Stock assessment of sea cucumbers from Phu Quoc, Vietnam

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Executive summary

Phu Quoc is the largest Vietnamese island and a biodiversity hotspot that supports many different important marine fisheries. However, at present, little information is available about its biodiversity, natural marine resources and their exploitation.

This project was set up to evaluate the diversity and abundance of sea cucumber populations in the shallow waters of Phu Quoc archipelago from February to December (excluding the period of June-October) 2004. Its purpose was also to investigate the current and historical levels of exploitation, fisheries activities and increased environmental awareness.

Fishing for sea cucumbers is mostly conducted by hookah divers at night. From the interviews conducted and the present underwater survey, it is concluded that the heavy fishing pressure has severely reduced the density of all commercial species of sea cucumber from this area. Species such as *Holothuria scabra* or *Stichopus variegatus* once highly abundant are nowadays rare or locally extinct. Fishing effort has also switched from high value to low value commercial species (i.e. *H. atra, H. leuscopilota, H. edulis, Stichopus nasus, S. horrens, Pentacta quadrangulis*,). During the dry season, harvesting of sea cucumbers has now moved to neighbouring Cambodian islands. There

is an urgent need to establish an integrated management program to preserve and restock the different sea cucumber populations. Some guidelines for this management scheme have been drawn in this document.

