

## Developing technologies for restocking sandfish: Update on the WorldFish–SPC project in New Caledonia

Steve Purcell<sup>1</sup>

The WorldFish Center project to develop strategies for restocking sea cucumbers is now in its fourth year. Originally planned for Solomon Islands, the project was relocated to New Caledonia and has been hosted and partnered by the Secretariat of the Pacific Community (SPC). Its main purpose is to develop optimal release strategies for the restocking of sandfish (*Holothuria scabra*) (see Purcell 2004). Multi-lateral funding for the project has come from grants by the Australian Centre for International Agricultural Research (ACIAR), the three provinces of New Caledonia, the Government of France and the ATSE Crawford Fund. Following an initial year of project rebuilding and hatchery construction, the team produced sandfish in three successive years in sufficient numbers for the experiments. In 2003 and 2004, we completed most of the field and hatchery experiments on sandfish, on topics including:

- methods for broodstock maturation and spawning
- methods for rearing juveniles
- growth of sandfish in earthen (shrimp) ponds
- optimal methods for transporting juveniles for restocking
- optimal habitats for release
- best times of the day for release
- co-culture of juvenile sandfish with juvenile shrimp.

Experiments in 2004–2005 at the hatchery north of Noumea have refined new methods, which the WorldFish Center pioneered (by Rayner Pitt) in Vietnam, to grow sandfish juveniles in net enclosures within earthen shrimp ponds up to larger sizes for release. Two types of net enclosures are used: “hapas”, of 670 mm mesh, and “bag nets”, of 1 mm mesh. The experiments determined the best size at which to transfer the newly settled juveniles from the hatchery to hapas, how to increase their growth rate, what food they should be given in bag nets (Fig. 1), and in which situations to feed. The growth of juveniles within bag nets in ponds was faster than in those within bag nets in the sea. The new methods furnish a more cost-effective mode to scale up the production of juveniles and provide solutions to the hatchery-space constraints when mass-producing juveniles. Hatchery production of sandfish was kept to an experimental scale, this

year totalling 20,000 juveniles, allowing resources to be spread to the field research.

