# Establishment and management of communal sandfish (*Holothuria scabra*) sea ranching in the Philippines

**Marie Antonette Juinio-Meñez[1]*, Marie Antonette S. Paña[1], Glycinea M. de Peralta[1], Tirso O. Catbagan[1], Ronald Dionnie D. Olavides[1], Christine Mae A. Edullantes[1] and Bryan Dave D. Rodriguez[1]**

**Abstract**

Sea ranching of sandfish is being piloted as a means to enhance the recovery of depleted natural stocks and provide a supplemental source of income for artisanal fishers. Participatory and adaptive approaches were employed in the establishment and management of sea ranches to ensure that benefits accrue to both the 'rights-holders' and other community members. Three pilot sea-ranching sites have been established in north-western Luzon, the Philippines. The sites are managed by members of a local association of small fishers with the support of the municipal government, which granted limited exclusive-use rights to the sea-ranch managers. Each site was delineated into two major use zones: the 1-ha no-take release and nursery area, and the 4-ha reserve area. Multiple releases of cultured sandfish juveniles produced from local wild broodstock were conducted in the sites. Within 7–10 months, effective spawning populations were established in the sea-ranching sites when the density of reproductively mature (>200 g) individuals (ind) exceeded 100 ind/ha. Growth and survival rates were variable among sites. At the Bolinao sea ranch, the maximum estimated overall density reached 1,119 ind/ha, with an estimated survival rate of 39% after 19 months. Mass spawning of sandfish in the sea ranch further demonstrated that community-based sandfish sea ranching can help rebuild depleted wild populations. Among the major threats to sustainability are periodic poaching and storms, which reduce harvestable biomass and economic returns to the rights-holders. Sea ranching should be integrated within a broader fishery management framework to improve the management of sea cucumber fisheries.

## Introduction

Rehabilitation of overexploited and depleted stocks is essential to securing continued production from capture fisheries (Bartley and Bell 2008). This has become imperative for species that are commercially important and heavily exploited, such as sea cucumbers. Sea cucumber collection has been an important part of the multispecies invertebrate fishery in the Indo-Pacific region for over 1,000 years (Conand 1990). Production of cultured species from hatcheries has been undertaken to increase and/or replenish yields through restocking, stock enhancement and sea ranching. However, despite progress in aquaculture, the application of hatchery technologies in fisheries management has yet to overcome many challenges. These include cost-effective production of juveniles; identification of where and when to use such interventions; integration of these initiatives with institutional fisheries management regimes; monitoring the success of interventions; and releasing juveniles into the wild in such a way that they survive in high numbers (Blankenship and Leber 1995; Bell et al. 2005, 2006; Lorenzen 2008). Putting these concepts

[1] Marine Science Institute, University of the Philippines, Diliman, Quezon City, Philippines

* Corresponding author: <meneza@upmsi.ph>

into practice in a developing-country context to harmonise socioeconomic and ecological benefits to small fishers was the primary consideration in the establishment of communal sandfish sea ranching in the Philippines.

## Historical overview of Philippine sea cucumber resources and fisheries

The sea cucumber fishery has been and is still an important source of livelihood for many of the coastal communities in the Philippine archipelago (Domantay 1934; Trinidad-Roa 1987; Akamine 2001). One of the earliest commercial sea cucumber fisheries in South-East Asia, dating back over 200 years, was in Sulu. Sea cucumbers were collected by the best pearl divers of the coastal Tausug and *vinta*-dwelling Samal and Badjao communities for the Sulu Sultanate. Licence to fish sea cucumbers was given by the sultan, while the *datus* (the local elites) commonly led or deployed several hundred fishers in fishing fleets (an early sign of fishery management) (Warren 1985).

In the late 18th century, the sea cucumber fishery in the southern Philippines developed rapidly as a result of trade with Spain, China and Britain (Warren 1985; Akamine 2001). From 1805 to 1830, dried sea cucumbers or *trepang* were shipped from Sulu to Manila twice a year in varying amounts up to 50 t (Warren 1985). Manila was also a main trading port between the South Pacific region and China (Ward 1972, cited in Akamine 2001).

Between 1924 and 1932, the Philippines exported an average of 272 t/year of dried sea cucumbers to China, British East Indies, Hong Kong and Japan (Domantay 1934). Post-World War II records show that the Philippines exported only 0.54 t in 1950 (Montilla and Blanco 1952), 5 t in 1958 (Surtida and Buendia 2000) and 12 t in 1970 (Akamine 2002). Export volume rapidly increased to over 600 t in 1978, exceeding pre-war records, and again doubled in 1983. Since then, the Philippines has maintained a total annual export of no less than 1,000 t, making sea cucumbers a major export commodity.

