A pilot study to investigate the survival of *Stichopus horrens* after viscera harvest in Samoa

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Introduction

In Samoa, sea cucumbers are harvested for subsistence and artisanal purposes. Four species are targeted by local fishers: peanutfish, *Stichopus horrens* [4] (local name *sea*); brown sandfish, *Bohadschia vitiensis;* lollyfish, *Holothuria atra*; and the leopard or tigerfish, *Bohadschia argus*. *S. horrens* is the most sought after species and is fished for its viscera (generally the intestine, but also respiratory tree and gonads). The viscera product is removed from live animals and consumed raw, while processed animals are returned to the water alive. The viscera product from *sea* is placed — along with body wall strips from other sea cucumbers — in bottles filled with seawater and sold at local markets and along the roadside (Figs. 1 and 2). This species is also fished in other parts the Pacific, such as Tonga (K. Friedman, pers obs). *Sea* supports a "gamat water"[5] industry in Malaysia (Baine and Forbes 1998; Baine and Choo 1999), where its use as a traditional nutrition and drug agent is well documented (Ridzwan et al. 2003; Hawa et al. 1999).

Some fishermen believe that animals survive the harvesting procedure and that returning processed *sea* to the ocean allows the animals to be harvested again after they regenerate their internal organs. The animals' survival and the possible regeneration of their viscera after cutting has attracted the attention of researchers, but few experiments have been conducted on potential survival and regeneration rates for animals harvested in the traditional fisheries in the Pacific (Lambeth 2000). Some studies show that intestinal regeneration is possible among holothurians (e.g. Quinoñes et al. 2002; Mashanov et al. 2005), as well as gonadal regeneration (Drumm and Loneragan 2005). Studies on another species (e.g. *Holothuria parvula*) suggest that full organ regeneration (following self-induced fission) may take up to a year (Emson and Mladenov 1987). It is not known if *S. horrens* survives the harvesting process in Samoa, and even less is known about whether regrowth of its internal organs would allow re-harvesting for the collection of more viscera product. The possibility that animals survive the removal of their viscera consequently provides an exciting possibility for the management of a declining fishery, where a rotational fishing scheme could boost productivity.

Figure 1. The *S. horrens* (*sea*) viscera product.

Figure 2. Bottles of sea cucumber raw product: the brown mass is viscera from *S. horrens* and the white mass is from the body wall of *B. vitiensis*.

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4. In the past, this species has often been referred to as *Stichopus herrmanni*, and nomenclature is currently under further review.
5. *Gamat* water is boiled coelomic fluid. It is taken orally for certain ailments.

Fishing for *sea*

In Samoa, *sea* are collected at night from a canoe using an underwater torch and a mask and snorkel (or goggles). The *sea* are kept in the bottom of the canoe in water (see Fig. 3) and brought back to shore after fishing where they are placed into buckets and held until processing. Fishing trips usually last around three hours. One-third of each bucket is filled with animals and then topped up with fresh seawater. Keeping the s*ea* in buckets allows the animals to empty their intestines of sand, which makes the viscera product more edible. In general, animals are left in buckets for two to five hours, although the time varies between sites and fishermen. The *sea* is then processed by cutting a slit in the side of the animal with a knife (Fig. 4) to expose the viscera, and the intestine is checked for sand before being placed in a glass bottle. After the animal has been cut and emptied of its viscera, it is discarded into a separate bucket that is filled with a small amount of seawater. It seems that less care is taken of these animals after processing. Processed animals are returned to the ocean, close to the shoreline, which is not the preferred habitat of *sea* in most fishing locations. Even if the animals survive the cutting procedure, they may stand less chance of survival after being returned to the ocean, away from their preferred habitat. In villages where fishing was observed, the nearshore areas had high sediment loading, were exposed to wave action, or had a very high terrestrial influence (including runoff of village wastes).

Pilot study

Following the PROCFish/C survey in Samoa, a pilot study was set up to learn about what happens to *S. horrens* after they have been cut and emptied of viscera. The authors believe that post processing handling of *S. horrens* could play a vital role in the future management of the fishery. The study was performed as a small-scale survival project and attempted to determine the survival rate of *S. horrens* after processing. The study was conducted from 8–12 December 2005 in the village of Toamua, just west of Apia.

Three hours were spent fishing from 19:30 to 22:30, and during this time 23 *S. horrens* individuals were caught. The catch was brought back to shore and left overnight (8 h) in a bucket. In the morning, the animals were cut and processed by a local fisher. These processed animals were placed in cages, three cages with six animals each, and one cage of five animals in a nearshore area (where the animals were usually returned). Two to three large rocks were placed inside each cage to hold it down; these rocks also provided shelter for the animals. On the following day, the animals were checked for survival and the possible heal of their cut. After 24 hours in the cages, 13 animals were still alive: nine had healed their cut, three had almost healed, and one remained in a similar condition to when it was processed. After four days, four of the animals were cut open to check for possible regrowth of viscera. No viscera

Figure 3. *Sea* fisher with live product in his canoe.

Figure 4. Cutting *S. horrens* for its viscera.

regrowth was noted for any of the animals. In spite of its small scale this study still reveals a rough survival estimate of about 50% after the first 24 hours in the cages, and that out of these survivors the majority had completely healed their cut. These findings are in agreement with a similar study of *Holothuria leucospilota*, where it was found that incisions in the body wall healed within a few days (Drumm and Loneragan 2005).

Outlook

The authors realise that the experiment was preliminary and wish to draw attention to the failings of this study and highlight what is necessary for future work.

Experience from this pilot study has shown that plastic mesh cages (size: base 450 mm x length 450 mm x height 200 mm, mesh size: 12–17 mm) used to hold post-processed animals may be unsuitable for use as a holding unit, because the mesh size is too large, allowing animals to escape, and the cage itself has an effect on the recovering animals. In a similar study with *H. leucospilota*, cages were lined with 2 mm nylon mesh with excellent survival rates of processed animals (Drumm and Loneragan 2005).

The authors believe that survival may be affected by two factors: processing and the selection of the catch–return area. Handling issues, which include transport and holding procedures, need to be assessed, and returning cut animals to inshore sites or areas of *S. horrens* habitat might also critically affect the survival of processed animals. Further studies would ideally include treatments that assess pre- and post-processing holding times, and the return of processed animals to both nearshore areas (where fishers currently return their catch) and preferred *S. horrens* habitat (where the animals are caught). Some fishers harvest *sea* by day when the animals are typically not feeding; this way, "clean" viscera can be removed immediately. Discards from this fishing activity are done in the vicinity of the collection site. Experiments designed to test the selection of the catch–return area might benefit from this difference in the catch–return method.

Other factors to be considered are post-processing predation and the effects of wave exposure in nearshore areas. More long-term assessments might also suggest the best time to harvest *sea*, and a time period that processed stock should be rested, before they are re-processed.

Summary

This pilot study showed that *S. horrens* can survive the harvesting and processing procedures that are necessary in order to collect viscera. This study also shows that the animals are able to heal their cut, although no further conclusions can be derived from these results. Future studies should address the probability of survival, depending on handling procedures and the catch–return area. The authors believe that such research will increase the understanding of *S. horrens* organ regeneration in the field, and will prove valuable for future management of this fishery.

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