

Sandfish (*Holothuria scabra*) farming in a social–ecological context: conclusions from Zanzibar

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Abstract

Sandfish (*Holothuria scabra*) farming is being promoted as a potential economic activity for coastal communities, and especially for those currently involved in fishing for sea cucumbers—an unsustainable fishery. With the collapse of many tropical sea cucumber stocks, and with agendas to find new income alternatives for coastal populations, the interest in aquaculture, particularly in sandfish, will most probably increase. However, in-depth analysis of the social and ecological consequences from introduction of sandfish farming is lacking. In Zanzibar, Tanzania, 74 sea cucumber fishers were asked if they would like to farm sea cucumbers. About 64% of the respondents were positive to farming. Their comments highlighted that they perceived farming as an addition, not a replacement, to catch from the fishery, and that they were concerned about the personal risks involved in an investment. The responses illustrate that aquaculture may have a negligible or negative effect on the fishery. There are also potential ecological impacts, which, of course, will depend on the scale of the activity, but for which there is currently little knowledge. The risk-awareness poses the question on what business model a sandfish enterprise should operate to reduce risk for communities with few income alternatives. The results from the interviews indicate that it is essential to learn from past sandfish farming initiatives and other aquaculture ventures that have resulted in the development of standards. It is also apparent that it is important to apply a social–ecological systems approach to sandfish farming development.

Introduction

Many sea cucumber fisheries around the world are suffering from overfishing (Purcell 2010). This can generally be attributed to insufficient capacity to manage the fishery (Muthiga et al. 2010), lack of ecological knowledge from which to form management (Uthicke et al. 2004), stochastic recruitment (Uthicke et al. 2009), strong market demand (Anderson et al. 2011), illegal fishing (Price et al. 2010) and limited presence of institutions (Eriksson et al. 2010). While local fisheries are becoming depleted, resulting in moratoriums being placed on exports in numerous locations (Purcell 2010), there is still a need to maintain income

opportunities in communities and nations. In this context, tropical sea cucumber aquaculture is currently gaining momentum.

The only suitable tropical sea cucumber varieties for farming, using hatchery-produced animals, are those in the sandfish species complex (Agudo 2006; SPC 2009). There is currently some uncertainty regarding species nomenclature across the Indo–Pacific region, where the taxon *Holothuria scabra* may contain varieties in need of species recognition (Massin et al. 2009). This text will therefore use the common name ‘sandfish’. Sandfish is a high-value species in strong demand on the international market, which makes it a promising candidate for aquaculture. Properties indicating its suitability for farming are, for example, that it feeds low in the food chain and occurs naturally in dense populations in many tropical coastal waters (Hamel et al. 2001).

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A number of scenarios exist for sandfish aquaculture. Commonly, emphasis is on farming hatchery-produced animals in enclosures or no-take zones, with the aims of rebuilding depleted stocks and enhancing livelihoods for coastal communities in areas with few income alternatives. The potential of aquaculture as a source of income in coastal communities is illustrated by the prospective suitability of sea ranching, or farming hatchery-produced animals in pens in coastal waters (Bell et al. 2008; Robinson and Pascal 2009), in particular where there is a need to reduce effort in the fishery to prevent stock demise and maintain income opportunities.

Fishers from poorer households are less likely to exit a declining fishery (Cinner et al. 2008), emphasising both how poverty traps communities in declining fisheries, and how important is the generation of income opportunities to support communities to reduce fishing effort. In addition, subsistence or artisanal fishers often support themselves from a diverse range of livelihoods (Allison and Ellis 2001), which raises a paradoxical question of whether profits from sandfish aquaculture will replace those of fishing, or if it will be perceived as an addition to fishing, with fishing effort continuing at similar levels. Subsistence or artisanal fishers are also generally exposed to high degrees of risk and uncertainty in terms of personal safety and income (Andersson and Ngazi 1998). This can prompt an increased emphasis on a cooperative behaviour to reduce risks, but, in a poverty situation, also reluctance to engage in activities that might further increase risk (Barrett et al. 2006). In Madagascar, where community-based sandfish farming from hatchery-produced animals has been introduced, sandfish juveniles are bought by families on credit and sold when harvestable (Robinson and Pascal 2009). Risk is thus to some extent borne by families. This risk raises concern with regard to how farming should operate to minimise risk in poor households.