Although the Philippines is the second-largest exporter of tropical sea cucumbers in the world (Conand and Byrne 1993), results of a multisectoral national forum established that there have been no significant efforts to effectively regulate and manage the fishery, either at the national- or local-government level (Casilagan and Juinio-Meñez 2007). The scarcity of useful fishery baseline information in most regions is often cited as an obstacle in the formulation of a management plan (Gamboa et al. 2004). Furthermore, resource managers at the local-government unit level and the national agencies generally know very little about the value and status of the sea cucumber resources.

The status of the sea cucumber resources and fishery in the municipalities where the pilot sea-ranching sites were established is characteristic of overexploited fisheries in many parts of the country. For example, in the Bolinao–Anda reef system, species diversity is high but population densities are very low, and the average sizes of sea cucumber are below reported sizes at sexual maturity per species (Olavides et al. 2010). Fishery-dependent and independent studies in the area found 49 species, 26 of which are being collected and traded (including the very low-value species). The catch per unit effort in the 1970s–1980s was reported to be over 100 kg/day, and had declined to less than 1 kg/day in 2008. Several high-value commercial species such as *Thelenota ananas* and *T. anax* have been fished to local extinction, while the populations of other target species, particularly *Holothuria scabra* and *Stichopus horrens,* are depleted.

## Sandfish sea ranch establishment process and management scheme

One of the highest valued sea cucumber species in the Philippines is *Holothuria scabra*, commonly known as sandfish. With the scaled-up juvenile production of sandfish (Juinio-Meñez et al. 2012), sea ranching was piloted in three coastal municipalities in north-western Luzon. The framework, establishment process and management scheme for communal sea ranching of sandfish were developed to ensure that benefits accrue to both the 'rights-holders' and other community members (M.A. Juinio-Meñez, unpublished data). These were also aimed at minimising social conflicts, which are inherent in the open-access and multiple-use nature of nearshore fisheries in the Philippines. The key implementation strategies are: (1) acquisition of exclusive communal-use rights for a 5-ha sea ranch, (2) increases in the production, and improvement in the quality, of hatchery-produced juveniles, and (3) regular monitoring to estimate population growth and survival in the sea-ranching sites.

Biophysical, social and governance criteria were considered in the selection of three sea-ranching sites in the provinces of Pangasinan and Zambales, north-western Luzon (Figure 1). The biophysical requirements included 50–60% seagrass cover, sandy–muddy substrate, minimum exposure to wave action, and presence of sandfish. Even if the biophysical prerequisites had been met, the final site selection was based on the presence of an interested local fisher association (or a group with experience in community-based coastal resource management) and a supportive local government unit willing to grant preferential-use rights to the sea-ranch managers.

Community consultations were conducted in the potential sites and in neighbouring villages that may be affected by restricted access in the sea-ranch area. Upon endorsement of the village council, the local partners applied for preferential-use rights to manage the sea ranch and exclusively harvest all sea cucumbers in the site. This was legitimised by an ordinance passed by the local legislative body, and the issuance of a gratuitous permit by the mayor. The responsibilities of the local sea-ranch managers were to help in conducting information and awareness campaigns, provide manpower in developing and maintaining the site, and guard the sea ranch (Figure 2A, B, C, D).

The sea-ranch rights-holders initially comprised 12–15 families of fishers per site, with an average annual income of US$640–5,600 per household. Each of the 5-ha sites was delineated into two major use and management zones composed of a 1-ha nursery no-take zone located at the centre of the sea ranch, and a 4-ha reserve zone surrounding the nursery zone. Inside the no-take zone is a core release area (50 × 50 m), where cultured sandfish juveniles were released. In addition, 3 × 100 m$^2$ circular pens were installed in the core release area and stocked with juveniles to facilitate monitoring of growth and survival of a single batch. To minimise disturbance of the released juveniles, entry into the nursery zone is restricted to release and monitoring activities. In the reserve area, boat passage and traditional fishing activities (except for any species of sea cucumbers) are allowed with permission from the sea-ranch managers.

Hatchery-produced juveniles (>3 g) were released in multiple batches, with varying numbers of individuals (ind) per batch. Juveniles were released individually by pressing their bodies lightly into the surface

