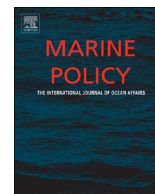




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## The economic contribution of the muck dive industry to tourism in Southeast Asia



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### ABSTRACT

Scuba diving tourism has the potential to be a sustainable source of income for developing countries. Around the world, tourists pay significant amounts of money to see coral reefs or iconic, large animals such as sharks and manta rays. Scuba diving tourism is broadening and becoming increasingly popular, a novel type of scuba diving which little is known about, is muck diving. Muck diving focuses on finding rare, cryptic species that are seldom seen on coral reefs. This study investigates the value of muck diving, its participant and employee demographics and potential threats to the industry. Results indicate that muck dive tourism is worth more than USD\$ 150 million annually in Indonesia and the Philippines combined. It employs over 2200 people and attracts more than 100,000 divers per year. Divers participating in muck dive tourism are experienced, well-educated, have high incomes, and are willing to pay for the protection of species crucial to the industry. Overcrowding of dive sites, pollution and conflicts with fishermen are reported as potential threats to the industry, but limited knowledge on these impacts warrants further research. This study shows that muck dive tourism is a sustainable form of nature based tourism in developing countries, particularly in areas where little or no potential for traditional coral reef scuba diving exists.

### 1. Introduction

Nature-based experiences are an integral part of many tourism activities with participation gaining popularity, especially in developing countries [5]. Recent estimates of the global revenue created by nature-based visits to wildlife protection areas is as high as USD \$6 billion per year [6]. If managed correctly, nature-based tourism can lead to increased local incomes and improved standards of living, and decreased dependence on less sustainable livelihoods such as fishing [27,50]. In contrast, poor management can lead to conflict between resource users, severe habitat degradation, and leakage of revenue out of the local area [22,48,51]. These challenges highlight the need for a clear understanding of specific drivers of nature-based tourism to enable the development of efficient local management plans.

Participation in nature-based tourism can range from the occasional standardized daytrip during a larger, more general holiday, to entirely customised holidays, focused solely on the nature experience [2]. Nature-based holidays are considered to be a broad tourism niche, which can be divided into multiple narrower categories [37,40]. One such narrow niche is specialist animal watching with bird watching a

classic example, and one that has been steadily increasing in popularity for two decades [13,40]. While fewer visitors participate in niche tourism compared to more general tourism, its specialised attractions appeal to higher spending participants and it has repeatedly been shown to have a high economic value to the local community [37]. In Point Pelee, a small national park in Canada, expenditure on bird watching can be as high as USD\$5.4 million annually while in Costa Rica, 41% of the total tourism income is estimated to come from bird watchers, a value close to USD\$400 million per year [25,41]. Demographically, tourists participating in bird watching tend to be middle aged, have relatively high incomes and are well educated [13,25].

While research interest in nature-based tourism has focused primarily on the terrestrial environment, a number of recent studies have investigated the value of nature-based marine tourism [10,38,39,50]. When practiced in a sustainable manner, marine tourism offers an alternative income for fishing communities while simultaneously increasing conservation awareness for the local population and tourists visiting the region [9,47,50]. Scuba diving in particular has been shown to be a valuable segment of marine tourism with estimates for Southeast Asia alone as high as USD\$4.5 billion per year [39]. An examination of

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species-specific scuba diving reveals the annual global value of diving or snorkelling with manta rays, for example, is approximately USD\$73 million [38] and for sharks between USD\$5.4 million to USD\$18 million per year, depending on the location and shark species [12,29,47].

Studies that have quantified the valuation of scuba diving mostly focus on regions with coral reefs, or on iconic megafauna such as sharks or whales [10,38,47]. Interactions with these species and ecosystems are mostly standardised package tourism and previous studies often do not account for other segments of the scuba diving market [2,20]. When placing a value on diving in tropical destinations these same studies assume diving activities only happen on or near coral reefs. As the dive industry matures, however, other types of diving in adjacent systems are being explored [15,26]. Inexperienced divers generally visit tropical destinations for a typical coral reef experience, but more experienced divers are often attracted to novel and specialised experiences [11,15,49].

One such novel and yet-unstudied sector in scuba diving tourism is the so-called “Muck diving” (sometimes also called “Critter diving” or “Macro diving”) [31]. Muck diving has previously been defined as “diving in mostly gravel and mud areas with little or no coral reef or rocky outcrops” [31] (Fig. 1). Often sites will also feature man-made or natural debris, such as rotting vegetation [33], and may be at sites that are adjacent to coral reefs. Understanding what drives this sector requires determining why tourists choose to dive in these less attractive and previously avoided habitats. Muck diving is in many ways the marine equivalent of bird watching, in that it offers a unique opportunity to observe or photograph unusual, rare, or cryptic species that are not usually encountered on coral reefs. The key motivation of muck diving is locating rare species, with greater customer satisfaction recorded when this goal is achieved [32]. The species of interest are not limited to fishes (e.g. frogfishes, seahorses), but also include molluscs (octopuses, nudibranchs, etc.) and other invertebrates (e.g. harlequin shrimp, bobbit worms).