Zanzibar Island, in the western Indian Ocean, has an active fishery targeting sea cucumbers for export as beche-de-mer (Figure 1). The fishery in Zanzibar is institutionally marginalised, lacking management and control; as a result, easy-access stocks are widely depleted, and exports are maintained with the aid of sequential exploitation and trade (Eriksson et al. 2010). In this study, information collected through interviewing fishers participating in the sea cucumber fishery in Zanzibar was used to explore how they perceive the potential activity of farming sea

cucumbers. The fishers had not been exposed to sea cucumber aquaculture previously, and no hatcheries were operating in Zanzibar. The results were analysed in the context of how farming would fit into a coastal setting where the fishery is active and income alternatives are few. The focus of the analysis was the potential effect on the sea cucumber fishery, and the potential risks involved for communities.

Methods

As part of a study to map and assess the local sea cucumber fishery in Zanzibar, fishers were interviewed regarding their perceptions of the fishery and its management (Eriksson et al. 2010). Here, answers from the categorised yes-or-no question, 'Are you interested to farm sea cucumbers', and the open-ended follow-up question, 'If so, why/why not', were used to analyse perceptions and attitudes. Interviews were conducted in eight villages (Nungwi, Mkokotoni, Uroa, Chwaka, Mazizini, Fumba, Unguja Ukuu and Mtende) (Figure 2), which were chosen because they had an active sea cucumber fishery. The interviewees were chosen randomly, and included men and women gleaning in nearshore areas, and men that breath-hold and scuba dive in nearshore and offshore areas. The interviews were semi-structured (Denscombe 1998) and conducted in Swahili with the assistance of a translator.

Results

Seventy-four fishers (51 men and 23 women) were interviewed. There was interest to farm sea cucumbers among both men and women; however, men showed a higher interest than women (69% and 52% positive answers, respectively) (Figure 3).

Almost one-third of the interviewed fishers indicated that they perceived farming as an addition to catch from the fishery, rather than a replacement (Table 1). For example, fishing was highlighted as a continuous activity while having to wait for harvest. Some fishers also expressed concerns about the personal risks involved in a farming enterprise, and one fisher highlighted that this could be avoided through employment. The perceptions of risk were illustrated by, for example, an emphasis on the current lack of knowledge, the weak management of the sea cucumber fishery in Zanzibar and the likelihood of catch being stolen. Ten percent of interviewees highlighted their reluctance due to the risk of animals



Figure 1. A: Middleman gutting and boiling recently caught curryfish in Mkokotoni village, Zanzibar. B: 'Pentard' teatfish product held in hand over brown sandfish products at an exporter's location in Stone Town, Zanzibar

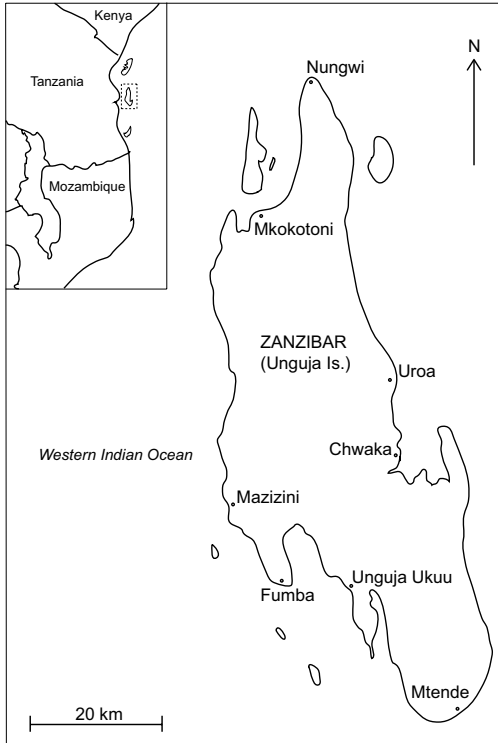


Figure 2. Map of Zanzibar (Unguja Island) showing locations of villages where interviews with fishers were conducted

