Economics and management strategies for restocking sandfish in Vietnam

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Abstract

This paper assesses the costs and benefits of a proposed project for restocking sandfish (*Holothuria scabra*) in Khanh Hoa Province, Vietnam. It identifies the key stakeholders, institutional framework, management and financing required for its implementation. The recommended management strategy includes a 50 percent harvest at optimum size. Limiting the number of boats fishing an area, possibly through licensing, can control the number of sandfish removed. The easiest way to prevent harvesting of undersized sandfish is to control the size of processed sandfish from processors. The potential benefits of restocking are shown by the rapid changes in selected indicators, particularly the net present value, the internal rate of return, and the benefit-cost ratio. Probability analysis is used to estimate the uncertainties in the project calculations. Based on a conservative estimate, the restocking of sandfish is expected to be profitable, although cost-benefit analyses are sensitive to the survival of restocked sandfish and their progeny, and the number of boats fishing for sandfish in the release area.

Introduction

Sea cucumbers form an important component of the fisheries of the Indo-Pacific region. They are harvested for processing to bêche-de-mer, a high-priced food item consumed in Asian countries. Market demands, ease of harvesting and inadequate management have led to the overexploitation of sea cucumber fisheries worldwide (Conand and Byrne 1993; Martinez 2001; Silva 2001; Ibarra and Soberón 2002; Battaglene and Bell 2004). Sea cucumbers are broadcast spawners and need a threshold population density for fertilization success. Hence, overexploited sea cucumber populations may take several decades to recover (Battaglene and Bell 2004). This "boom and bust" cycle has negative socioeconomic effects on local communities (Ibarra and Soberón 2002; Jangoux et al. 2001). Depleted sea cucumber stocks can be restored (Battaglene and Bell 2004; Bell and Nash 2004). Recent research has focused on the development of breeding and rearing methods (Pitt and Duy 2004) and optimal release strategies for hatchery-reared juveniles (Purcell 2004). In Vietnam, the sandfish, *Holothuria scabra*, is the most valuable species. A restocking project releasing 540 000 juvenile sandfish per year, over a period of ten years, was planned and evaluated. The study was carried out in the Van Ninh, Ninh Hoa, Nha Trang, and Cam Ranh municipalities of Khanh Hoa Province, Vietnam from June to August 2002.

Methodology

An *ex ante* evaluation, necessary to determine if a project is suitable for investment, involves many predictions and estimates (Sang 1998). Several steps were taken to identify the relevant costs and benefits in the restocking model (Figure 1). Data were gathered through participatory rural appraisal (PRA) following a stakeholder analysis, using group discussions and semi-structured questionnaires with 37 fishermen (divers), four processors, five shrimp pond owners, the Fishery Extension Center, the Fishery Exporting Company No. 17, and two banks.

After estimating production costs and survival rates for restocking, the next step was to identify the costs and benefits to the relevant stakeholders in the project. These were used to generate a project cash flow. On the basis of the project cash flow, selected indicators were calculated, i.e., the net present value (NPV), the payback period, the internal rate of return (IRR), and the benefit-cost ratio (BCR). A probability analysis was applied to deal with uncertainty.

The hatchery and restocking

The hatchery and nursery complex was planned to supply and release 540 000 juvenile sandfish at 10 g bodyweight each year for 10 years, from an initial broodstock of 800. The materials needed to construct the facilities were estimated by the WorldFish Center and the Research Institute for Aquaculture No. 3 (Vietnam) and valued at local purchase prices. The survival rate of the cultured sandfish was set at 15 percent based on results from Yanagisawa and Honda (1992) who released 200 000 seed of *Stichopus japonicus* of average length 2.5 mm, with a confirmed survival rate of 12.3 percent seven months later. From the 540 000 juvenile sandfish released in year 1, and