Introduction

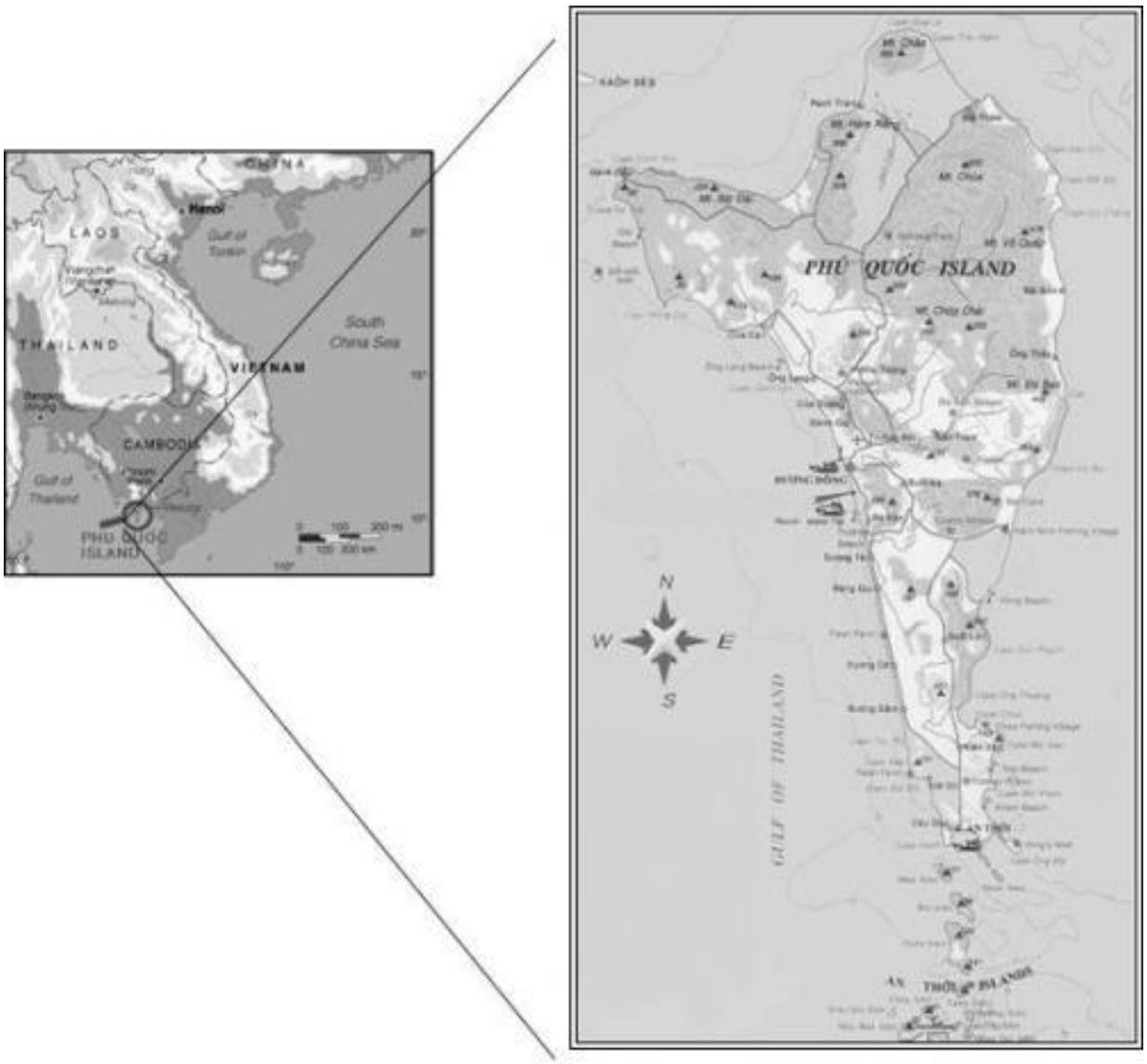
Background

Phu Quoc Island lies in the Gulf of Thailand, 45km from mainland Vietnam and 15km south of the Cambodian coast (Fig. 1). With an area of 585 km^2, Phu Quoc is the largest island of an archipelago consisting of 14 islands. Due to its geographic location and the territorial disputes between Vietnam and Cambodia, its development has until recently been quite restricted while its seas support a rich marine fauna (Anon., 2005). However, the growing human population, mostly dedicated on fishing, the increase in trade and boom in tourist development is starting to threaten the coastal ecosystem.

The island is situated on a shallow continental shelf in the tropical monsoon zone. Part of the island's tropical forests, mostly in the north, were declared National Park in 2001 (31,420 ha), and are still inhabited by some important wildlife such as monkeys, boar, deer and squirrels. Thin mangrove forest fringes most of the east and north-west coastlines and river banks. The most fertile areas are generally used for spice production, especially pepper.

A combination of the oceanographic conditions with the stable monsoons, diverse geomorphologic areas and the influence of nutrient rich water from the gulf of Thailand sustain a rich fauna and some of the most important coral reefs and algae beds in Vietnam (UNEP World Conservation Centre).

Figure 1. Outline of Vietnam and Phu Quoc Archipelago.



Sea cucumbers

Sea cucumbers serve a vitally important ecological role in the marine ecosystem as deposit feeders, filtering ocean sediments and recycling nutrients back into the food web (Uthicke, 2001b). Relatives of the sea urchins and starfishes, the sea cucumbers (Holothuridea) belong to the family of echinoderms. Very little information is known about these animals, how they reproduce, their spatial and temporal distributions, growth requirements or ecological characteristics. Some sea cucumbers can reproduce both asexually by transverse fission, and sexually (Uthicke, 2001). But the majority of sea cucumbers are broadcast spawners, where each individual of the population simultaneously releases sperm or eggs into the sea. The fertilized eggs develop through different stages of planktotrophic larvae (approx. 13-25 days) until they settle to the seabed and become juvenile sea cucumbers.

The dried body wall of sea cucumbers is considered a highly prized delicacy in Asian cuisine and traditional Chinese medicine. This has stimulated their exploitation causing the severe depletion of sea cucumber stocks in many areas around the Indo-Pacific. Global demand of sea cucumbers was 10743 metric tonnes dry weight in 2001 and the production continues to grow as countries increase their landings (Conand, 2004).

Hai Sam is the common Vietnamese name for dry eviscerated sea cucumbers. The main fishing grounds in the south of Vietnam include the provinces of Khan Hoa, Bin Thuan and Kien Giang (mainly around Phu Quoc). They are sold in fishing markets in Ho Chi Minh City and exported to mainland China, Hong Kong, Japan, Taiwan and Singapore. More than 10 different edible species are sold in Ho Chi Minh markets, among the more easily identified are *Holothuria scabra, Thelenota ananas, Bohadschia argus, Holothuria nobilis* and *Stichopus chloronotus*. The prices vary according to the species and time of the year between 60,000 to 700,000 Vietnam Dong per kilo.

Sea cucumbers are very susceptible to over-exploitation as populations grow very slowly and individuals are slow moving, easy to catch and highly visible. Intensive fishing in areas with no

existing management plans can reduce the numbers to a point where wild populations are unable to recover.