Table 1. Perceptions of sea cucumber farming among interviewed fishers in Zanzibar, Tanzania

Issue	Comment/concern
Effect on fishery	'I can still fish while I farm' 'Can develop more catch' 'Too long to wait for harvest' 'More to sell' / 'More income'
Risk for communities	'Some could steal' 'Need training on how to do it' 'Cannot afford to wait for harvest' 'Only if employed'

being poached. In relation to knowledge, four fishers (female) said they had no interest because they did not know how to do it, while three fishers (men) indicated an interest if taught how to farm. One fisher highlighted that it might be an activity for the whole village to get involved in.

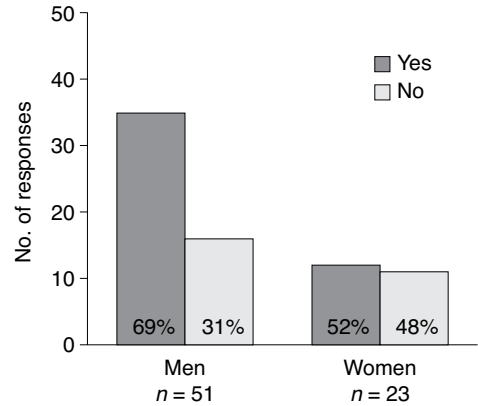


Figure 3. Distribution of answers among men and women in Zanzibar, Tanzania, regarding their interest in farming sea cucumbers

Discussion

Effect on fishery

The responses by sea cucumber fishers in this study illustrate that there is an interest to farm sea cucumber, but that it cannot be taken for granted that farming will reduce fishing pressure or improve the health of wild stocks. In many developing countries, a diversified palette of livelihoods (e.g. fishing, farming, trading or casual work) is common (Allison and Ellis 2001), arguing that it is unlikely that aquaculture will replace any one fishing activity; rather, it will diversify alternatives, thereby providing a potentially important source of social resilience. Whether it will alleviate fishing pressure on other marine resources, however, is a complex question. As experienced in seaweed farming, aquaculture can have a negligible effect, or even a negative effect, on use of other marine resources, for example through increased capital required for fishery improvement (Sievanen et al. 2005). In Zanzibar, a majority of both fishers and trade middlemen make it clear that they want access to more capital to invest in the fishery (Eriksson et al. 2010), and it is therefore probable that profits from farming may be used for investing in the already depleted fishery. To what extent this scenario can be generalised is difficult to gauge. However, in most tropical sea cucumber fisheries, it is likely that fishing will continue or increase as long as the trade is profitable and the governance weak.

There are also potential ecological systems effects with sandfish farming that have not been properly evaluated or studied. Seaweed farming, which was introduced into Zanzibar during the 1990s, is today widespread, and may perhaps provide some reference for sandfish farming. It is also a low-intensive (i.e. does not require additional nutrient input) cash crop, grown in the same coastal communities where sea cucumbers are fished, and serves the international market. When seaweed farming was introduced, it was endorsed with minimal environmental concerns. Today, however, ecological studies have shown that it reduces the abundance of seagrass and macrofauna (Eklöf et al. 2005), reduces above-ground biomass up to 40% (Eklöf et al. 2006), and alters community structure (Bergman et al. 2001). These effects obviously depend on the scale of the activity. It is likely that sandfish farming will have ecological effects not yet studied, which may compromise ecosystem integrity (e.g. translocation of broodstock) or deteriorate ecological goods and services already providing subsistence to coastal communities. Therefore, it is equally important to set aside resources for studying the ecological systems effects of farming as it is to technically develop the hatchery and marketing aspects.

