# The Galapagos sea cucumber fishery: a risk or an opportunity for conservation?

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The increasing demand for sea cucumbers from Asian markets and their over-exploitation in the Western Pacific has caused this fishery to move into the eastern Pacific as far the Galapagos in recent years. The Galapagos Islands are known worldwide for their unique fauna and flora. About 97% of the terrestrial area of the Galapagos was declared a National Park in 1959, and the marine and coastal environments were declared a Marine Reserve in 1986. Since the establishment of the Galapagos National Park, the Government of Ecuador has made efforts to maintain the integrity of the islands and to protect their unique environments. This contributed to the declaration of the Galapagos Islands as a World Heritage Site by UNESCO in 1978, and later in 1985 its recognition as a Biosphere Reserve. However, new pressures from the mainland threaten the well-being of the Galapagos, including the sea cucumber fishery.

The exploitation of sea cucumbers started in the Galapagos in the early 1990s and concentrated on one species, *Stichopus fuscus*. This new fishery was introduced by Asian entrepreneurs that settled in mainland Ecuador around 1989. After depleting *Stichopus fuscus* populations along the coast of Ecuador, they moved their operations to the Galapagos, carrying with them a flux of people looking for new opportunities. From the beginning, this fishery developed without baseline biological data, and without a monitoring plan. It has had an enormous socioeconomic impact, resulting in increased human migration to the Galapagos, illegal fishing, and violations of the regulations of the National Park. For all these reasons the Government of Ecuador in 1992 prohibited fishing for sea cucumbers in the Galapagos by a presidential decree.

Nevertheless, an illegal fishery continued. In 1994, an experimental two month artisanal fishery was allowed. This harvest was closed one month after it started, due to a lack of commitment by the fishers to the rules imposed by the National Park and Fisheries authorities.

Sea cucumber fishing was then banned in the Galapagos. But the clandestine fishery continued, due to poor enforcement. Meanwhile, population studies of the sea cucumber *Stichopus fuscus*, by researchers at the Charles Darwin Research Station, revealed a continuous decline in the number of sea cucumbers. The scientific and conservation community urged the Government of Ecuador to dedicate more effort to the conservation of the Galapagos Marine Environment.

As a response, in 1996, a consensus-based, participatory management process, with representatives of various stakeholders was established. The stakeholders include the fishing, tourism, science and education sectors, and National Park authorities. This group has maintained regular meetings to review and develop sustainable management and conservation policies. Their work resulted in the approval of a special law for the Management of the Galapagos Islands, signed by the president of Ecuador in 1998, and the second Marine Management Plan of the Galapagos, which was legally approved by the executive in 1999. With these important achievements, the Galapagos now have a legal framework for conservation and resource management in the Marine Reserve.

In the meantime, the artisanal fishing sector continued to petition the Government for the reopening of the sea cucumber fishery. Their petition was accepted, and a two month sea cucumber fishery was opened during April and May 1999. The Galapagos National Park Service, the Charles Darwin Foundation, the National Fisheries Institute, and the Ecuadorian Navy carried out the control and management of this fishery with the collaborative support of the Artisanal Fisheries sector. This arrangement made it possible to organise an inter-institutional working team to plan, coordinate, control and follow up the whole fishing activity and the commercialisation of the product.

Approximately 795 fishermen and 222 artisanal vessels participated in this fishery. A total of 4,401,657 sea cucumbers were exported from the Galapagos during this two month harvest season, representing a total of over 122 metric tonnes of dry product, worth USD 3.4 million. There were many lessons, both positive and negative, learned during this first fully organized and monitored sea cucumber fishery, and a very important point was that a new fisheries management and control system was established and respected by most fishermen and local community. This was a big step forward.

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This year, a new sea cucumber season was included in the fishing calendar, from May to July. On the basis of past experience, many efforts have been made to conduct this fishery with a better management and control system. A fixed quota and a zoning plan with "no take" areas have been established. However, just a few days before the sea cucumber season started, a group of fishermen revolted in protest against the rules established by the authorities. They took by force the National Park and Charles Darwin Research Station offices on Isabela Island, and removed tortoises from the rearing center as ransom in an attempt to get the rights to fish more sea cucumbers. Fortunately, the government kept to the rules established by the management authorities and the threat was unsuccessful. The tortoises were recuperated and actions have been taken against those responsible for this criminal act.

Although, this type of event caused instability and raised questions about the management process, not all the fishermen support this kind of deed. The leader of the fisheries cooperative of Santa Cruz Island declared his rejection to this action and expressed his total support to the participatory management process. There is a long way to go in this slow process but a basis for conservation has been established in the Galapagos.

It is hoped that this new strategy of conservation based on participatory management will not be another human experiment with nature, but the beginning of a solid basis for protection of the Galapagos as a whole.

# The process of asexual reproduction by transverse fission in *Stichopus chloronotus* (greenfish)

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## Introduction

*Stichopus chloronotus* (greenfish) is generally considered a low value beche-de-mer species. However, due to overfishing of high commercial species worldwide (Conand and Jacquemet 2000) it is likely to become more important in tropical fisheries. This species is one of eight aspidochirotide species known to have asexual reproduction by transverse fission in addition to sexual reproduction by broadcast spawning (Harriott 1980; Conand et al. 1998; Uthicke 1997; Uthicke et al. 1999). Asexual reproduction is a seasonal event mainly occurring in winter and is an important means of population size maintenance in this species (Uthicke 1997; Uthicke et al. 1998). Therefore, information on this reproductive mode is important for the sustainable management of the fishery for this species.

Most holothurian species with asexual reproduction follow the "twisting-and-stretching" mode (Emson and Wilkie 1980): the anterior and posterior sections slowly rotate in opposite directions, resulting in a constriction in the holothurian. In a second step, the two halves slowly move in opposite directions, until the bodywall tears at the constriction and the two halves become completely separated. This process had not been previously observed in *S. chloronotus*. Observations on this process are reported here.

## Observations

During routine surveys of holothurian populations on Lizard Island (Great Barrier Reef) on 8 June 2000 at 14h00, I observed on the shallow reef flat a specimen of *S. chloronotus* that appeared constricted slightly anterior to the middle and showed some white tissue at the constriction (Fig. 1A). I carefully collected this individual and transported it to a nearby aquarium with running seawater. After some initial activity, this specimen remained nearly stationary on the wall of the aquarium for about four hours. At 19h30, the constriction became slightly more distinct, and the animal started to move (Fig. 1B). Shortly after, the posterior half of the individual remained stationary, while the anterior end continued to move forward. This resulted in a more distinct constriction (Fig. 1C). At this point, the bodywall at the fission site was nearly liquid, and the two body parts separated apparently without effort, remaining connected only with a string of mucus for about 30 seconds (Fig. 1D). The entire process of fission lasted only for about five minutes. The bodywall at the fission

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