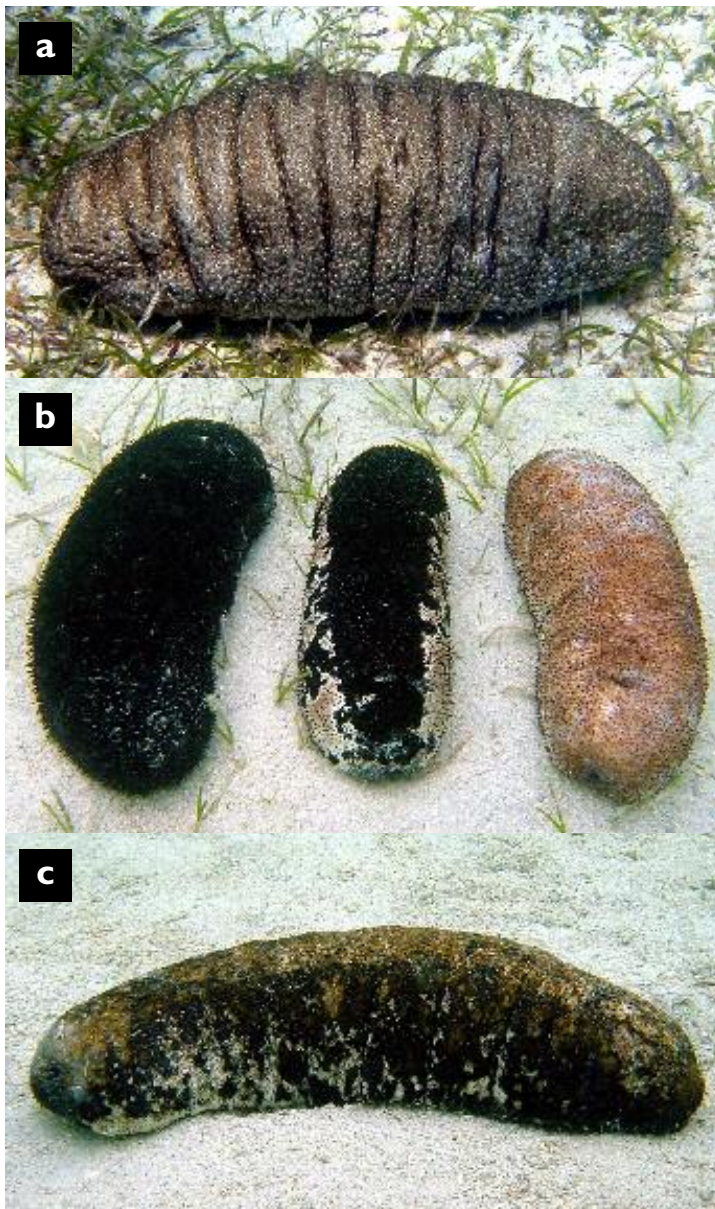


**Figure 1.** Bag net enclosures (1 mm mesh), 2 m x 2 m x 1 m high, set up in an earthen pond and used to grow sandfish juveniles from around 0.5 g to larger sizes (1–20 g) for release into the wild.

Following a collaborative study on the population genetics of sandfish along the main island of New Caledonia, La Grande Terre (Uthicke and Purcell 2004), we conducted further sampling and genetic analyses. These showed that the putative subspecies *Holothuria scabra* var. *versicolor* (golden sandfish) is actually a separate species, but can naturally hybridise with *Holothuria scabra* (sandfish) (Uthicke et al. in press). Figure 2 illustrates the two species and one hybrid morph.

As part of a commitment to the Provincial Government, we conducted broad-scale surveys of sea cucumbers using the “manta tow” technique in all three provinces in New Caledonia (Fig. 3). The Loyalty Islands Province had generally good stocks of reefal species, particularly black teatfish, which were in densities up to 244 adults ha<sup>-1</sup>. Surveys for sandfish along La Grande Terre showed that some sites had healthy populations (up to 1016 adults ha<sup>-1</sup>) while populations at other sites were depleted, apparently from a history of heavy fishing pressure. It is encouraging that the Northern Province is now developing management regulations to limit the harvest and trade of sea cucumbers.

1. The WorldFish Center, c/o Secretariat of the Pacific Community, BP D5, 98848 Noumea Cedex, New Caledonia.  
Email: [s.purcell@cgiar.org](mailto:s.purcell@cgiar.org)



**Figure 2.**

Underwater photographs of:  
 a) *Holothuria scabra*,  
 b) black, blotchy and beige colour morphs of a new species previously called *H. scabra* var. *versicolor*, and  
 c) a blotchy hybrid of the two putative phenotypes, distinguished by colour pattern and length of papillae and identified by DNA sequencing.

**Figure 3.**  
 A diver conducts a transect survey (2 m x 200 m) using the manta tow method. A boat tows the manta board, with attached data sheet, at ~2 km h<sup>-1</sup>. GPS is used to control distances, and transect width is reduced to 1 m for surveys at shallow or turbid sites.