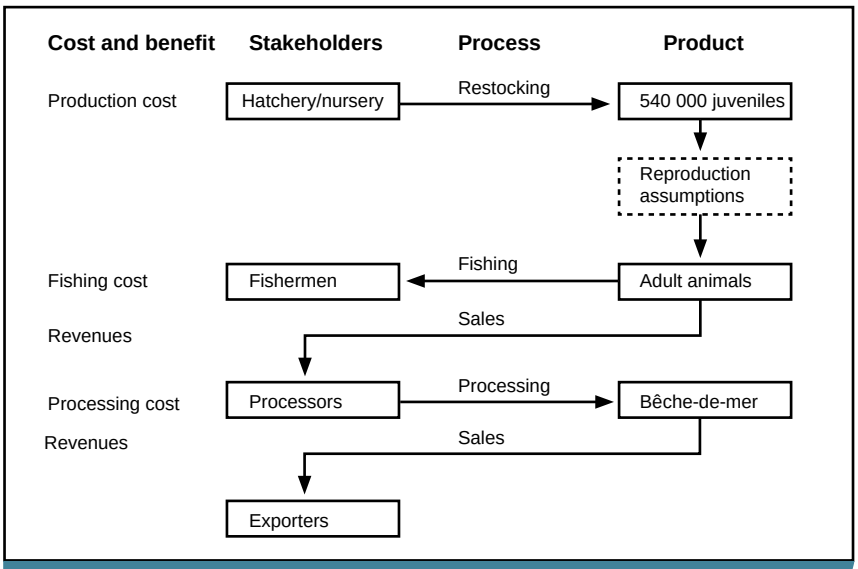


Figure 1. The restocking model: project costs and benefits, stakeholders, processes and products.

Table 1. Restocking assumptions for sandfish, over two years, based on propagation of 540 000 released sandfish.

Restocking assumptions	Survival rate	No. Individuals
Survival rate of released sandfish	15%	81 000
Subsequent survival rate until reproduction[1]	50%	40 500
No. of females spawning in 1st year of reproduction	50%	20 250
No. of females spawning in 2nd year of reproduction	25%	5 062
Total spawning females from year 1 and 2		25 312

[1] Estimate survival based on fishing.

again in year 2, only just over 25 000 females were assumed to survive to spawning (Table 1).

Females spawn three times a year. The average number of eggs per spawning is assumed at 1 500 000; the survival rate of progeny was set at 0.0001 percent (1 in a million) from egg to adult animal.

Sales

The price received for live and processed sandfish depends on size (Table 2). Three categories were identified. When sold to middlemen, e.g., in Can Tinh Dong in the municipality of Cam Ranh, the average price was only 1 000 VND per 20 cm sandfish. This low price reflects the fact that middlemen lend money to fishermen, with the obligation to sell the catch to them at a low price.

The Fishermen

The average income of the fishermen is about 2 million VND per month. The average contribution of sandfish to the annual income of fishermen is calculated at 8 percent, based on 600 individuals caught per boat per year. According to the fishermen, diving takes place six months a year. For the other six months, the fishermen engage in farming or other activities. The fishermen use standard size vessels (about 9 m long) equipped with a hookah to deliver compressed air to two divers. Fuel is their single largest expense; depreciation on capital such as boat and engine, hookah, wetsuits and masks is the second largest; and labor costs for traveling to the fishing site and diving is the third.

Processing consists of the following steps: de-gutting, salting, boiling, washing, drying and grading. Processors use very simple facilities, drying frames and second-hand sacks. No depreciation cost on building or equipment is included in the estimates. Costs are estimated for each labor-intensive activity based on the opportunity cost for unskilled labor. Consumables such as gas, salt, water and charcoal are valued at their actual cost.

Like fishermen, processors do not specialize in a single species. Although profits from certain sea cucumber species may be low or even negative, they still process them. As there are quite large fluctuations during the year in the availability of sandfish, less valuable species can sometimes be sold at higher prices, compensating for times when the general price is low.

Project evaluation

The planned hatchery/nursery complex, covering about 1 ha, is to be run by ten full-time employees and a manager. The capital investment is estimated at a little over 931 million VND, with an incremental working capital of 29 million VND. The total project cost is estimated at 960 million VND or 64 000 USD. The annual operating cost is estimated at 287 million VND.

The average estimated cost of producing a juvenile sandfish at 10 g is about

Table 2. Price received for live and processed sandfish in Vietnam (VND).

Size of sandfish	Piece/kg	VND/piece	VND/kg
Small	5-15 (100)*	1 000 (1 500)*	15 000 (150 000)*
Medium	3-4 (~70)*	4 000 (4 000)*	16 000 (250 000)*
Large	1-2 (15-20)*	8 000 (18 000)*	16 000 (350 000)*

* Price received for processed sandfish (bêche-de-mer)
15 000 VND = USD 1

700 VND or 0.05 USD. The production cost is directly related to the size of the animal at release. This is due to the large area required for tank and pond nurseries. The price still compares very well with the cost of 0.04 USD to produce a juvenile *Stichopus japonicus* with an average size of 9 mm, as reported by Yanagisawa (1998).

The revenue generated by the project is almost equally distributed between processors and fishermen (Figure 2).

The estimated revenue accruing to the fishermen is based on the assumption that 50 percent of the released, surviving animals will be harvested after two years, including a proportion from previous years. The additional net revenue for the fishermen increases to 34 million VND/boat/year in the final year of the project. Assuming the usual six people per boat, the additional seasonal net revenue would average 5.7 million VND per fisherman (380 USD).

The gross revenue resulting from the restocking efforts depends on the percentage of the population harvested. This is very closely linked to the survival rate of the restocked juveniles, the increase of the population through progeny, institutional factors, and the number of fishing boats in the area. To obtain a significant impact through restocking, the number of boats fishing the area of release was assumed to be limited to 40. The other factors significantly affecting revenue are the size of the animals at harvest and market prices.