Objectives

The primary end of this study was to estimate the population of each exploitable species of sea cucumber as a baseline evaluation of stocks in Phu Quoc Archipelago. This report however does not claim to represent the status of sea cucumbers of the Phu Quoc group of islands as a whole, but only the areas that were surveyed.

The work also focuses on:

- Spatial abundance, length and weight analyses of exploitable species of sea cucumbers.
- Taxonomy and ossicle analysis for identification of sea cucumber species. The identification includes micrographs of the body wall ossicles found in the dorsal side of each species.
- General ecological observations.
- Collection of information on the status of the exploitation, capture techniques, areas and past history of the exploitation.
- Reproductive biology of three species of sea cucumbers.
- Education awareness activities on sea cucumber exploitation with local fishermen

Results

The marine environment

Sea cucumber populations were surveyed along the coast between January and December 2003, excluding during the monsoon season (June-October).

As most sea cucumbers species show nocturnal foraging activity, hiding during the day time, sampling was restricted to early morning dives always conducted before 9 am. Logistic and safety considerations such as sites with strong currents, bad visibility on repeated occasions, difficult

access by road and high boat traffic constrained the samples areas surveyed. Overall, 170 transects were surveyed between 2- 15m depth. These results therefore only pertain to shallow water communities.

Spatial abundance of exploitable species of sea cucumbers

A total of twenty-five species of sea cucumbers were reported from the shallow waters of Phu Quoc archipelago (Table 1). Eleven of these species are edible and exploited commercially but *Holothuria scabra* (Figure 2 and 3) is the most valuable by far.