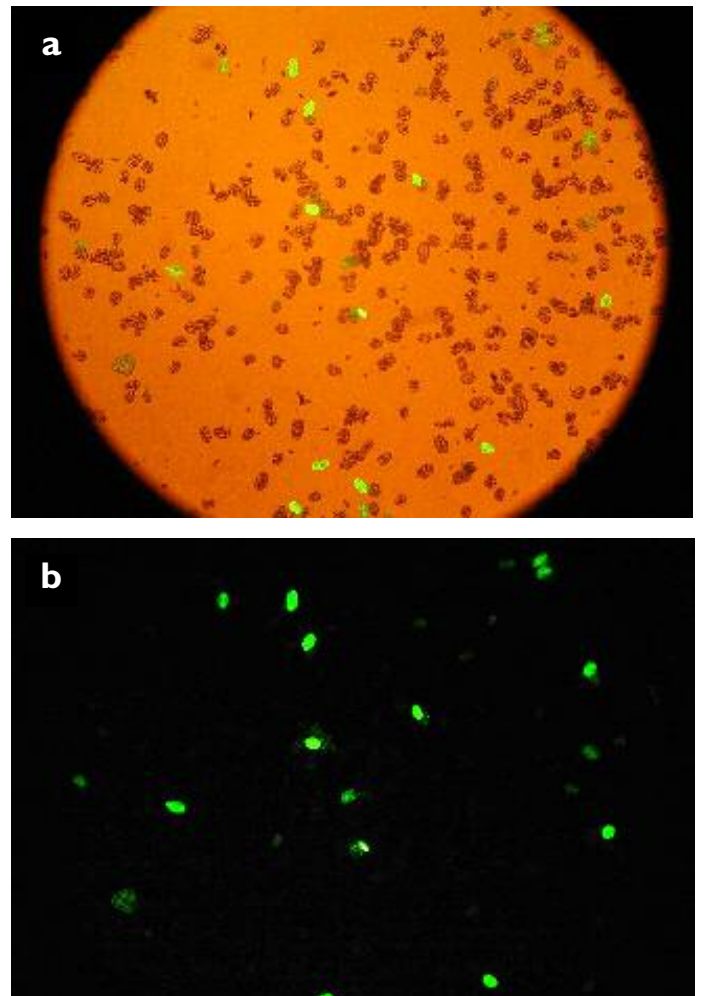


As an adjunct to the stock assessment surveys, we measured the *in situ* movement and burrowing behaviour of wild sandfish adults and released juveniles. These data, along with estimated growth rates, furnished an individual-based model of the dispersal of sandfish from release sites, which was then used to predict the requisite size of no-take zones for restocking (Purcell and Kirby in review).

Several complementary studies were completed to develop cheap, simple, methods for marking juvenile sea cucumbers so they can be distinguished from wild animals following their release. After short trials comparing the viability of five methods, we tested two fluorochromic markers and injected wire tags into sandfish juveniles held in enclosures in an earthen pond. Breaking new ground, the study showed that tetracycline and calcein permanently stained the spicules of sandfish and fluorescent spicules can be detected from skin samples after at least one year (Fig. 4a and b). Further experiments established the best protocols for tagging the juveniles and these studies are now in preparation for publication. The two markers stain the spicules different colours; this allows up to three groups to be tagged (with each marker separately and with both combined). The tagging methods will be invaluable for demonstrating the success of restocking in “mixed-stock” scenarios (i.e. when both released and wild animals could be present).

As a means of gauging the viability of restocking using the release methods developed in 2003 and 2004, we planned a final, “large-scale release experiment”, employing the release of juvenile sandfish into large sea pens. To develop the methodology for that experiment, we started a pilot study in July 2004 by installing a large sea pen (500 m<sup>2</sup>) at each of two sites, and releasing 2000 juvenile sandfish into each pen. The sea pens are simply a short plastic mesh fence, without cover, to limit juvenile emigration from the natural habitat. Although mortality was high during the first 1–2 months after release, the rate of mortality thereafter became much lower, when the juveniles reached ~50–100g (Fig. 5). Following the trends in Figure 5, sandfish survival is estimated at 5–9% after 18 months from release, when they would be expected to reach maturity.

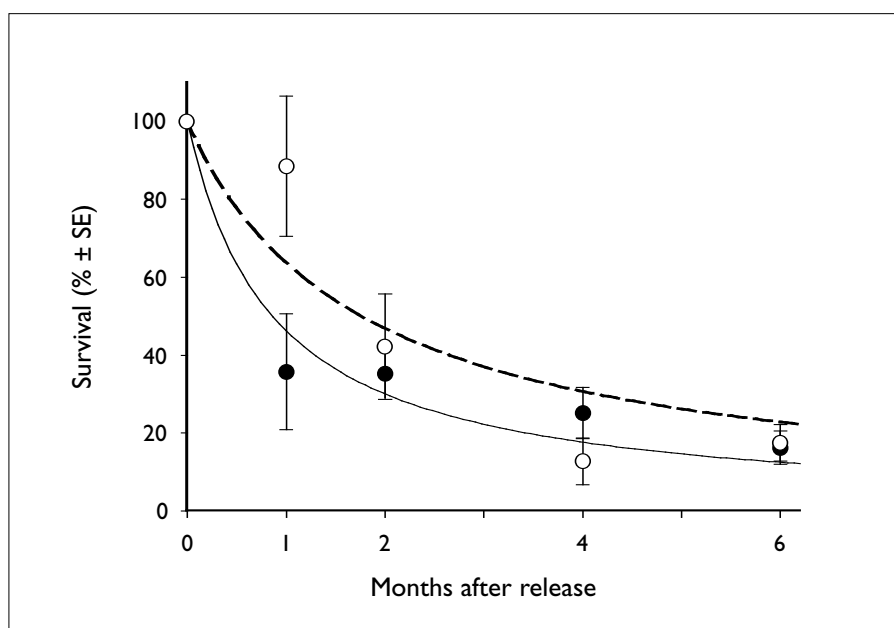
Based on the success of that pilot study, the large-scale release experiment was launched in April 2005. It involves 12 sea pens (each 500 m<sup>2</sup> in area) and an initial 9000 hatchery-produced sandfish juveniles, batch tagged in three size classes. At each of the four sites along La Grande Terre, sandfish juveniles were released into three sea pens, each with a different release density (0.5, 1, and 3 juveniles m<sup>-2</sup>). Quadrat