With a discount rate of 10 percent, the positive net present value (NPV) is 1 134 million VND or 75 600 USD. The realized internal rate of return (IRR) of 17.3 percent is higher than the external rate of return, namely, the opportunity cost for capital. The payback period for the restocking project is eight years. The benefit-cost ratio (BCR) is 1.76. This means that even if cost increases by 76 percent or revenue drops by 76 percent, the investment is still profitable.

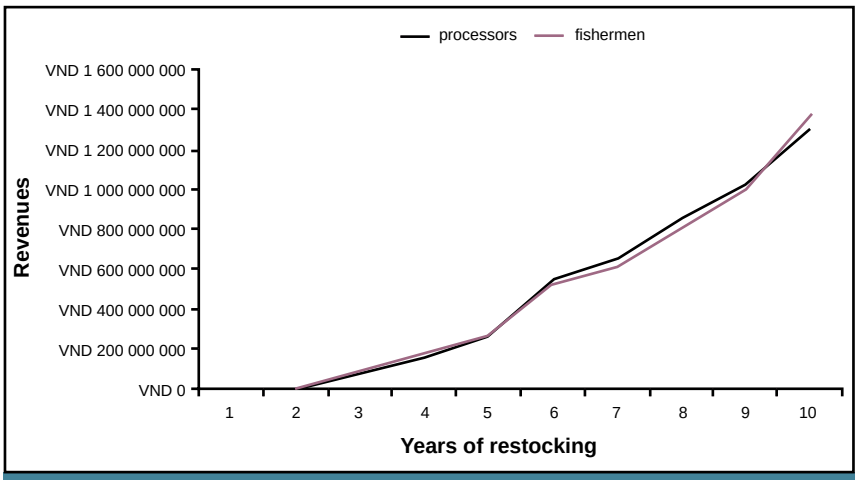
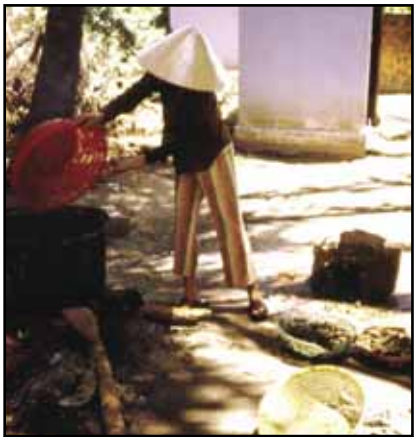


Figure 2. Revenue projections for processors and fishermen over the lifetime of the restocking project, based on a 15 percent survival rate of restocked juveniles and a survival rate of progeny of 0.0001 percent.

Grading of different sea cucumber species at the processor in Nha Trang.

The NPV is highly sensitive to the survival of the juveniles after restocking. For this reason, the NPV is calculated for different survival rates (10 percent to 20 percent) and at different discount rates (Figure 3). The break-even point for the investment is reached with a survival rate of 11.5 percent (with the assumption that one in a million eggs spawned by the surviving sandfish reaches maturity).

To assess different scenarios, the survival rate of restocked juvenile sandfish was fixed at 15 percent and the survival of progeny varied. The break-even point was



A processor boiling sea cucumbers.

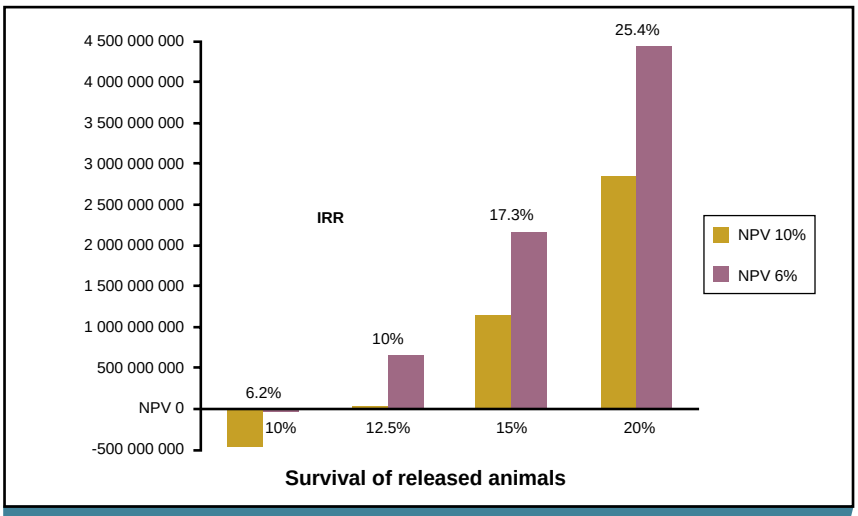


Figure 3. Changes in the net present value (discount rate 10% and 6%) and the internal rate of return for different survival rates.

reached when 0.83 individuals from one million eggs survived to maturity.