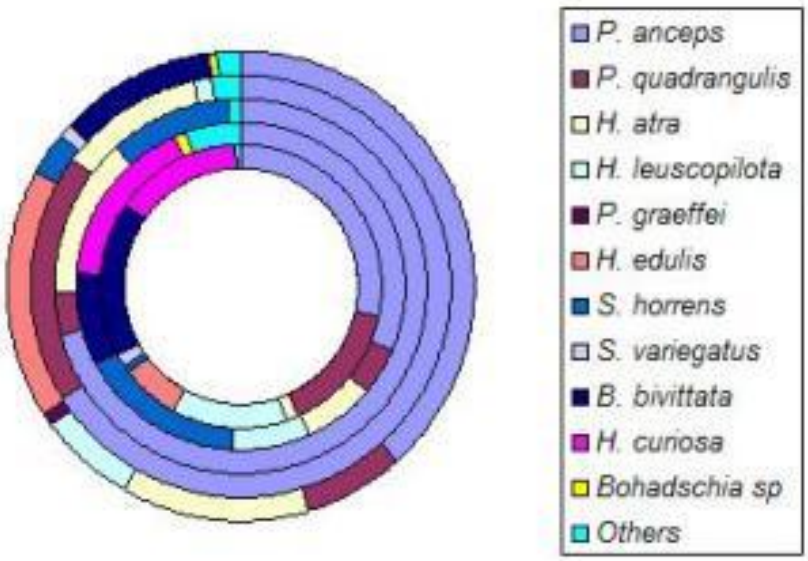


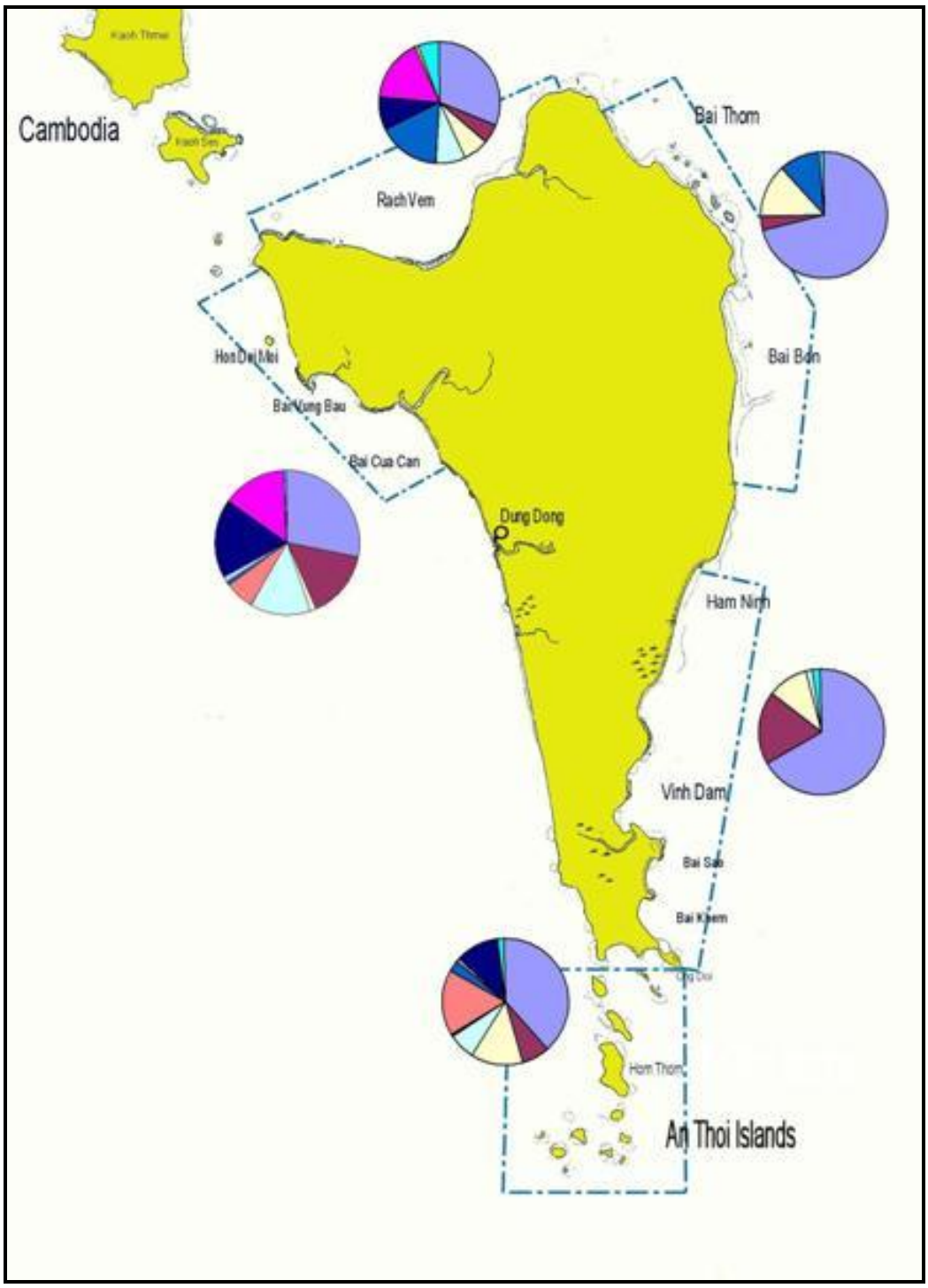
Table 1. Summary table listing sea cucumber species observed during surveys at the occurrence in each of the five sampling sectors visited. Other areas visited: DD (Dung Dong, Phu Quoc Island); TCh (Tho Chou islands); CD (Con Dao Islands). (*) Find by fishermen during time of sampling in the area.

Scientific name	**Family**	**AT**	**HN**	**BTB**	**RV**	**CC**	**Other**
Class Holothuroidea							
*Holothuria scabra**	Holothuriidae	-	-	-	+	+	
Holothuria atra	Holothuriidae	+	+	+	+	+	
Holothuria leuscopilota	Holothuriidae	+	+	+	+	+	
Holothuria edulis	Holothuriidae	+	-	-	-	+	TCh
Holothuria coluber	Holothuriidae	-	-	-	-	+	
Holothuria rigida	Holothuriidae	-	-	-	+	-	
Holothuria sp (Doi Moi)	Holothuriidae	-	-	-	-	+	
Bohadschia bivittata	Holothuriidae	+	-	-	-	-	
Bohadschia sp.	Holothuriidae	+	-	-	+	-	
Bohadschia marmorata	Holothuriidae	+	-	-	-	-	TCh
Bohadschia argus	Holothuriidae	-	-	-	-	-	CD
Stichopus nasus	Stichopodidae	+	-	-	-	-	CD
Stichopus chloronotus	Stichopodidae	-	-	-	-	-	TCh
Stichopus horrens	Stichopodidae	+	-	+	+	-	
Stichopus variegates	Stichopodidae	+	-	-	-	+	
Synaptula maculata	Synaptidae	+	-	-	-	+	
Synaptula sp.	Synaptidae	+	+	+	-	+	
Synaptula lamperti	Synaptidae	+	+	+	-	+	
Enapta godeffroyii	Synaptidae	+	-	-	-	+	
Phyllophorus sp.	Cumariidae	-	+	-	-	-	
Stolus sp.	Cumariidae	+	-	-	-	-	
Pentacta anceps	Cumariidae	+	+	+	+	+	
Pentacta quadrangulis	Cumariidae	+	+	+	+	+	
Cucumaria sp. 1 (Green)	Cumariidae	+	-	-	-	-	
Cucumaria sp. 2 (Orange)	Cumariidae	+	-	-	-	-	

