from stakeholders in three Southeast Asian countries. Mar. Policy 32, 682–700.
SEAFDEC, 2012. The Southeast Asian State of Fisheries and Aquaculture. SEAFDEC, Bangkok, Thailand.
Sea Resources Management, 2008. Case Study of Illegal, Unreported and Unregulated (IUU) Fishing off the East Coast of Peninsular Malaysia. Asia-Pacific Economic Cooperation (APEC), Singapore. APEC Publication No. 208-FS-01.4.
Teh, L., Teh, L., 2009. Illegal gill net catch in the Sugud islands Marine conservation area, Malaysia. Fish Bytes 15 (5), 1–2.
Teh, L.S.L., Teh, L.C.L., Sumaila, U.R., 2011. Quantifying the overlooked socio-economic contribution of small-scale fisheries in Sabah, Malaysia. Fish. Res. 110 (3), 450–458.
Teh, L., Teh, L., 2014. Total Economic Value of Marine Turtles in the Semporna Priority Conservation Area, Stage 1 Report. Unpublished report, WWF, (Semporna).
Teoh, S.W., Jaaman, S.A., Palaniappan, P.M., 2013. A preliminary study of population size of Irrawaddy Dolphins (Orcaella brevirostris) in Cowie Bay, Sabah, Malaysia. J. Trop. Biol. Conservation 10, 23–26.
Tokrisna, R., Boonchuwong, P., Janekarnkij, P., 1998. A Review on Fisheries and Coastal Community Based Co-management Regime in Thailand. Working Paper 32 of the Fisheries Co-Management Project. ICLARM, Manila, Philippines.
Vaz, J., 2012. An Analysis of International Law, National Legislation, Judgements, and Institutions as They Interrelate with Territories and Areas Conserved by Indigenous Peoples and Local Communities. Report No. 14 Malaysia. ICCA Consortium.
World Bank, 2014. World Development Indicators. http://wdi.worldbank.org/table/2.7. Accessed 14 Aug 2015.