**Figure 4.** Photos under epifluorescence microscopy of spicules from a juvenile sandfish, tagged with calcein 12 months prior: a) stained and unstained spicules under normal and fluorescent light; b) the same field of view under fluorescent light only, showing stained spicules only.

sampling will be used to monitor juvenile survival and growth every two months for one year. The experiment will allow us to compare survival between size classes and among the three release densities, to see if survival in the long term is higher at lower densities than used in the pilot study. Because the experiment involves four sites (roughly 50–100 km apart), the results will give a range in survival and time frame for juveniles to reach maturity and commence spawning; the ecological goal of restocking. A cost-benefit analysis will be made, and only then can the utility of restocking with hatchery-produced juveniles be weighed against other forms of management (Bell and Nash 2004).

If the large-scale release experiment indicates that restocking sandfish through the release of hatchery-produced juveniles is economically viable, this



**Figure 5.** Plots of the estimated survival ( $\pm$  SE) of juveniles in open sea pens at two sites in New Caledonia from random quadrat surveys. Fitted lines are non-linear regressions of survival v time for the two sites (Ouano, dotted line; Népoui, solid line).

strategy will provide a way forward for restoring breeding populations that were overfished to levels too low to allow natural recovery. WorldFish hopes to embark on the Phase 3 project of the programme in July 2006, which will seek to carry out broad-scale restocking of sandfish in several Pacific Island countries. The purpose of such restocking would be to rebuild a breeding population to generate larval supply to depleted fishing grounds rather than a “put-and-take” fishery. Clearly, better management of sea cucumbers is needed as a precursor to restocking. Encouragingly, Pacific Island nations (e.g. Papua New Guinea, Solomon Islands, Fiji) are making strong moves to implement such management. In places where management can safeguard the means of restocking, this research will be a basis by which livelihoods and household income of coastal fishers can be restored.

## References

- Bell J. and Nash W. 2004. When should restocking and stock enhancement be used to manage sea cucumber fisheries? p. 173–179. In: Lovatelli A., C. Conand, S. Purcell, S. Uthicke, J.-F. Hamel and A. Mercier (eds.). Advances in sea cucumber aquaculture and management. FAO, Rome.
- Purcell S. 2004. Criteria for release strategies and evaluating the restocking of sea cucumbers. p. 181–191. In: Lovatelli A., Conand C., Purcell S., Uthicke S., Hamel J.-F. and Mercier A. (eds.). Advances in sea cucumber aquaculture and management. FAO, Rome.
- Purcell S. and Kirby D. (in review) No-take zones for restocking of the sea cucumber *Holothuria scabra* defined through individual-based movement modelling. Fisheries Research.
- Uthicke S. and Purcell S. 2004. Preservation of genetic diversity in restocking of the sea cucumber *Holothuria scabra* investigated by allozyme electrophoresis. Canadian Journal of Fisheries and Aquatic Sciences 61:519–528.
- Uthicke S., Purcell S., Blockmans B. (in press). Natural hybridisation does not dissolve species boundaries in commercially important sea cucumbers. Biological Journal of the Linnean Society.