Figure 3. *Holothuria scabra* collected by fishermen in the North of Phu Quoc.

Figure 4. Divers in Bai Thom during a workshop in sea cucumbers.

Figure 5. Phu Quoc study area showing population density of most abundant sea cucumbers. Legend as Figure 3.



Reproductive cycle

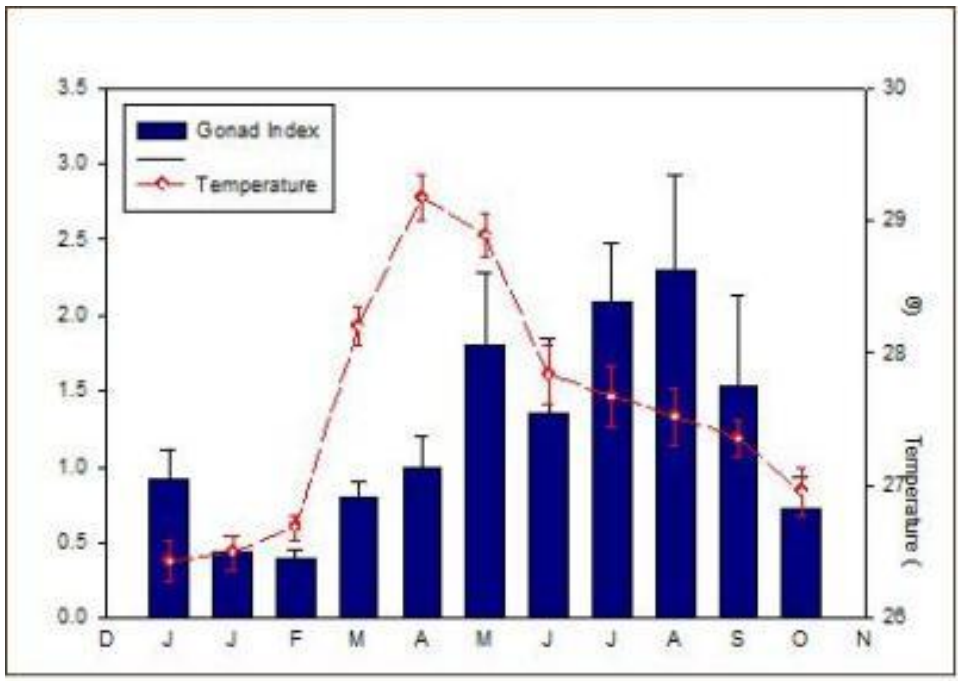
Holothuria edulis is one of the sea cucumber species known to have asexual reproduction by fission as well as sexual reproduction by broadcast spawning. This process is believed to be an important mechanism in maintaining population size (Uthicke, 2001a).

During the current survey, individuals of this species were first seen in the process of transverse division in June at the beginning of the rainy season (Fig. 6). Fission specimens, those that just divided and only possessed the posterior or anterior part of the body were currently found from June to October. From the whole population surveyed over a year only 16% were males, 2.4% females and 81.4% had immature gonads which indicate a very low reproductive capability.

The gametogenic cycle of *H. edulis* in this area over the year is represented by gonad index analysis (Fig. 7). The gonad index (GI) was calculated as: (Gonad wet weight x 100/ Total wet weight). Gonad index for both sexes was pooled as a high percentage of individuals showed immature gonads. The largest GIs were recorded from May to September followed by a decrease at the beginning of the dry season. A further study to quantify the degree of gonad maturity is currently being undertaken.

Figure 6. *Holothuria edulis* undergoing fission, July 2004.