As with birdwatching, muck diving relies heavily on tourists observing and often photographing cryptic and rare species. The failure to see the animals of interest affects the number of tourists visiting a location, and therefore the incomes of communities dependent on them [49]. The species important to this type of diving are often rare and data deficient resulting in researchers having little awareness of their population size, distributions, critical habitats or conservation status. Due to this lack of information it is difficult to assess whether threats exists that could affect the abundance and distribution of these species, and the tourism industry that relies on them. Destructive uses of the environment where these species occur, such as trawling, mining, or fishing for the marine aquarium trade could have a significant impact, but data is lacking.

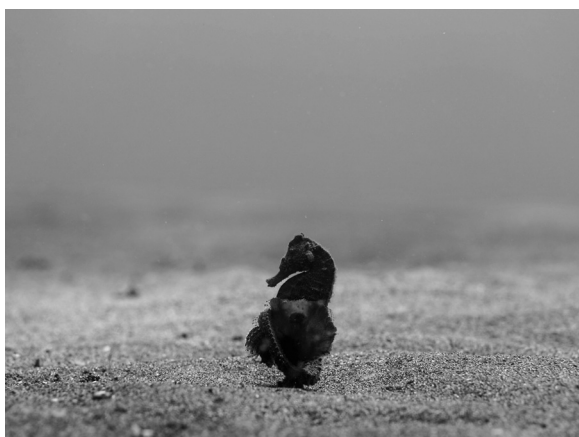


Fig. 1. A typical muck diving scene: a sandy bottom with few defining features. In the foreground an Estuary seahorse (*Hippocampus kuda*) holding on to algae (Photo by Dragos Dumitrescu).

While muck diving is practiced globally, the name originated in Milne Bay, Papua New Guinea [42] and it is currently most practiced in Southeast Asia [31]. Indonesia is one of the most important dive destinations in the world [23,51], but the importance of muck diving compared to general types of scuba diving is unknown. At present, the world's most popular muck diving sites are in Indonesia and Philippines, often in locations where other tourism activities are limited. Consequently, muck diving might provide a substantial alternative income for communities that otherwise depend on subsistence fishing or other extractive uses of the marine environment [21].

Since muck dive tourism is mostly practiced in developing countries, often in areas with limited alternative forms of income, there is a need to define the characteristics of the industry and quantify the value of this type of niche tourism. If muck diving is the marine equivalent of bird watching, it is to be expected that substantially larger revenues will be generated. To evaluate the sustainability of the muck diving industry, it is imperative to determine whether the money spent by dive tourists benefits the local population. Due to the heavy dependence on rare species and the lack of data on their conservation status, it is equally important to define which potential threats exist for the industry. This study has four goals:

1. Describe the demographics and attitudes of divers participating in muck dive tourism.
2. Identify the value of muck dive tourism in Indonesia and Philippines.
3. Describe the demographics and earnings of those employed (dive guides) in muck dive tourism.
4. Describe the main perceived threats to muck dive tourism.

## 2. Methods

### 2.1. Muck diving

For the purpose of this study, “Muck diving” is defined as: Scuba diving in soft sediment habitats with limited landscape features, with the explicit goal to observe or photograph rare, unusual, or cryptic species that are seldom seen on coral reefs. Taking photographs of these rare species is what makes muck diving especially popular with underwater photographers. While Southeast Asia is the region best known for muck diving it is frequently practiced in other regions, albeit without the same intensity [33].

### 2.2. Study area

The areas surveyed for this study are three of the most popular muck dive destinations in Southeast Asia. Two locations were surveyed in Indonesia and one was surveyed in the Philippines (Fig. 2).

#### 2.2.1. Indonesia

**2.2.1.1. North Bali.** Bali is Indonesia's most popular tourist destination, it was visited by more than 4 million people in 2015 [4]. The majority of visiting tourists remain in the south and centre of the island, but the north-east coast of Bali is a popular destination for scuba divers. The area with the best established scuba dive infrastructure is based around the village Tulamben (8° 15' S, 115° 36' E). The population of Tulamben mostly relies on subsistence fishing or tourism for their incomes. Dive tourism in Tulamben has long since been established around the site of the *USAT Liberty*-shipwreck, but in recent years, new dive centres have been built that specialise in muck diving on the nearby black sand slopes. In the high season the popular shipwreck-site can receive up to 300 divers per day (pers. comm. with local authorities). There are an estimated 14 dive centres and resorts in Tulamben, with an additional 40 in nearby villages. The area is also visited by operators from the south which organise daytrips to the wreck.

Unlike the south of Bali, the Tulamben area has few tourist

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