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Status of sea cucumber fishery and populations across sites with different levels of management in Palawan, Philippines

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ABSTRACT

This study was conducted to investigate the sea cucumber fishery and compare populations between exploited and unexploited sites. Three islands were selected, the Arrecife Island as the unexploited site and the Johnson and Green Islands representing the exploited sites. In each site, sea cucumber species richness, diversity and densities were assessed by laying as much as 15 transects (50 m × 5 m) per habitat in each island. Differences in species richness, diversity and relative densities across sites and habitats were tested using a Two-way Analysis of Variance (ANOVA) and Tukey test for post hoc comparisons. An interview with gatherers, key informants and focus group discussions were also conducted to gather information on the sea cucumber fishery and its management. Results showed that the unexploited site had a higher species richness (14 vs. 7 and 7). Relative density of species was also higher in the unexploited site at 1245 ind ha^{-1} while it was only 78 and 39 ind ha^{-1} in exploited sites ($p < 0.05$). Interviews and a focus group discussion revealed that national regulations on permit system and size limits were not enforced at the local level and that gatherers had low levels of awareness regarding regulations on sea cucumber harvest. Current management measures appear to be ineffective and insufficient, leaving the sea cucumbers in areas open to exploitation at risk of depletion. Given that sea cucumbers provide substantial income to local communities, the depletion of this resource could compromise the livelihood of people in island communities that rely heavily on marine resources for living. Thus, this study highlights the need to review national policies on sea cucumber fishery and place the management at the local level.

1. Introduction

Sea cucumbers are primarily harvested for the production of *trepang* locally called *balat* or *balatan*. *Trepang* refers to the dried body wall of a sea cucumber, which is a prime delicacy in some Asian cultures (Akamine, 2005; Choo, 2008). Sea cucumbers are also used in the production of various nutraceutical and pharmaceutical products and recent studies have shown that they have anti-fungal, anti-microbial and anti-cancer properties (Bordbar et al., 2011). Over 70 species of sea cucumbers are harvested in more than 70 countries all over the world but most are sourced from the wild fisheries of tropical countries (Purcell et al. 2012, 2018).

The sea cucumber fishery forms a multi-million dollar industry (Gamboa et al., 2004) and the increasing demand in the world market fueled massive exploitation in many areas across the globe (Uthicke, 2004; Conand, 2006; Purcell, 2010; Hasan and Abd El-Rady, 2012; Pakoa and Bertram, 2013; Conand et al., 2014). In fact, many sea cucumber stocks worldwide are overfished because of their high value and ease of capture. Among the overfished areas are Galapagos, Indonesia, Malaysia, Papua New Guinea, Solomon Islands, New Caledonia, Australia, Red Sea in Egypt, Madagascar, Fiji Islands and the Philippines (Uthicke and Conand, 2005). For most of the traded species, prices have increased tremendously with increasing size especially for the high valued ones like *Holothuria fuscogilva*, *H. lessoni* and *H. scabra* (Purcell et al., 2018).

The Philippines is one of the major producers and exporters of *trepang* in the world (Choo, 2008; Anderson et al., 2010). About 20% of Philippine sea cucumber landings come from Palawan (Brown et al., 2010). In 2014, sea cucumbers ranked 9th among the major fishery exports of the country in terms of value (DA-BFAR, 2014). In 1992, the

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Philippines contributed almost 16% of the world's production by volume but accounted only 8.2% of the global production value for the exports were mostly of low value (Akamine, 2005). Akamine (2002) also reported that the Philippines sea cucumber fishery had shifted from low-volume/high-value to high-volume/low value due to speculated shortage of supply from the wild. Despite being artisanal in scale, the sea cucumber fishery provides substantial income to many marginal fishers in the country (Labe, 2009). Its exploitation has not been regulated since the 1970s and in fact, the country has been identified as sea cucumber hotspot in Asia for the lack of regulations on its collection and trade and poor statistical records (Choo, 2008). The number of exploited species had also increased over the years from 24 in 2000 to at least 32 in 2012 (Schoppe, 2000; Jontila et al., 2014). The need for management of the Philippine sea cucumber fishery has long been emphasized (Gamboa et al., 2004) yet it was only in 2013 that the government released the Administrative Circular (AC) Order 248, which requires permits among collectors and traders and imposes a 5 cm size limit on dried products (DA-BFAR, 2013). However, the effectiveness or enforcement of this regulation is not known and preliminary information revealed that gathering of sea cucumbers remains open-access and unregulated.