Figure 7. Monthly mean and standard error in gonad index for all individuals of *H. edulis* versus seawater temperature.



The pattern of gonad growth for *Pentacta anceps and P. quadrangulis*, as exhibited by the GI data, was variable for both species. Gametogenesis was synchronous between both sexes of *P. quadrangulis* although most gonad samples contained tubules in several stages of development . The largest GI for *P. quadrangulis* was found in March.

Further analysis of the histochemical preparations of the gonads will help to determine the frequency on maturity stage of each gonad sample for each of these species. Data from the GI and histology need then to be examining together to ascertain the pattern of gonad development of these two sea cucumber species in Phu Quoc Island.

Fission products of *H. atra* from the same area where both *Pentacta sp.* were collected were observed in September towards the end of the monsoon season.

Discussion

From the interviews of local divers and sea cucumber traders is clear that sea cucumbers were once very abundant in the waters surrounding the Phu Quoc archipelago before harvesting commenced during the 80s. The community itself believes that the drastic decline of sea cucumbers is mainly a consequence of their overexploiting them. Now only those species of little or no commercial value are found in these waters (*H. atra, H. leuscopilota, H. edulis, Pentacta* sp.) and those species of medium or higher value are rarely seen (*H. scabra, Bohadschia* sp., *Stichopus* sp.) (Figure 4).

In general, it appears that sea cucumber populations have been heavily exploited (Figure 5). All commercial sea cucumbers species encountered were at extremely low densities and showed a very patchy distribution, often concentrated in a single transect line, hidden between rocks, crevices or seagrass and not reappearing for kilometres. Surveys carried out in other countries also have shown a similar pattern, concluding that the distribution of these echinoderms might be highly dependent on a suitable habitat that offers protection from rough seas and predators (Uthicke and Karez, 1999). Edible sea cucumber species such as *H. scabra, S. variegatus, S. nasus, B. argus, B. vitiensis* or *B. bivittata* were rarely seen around Phu Quoc archipelago, most probably as a consequence of a extremely heavy exploitation that have locally extinct some species and reduced others to unsustainable reproductive levels.

Phu Quoc is one of the most attractive and productive coastal ecosystems remaining in Vietnam. However, recent reports have begun to indicate overfishing and a decline in common capture fisheries of many organisms such as squid and anchovies (Keith, 2005). Of concern also are the destructive fishing practices such as cyanide fishing, coral damage and trawling operations, especially those which occur over coral reefs and in important spawning grounds for many species like seagrass beds. Aquaculture activities such as shrimp farming and mariculture of pearl oysters are restricted to small areas around the archipelago and probably have a limited ecological impact in the area. However, tourism and urban development are expanding rapidly and consequent coastal habitat degradation and pollution (i.e. waste disposal, nutrient input) might have major effects on the future of sea cucumber populations, associated communities and their environment through habitat loss or community change. Over-fishing coupled with the degradation of coastal habitats and

a lack of an integrated management program will be major factors affecting the recovery of sea cucumber populations in Phu Quoc.

There is a need to increase our understanding of the biology and reproductive behaviour of sea cucumbers, their relationship with their habitat (i.e. nutrient cycling), their ecological role and interactions with their environment. Greater understanding will provide the information needed to characterize and quantify the dynamics of sea cucumber populations around Phu Quoc archipelago, the anthropogenic impact on the populations and their links with coastal processes.

From an economic point, a future management scheme once the populations have achieved a certain recovery level, might include no-take zones, fishing quotes for different species and a full multi-species restocking program. This could convert sea cucumber fisheries into a sustainable natural resource for local communities and increase its marketable value. Nonetheless, a management program for sea cucumber populations need to be coordinated regionally and developed in conjunction with an integrated program of action designed to reverse environmental degradation particularly in coral reefs, mangroves and sea grass habitats, halt human land-pollution, increase environmental awareness and address the issues of fisheries over-exploitation.

Species of sea cucumbers like *Holothuria scabra*, *Stichopus variegatus* or *Bohadschia bivittata* may need further protection by including them in the Vietnam Red Data Book (Sach Do Viet Nam) as they appear to be in serious decline worldwide.

The waters of Phu Quoc Archipelago are still virgin for the scientific community. Vietnamese scientists have the great challenge to discover the biodiversity in their coastal waters, its functionality and richness, and overall be able to share their knowledge and encourage its protection.

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