Risk for communities

Although a majority of fishers that were interviewed showed an interest in farming, some were reluctant to engage in the activity due to the perceived financial risk and lack of knowledge. This raises the issue of which business model an enterprise should operate under. In Zanzibar, use of coastal marine resources is characterised by cooperative and conflicting institutions that both cushion and exaggerate resource-use conflicts and sustainability (de la Torre-Castro and Lindström 2010). This can be attributed to many similar fishing situations elsewhere, and highlights the institutional complexity that often affects resource use and ability to implement management. The risks of farming will therefore be dependent on the context in which it is introduced, highlighting the importance of a proper feasibility study before initiation. There are no universal blueprints.

Fishers in Zanzibar also expressed concerns about the risk of poaching, a problem experienced in Madagascar (Robinson and Pascal 2009). This highlights a governance issue that is difficult to circumvent, but certainly compromises the activity

and constitutes risk for investors. In Madagascar, some communities that bought subsidised juveniles for grow-out in 2008 are still in debt from lost stock (G. Robinson, pers. comm.). This was obviously not the objective for any of the participants in this operation, but it pinpoints that the full production chain is not foolproof, and that there are monetary risks involved. In addition to risks of crop losses, it is costly to operate a hatchery, and profits are 'far from certain' (Hair et al. 2011). Some interviewed fishers consequently indicated that they would prefer employment, limiting their personal investment to labour. That women are being exploited for profits, as evidenced by an astounding discrepancy in catch value between fishing men and women (i.e. approximately US\$2.40/kg versus US\$0.10/kg paid to men and women, respectively, for similar catch (Eriksson et al. 2010)), is probably the reason why they are more reluctant to engage in farming than men are. This situation illustrates that fishing communities are already vulnerable and not resilient to cope with change. If the ambition is to create independence and economic opportunities for fishing communities, risk in farming enterprises should consequently not be borne at the community level.

Outlook

The reasons for sea cucumber overfishing and stock degradation are complex. In some cases, however, weak governance and absence of capacity to implement control appears to be a central problem (Muthiga et al. 2010; Eriksson et al. 2010). In this context it is important to underscore that new technology cannot replace governance, nor can it produce the same number of species (sometimes reaching 35) that are targeted in the fishery (Purcell 2010). Successful introduction of hatchery enterprises to restock depleted populations or alleviate pressure from fishing is therefore not guaranteed with the current level of knowledge, and the level of management participation in fisheries where governance is weak. That expectations from sandfish aquaculture need to be balanced was illustrated in a brief questionnaire sent out to five scientists with leading insight and experience in the topic of sandfish farming, asking them to rank on a 1–5 scale how likely some considerations are to be realised (Eriksson 2009). The highest scoring concern was that farming would be introduced on inflated promises. This is very unfortunate—not living up to unreasonable initial expectations may undermine

the future potential success of sandfish farming. Moreover, it may lead communities into taking unnecessary risks.

The future of sandfish farming lies in understanding and managing the fishery and beche-de-mer trade (e.g. Friedman et al. 2008), and in the critical evaluation of experiences and development of research in relation to successes and failures of farming; for example, filling the knowledge gap regarding business models that benefit fishers and communities. Therefore, it is very important to share knowledge and experience so that successes are replicated and mistakes not repeated. In this sense, developing new, or strengthening existing institutions, requires that learning mechanisms are implemented, and that a social–ecological systems perspective is applied. This whole process would be made easier by adopting a benchmark approach to developing standards for responsible sandfish farming, on which managers and political decision-makers can base decisions, as has been done for other aquaculture organisms (e.g. WWF 2010).

Conclusion

There is an interest among communities to farm sea cucumbers. However, the current fishery situation in Zanzibar is a result of weak governance, in that actors in the trade operate with minimal ambition to allow fishers to capture profits, and this raises questions regarding the feasibility of farming. The lack of governance mechanisms that would allow for a sustainable and functioning fishery cannot be substituted with new technology (hatcheries). Therefore, unless governance issues are addressed and improved, it is very likely that a farming enterprise will go down the same road as the fishery—impoverished and with marginal social equity.

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