The proper management of the sea cucumber fishery is very important especially in island communities where marginal fishers have limited livelihood opportunities. This study was therefore conducted to investigate the sea cucumber fishery and its populations to generate information that can be used to improve its management. Specifically, it aims to assess the present status of sea cucumber population in terms of species richness, diversity and density between exploited and unexploited sites. It also aims to evaluate the enforcement of laws and regulations on sea cucumber fishery at the local level. Based from the data gathered, a management plan that can be adopted by the local government units in Palawan is suggested. Results of this study are useful for local and national officials who are tasked to manage valuable yet endangered aquatic resources such as sea cucumbers.

2. Materials and methods

2.1. Study sites

Three islands were selected in this study - Arrecife Island, Johnson Island and Green Island. All islands are situated in the east coast of Palawan, Philippines (Fig. 1). Arrecife Island is a private island resort located in Honda Bay, Puerto Princesa City, Palawan. It represented the unexploited site for gleaning and fishing are not allowed in this area since its establishment in 1997. There were no fishing communities within the island and only the resort personnel and tourists were allowed to stay. Security personnel were stationed in strategic areas around the island for the safety of tourists and ensured that no fishers encroached inside and around the island. The exploited sites were represented by Johnson and Green Islands in Roxas, Palawan. Johnson Island had 154 households with a population of 617 while Green Island had 455 households with a population of 1813. As island communities, fishing was the main livelihood of residents.

2.2. Data collection

The study was conducted from 24 April to 5 June 2015. The various sea cucumber habitats such as sea grass beds, reef flats and coral reefs (Conand, 1998; Purcell et al., 2012) were assessed using a 50 m × 5 m (250 m^2) transect line. Three stations were established in reef flats and five in seagrass beds and coral reefs. Each station had three transects rendering a total of 9750 m^2 area covered per island. All commercially important species within the transect were identified and counted. Only one non-commercially important species was recorded in the study sites, i.e., *Synapta maculata*, which was noted for occurrence. The seagrass beds and reef flats were surveyed by walking during low tide in the afternoon while shallow coral reefs (~1 m deep during lowest tide) were assessed through snorkeling at night as most of the reef species are nocturnal (Purcell et al., 2012). *In situ* photos were taken. Identification of species was based on the works of Conand (1998), Massin et al. (2002), Purcell et al. (2012) and Samyn (2013).

To investigate the socio-demographic profile and harvesting practices of sea cucumber gatherers in exploited sites, a survey was conducted among 36 gatherers in Green Island and 43 in Johnson Island. This number represented about 13% of the total households in the two study sites. A structured questionnaire was used in the study which included questions on 1) harvesting method, 2) harvesting grounds, 3) time of harvesting, 4) number of persons involved in the harvesting, 5) gatherers' perception on the abundance and diversity of sea cucumbers in their area, and 6) comparison of sea cucumber catch between the past (10 years before) and the present (study period). The gatherers were also asked to identify sea cucumber species that they were harvesting through the use of sea cucumber photos and pictures (Purcell et al., 2012).

To gather information on the sea cucumber fishery and its management, key informant interviews (KIIs) were conducted involving three sea cucumber processors, three Barangay or village officials, one leader of a Fishers' Association, two staff members of the Palawan Council for Sustainable Development (PCSD) and one from the Bureau of Fisheries and Aquatic Resources (BFAR)-Provincial Fishery Office (PFO). They were asked about existing national and local policies on sea cucumber collection (e.g., size limit) and the management measures implemented or adopted by their respective offices. A Focus Group Discussion participated by five personnel of the Roxas Municipal Fishery and Aquatic Resource Management Office (MFARMO) was also conducted to discuss implementation of national regulations on sea cucumber collection at the local level.

2.3. Data analysis

Sea cucumber populations were assessed in terms of species richness, diversity and density. Species richness is simply the number of species found in each site while diversity relates to the number of sea cucumber species in the community to the relative abundance of each species.

Diversity across habitats and sites was determined using the Shannon Diversity Index (SDI) with the formula:

$$H = -\sum_{i=1}^{S} (P_i * \ln P_i)$$

where:

H = the Shannon diversity index
P_i = fraction of the entire population made up of species i
S = numbers of species encountered
Σ = sum from species 1 to species S

For density, only the commercial species were considered for these are the target of fishers. Relative density was calculated as number of individuals per hectare (Purcell et al., 2009). Relative density did not show normal distribution, thus these were log transformed and subjected to Two-way Analysis of Variance (ANOVA) to determine the differences in species richness, diversity and relative density among sites and across habitats. The Tukey test was used for post hoc analysis and all tests were performed using the Statistical Package for Social Sciences (SPSS) version 16. Results of the interviews and FGD were tabulated accordingly.