Using a probability analysis it was determined that in 37.5 percent of all cases the predicted NPV of 1 134 million VND with an IRR of 17.3 percent would be reached and that in 44 percent of all cases the project would break even and be viable.

Discussion

Management issues

The potential benefit of a restocking program for sandfish can only be realized if there is strong and effective management of the released animals. This poses a challenge under the current open-access arrangements for coastal fisheries in Vietnam. Restricting the number of boats fishing an area, possibly through the use of licenses, can regulate the quantity of sandfish removed. The easiest way to prevent harvesting of undersized sandfish is to control processors, on the assumption that fishermen sell all their sandfish to processors and demands for minimum sizes are handed down from processors to fishermen. Bhaskar and James (1989) studied the necessity for an export ban on processed sandfish smaller than 75 mm from the southeast coast of India. Studies on *H. scabra* at first maturity indicate that the spawning size is 201-230 mm (average 220 mm). Sandfish of this size are reduced to an average size of 76 mm after processing. However, the processing methods in Vietnam are different. The average reduction in length after processing at the processor in Nha Trang was 45.7 percent, but more detailed studies are required. Conand (1989) estimated the size at first maturity of *H. scabra* in New Caledonia as 160 mm and 184 g total weight, which differs from the results reported by Bhaskar and James. Size regulations are extremely important, because a large proportion of the processed sandfish currently fall into the category 70-100 pieces per kilo. This means that the size before processing is approximately 160 mm. At best, these sandfish have just reached maturity and have spawned once; at the worst, these sandfish have not yet reached maturity or spawned.

Organization and finance

There is a huge potential in Vietnam for organizing local communities to overcome problems relating to fisheries. At the provincial level, municipalities must be empowered to introduce their own use-rights. Use-rights governing use, access to, and enhancement of sandfish stocks could be introduced through collective action and enforced through voluntary surveillance. The institutional requirements for community-based management consist mainly of limited access to outsiders, ensured property rights and defined utilization strategies.

The Ministry of Fisheries or other local government institutions should manage the institutional framework, give organizational assistance and engage in further research. The participatory approach to organizing the local communities could be carried out by non-governmental organizations (NGOs) to assure that the poorest households are included in the decision-making process.

International donors, NGOs or the government could fund the initial phase, e.g., construction of the hatchery and provision of the necessary knowledge. Fishermen and processors should finance the annual operating cost. In New Zealand's scallop fishery, "fishers agreed to finance the enhancement operations through a levy on their annual catches in exchange for access to existing stocks and some guarantee of future rights in the fishery" (Bull 1999). A similar approach could be followed in Vietnam.

Conclusion

The sea cucumber fishery in the province of Khanh Hoa is rapidly declining. In some areas sandfish have vanished completely due to overfishing. Restocking combined with an adequate management scheme seems to be an appropriate way of improving the situation.

The contribution of a hatchery capable of rearing 540 000 sandfish (weighing 10 g each) per year was investigated. The estimated investment cost is 959 million VND or 64 000 USD. The average cost of producing juvenile sandfish is 700 VND or 0.05 USD each. The participants could be asked to finance the annual operating cost through a levy on catching and processing sandfish, but outside assistance would be needed to meet the

initial capital outlay. The management of the restocking project could be community-based with institutional help from the Ministry of Fisheries.

The estimated benefits to fishers range from 90 million VND (6 000 USD) within year threes, to over 1 376 million VND (91 700 USD) in the tenth and last year of the restocking project. On average, the fishermen's income was estimated to increase by 50 percent in the final year of the project. Benefits to processors range from 76 million VND (around 5 000 USD) in the third year to 1 297 million VND (86 000 USD) in the final year.

At an assumed survival rate of 15 percent for hatchery-reared sandfish, a survival rate of 0.0001 percent for their progeny, and a discount rate of 10 percent, a NPV is estimated at 1 134 million VND (75 600 USD). The IRR on capital invested is 17.3 percent. The benefit:cost ratio is 1:76. The payback period is eight years. The cumulative probability indicates that these benefits are achievable, and the restocking project is profitable in 37.5 percent of all scenarios. The factors with the biggest influence are the survival rates of restocked sandfish and their progeny. A survival rate of 11.5 percent makes the project break even. The same applies for a fixed survival rate of 15 percent, when 0.83 progeny from one million eggs survive to maturity. The break-even point for the project occurred in about 45 percent of all modeled scenarios. With increasing survival rates, the project's profits rise substantially. Additional non-monetary benefits include a reduction of fishing pressure on other marine species.

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