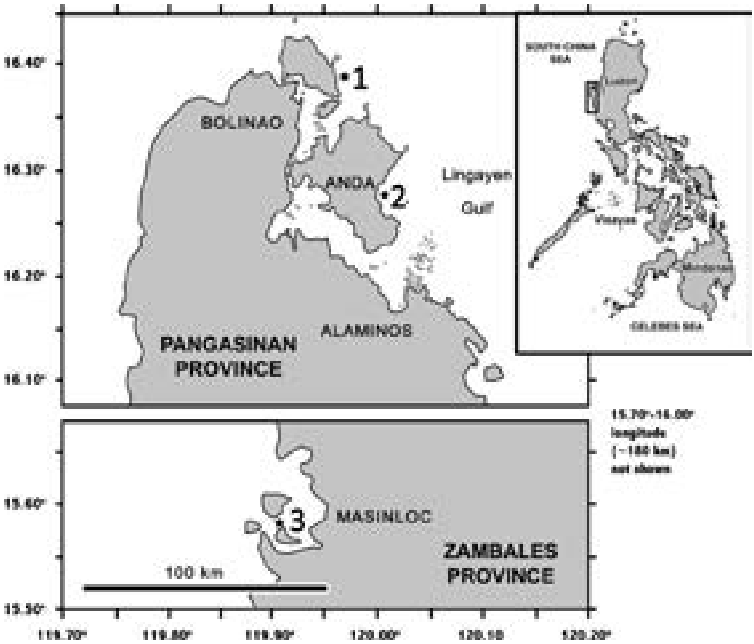


**Figure 1.** Map of the three sea-ranching sites in north-western Luzon, the Philippines: (1: Barangay Victory, Bolinao, Pangasinan; 2: Barangay Sablig, Anda, Pangasinan; 3: Panglit Island, Masinloc, Zambales)

**Figure 2.** Regular activities of sea-ranch managers. **A**: Conducting information and education activities for local communities and site visitors. **B**: Site development (e.g. delineation and pen construction). **C**: Release of hatchery-produced sandfish juveniles. **D**: Guarding the sea ranch. **E**: Periodic monitoring. **F**: Mass harvest and processing

of the sediment, partially burying them, to reduce the risk of predation. Stratified belt transect surveys in different areas of the sea ranch were conducted with local partners every 3–4 months to estimate survival and growth. Population densities, abundance and biomass of sandfish were also estimated. The results of the surveys were discussed with the sea-ranch managers to assess the status of the sandfish in the sites and schedule harvests. The managers processed the harvested sandfish themselves (Figure 2E, F), and sold their products to sea cucumber wholesalers or exporters in Manila. A comparison of key information on the management and monitoring surveys in the three pilot sea-ranching sites is presented in Table 1.

## Lessons learned and insights

### A viable spawning population can be established and maintained in a sea ranch

Growth and survival of sandfish in the sea-ranch sites were widely variable. From an average release size of 5–7 g, sandfish reached an initial size of sexual maturity of about 180 g within 7–10 months. The density of sandfish in the sea ranches increased rapidly in the first year of operation, with maximum densities across the three sites in the range 302–1,119 ind/ha (Table 1**).** The highest estimated survival was 39% in the Bolinao sea ranch after 19 months, with density reaching 1,119 ind/ha. This is over 400 times the density of the wild population in the Bolinao–Anda reef system, which is only about 6 ind/ha (Olavides et al. 2010). This density approaches that of a relatively unexploited natural population of 2,900 ind/ha reported from Papua New Guinea (Shelley 1985). In contrast, the maximum survival estimate in the two other sites was only 14% (Table 1).

More importantly, within 10 months after the first release of juveniles, the density of reproductively mature (>200 g) individuals exceeded 100 ind/ha. The highest density of reproductively mature sandfish was 499 ind/ha after 19 months, comprising over 40% of the sandfish in the Bolinao sea ranch. Synchronous spontaneous spawning was also observed in the Bolinao and Anda sites on 23 February 2010 (Olavides et al. 2011). Prior to and after this mass spawning event, the sea-ranch managers observed sandfish exhibiting spawning behaviour, clearly demonstrating that a viable spawning population has been established in these sites.

## Typhoons and poaching are major threats to economic viability

The modal size (total weight) of sandfish in the Bolinao sea ranch decreased drastically after protracted periods of heavy rainfall and strong waves brought about by two consecutive typhoons during September and October 2009 (Juinio-Meñez, unpublished data). There was a decrease of about 70% in the estimated total biomass in the sea ranch—from 1,100 kg to 347 kg over a 7-month period—after the typhoons (6th to 8th monitoring periods). The estimated harvestable biomass (i.e. sandfish >320 g) prior to the typhoon in July 2009 was about 188 kg. Four months after the typhoon, there was no harvestable biomass. The negative impact of typhoons on the growth of sandfish may be attributed to drastic changes in environmental factors and habitat modification. The heavy rains may have caused significant exposure to suboptimal salinity levels that stressed the sandfish—preliminary laboratory experiments showed that sandfish ceased to feed at around 20 ppt salinity (J.R. Gorospe, unpublished data). Further, it was also observed that, after the typhoon, sediment in the sea-ranching area became coarse, with abundant coral rubble on the surface. The progressive decrease in weight of individual sandfish months later indicates that the strong typhoons decreased sediment quality in the sea ranch.

**Table 1.** Management and sandfish population data in the three pilot sea-ranching sites in north-western Luzon

| | **Location of sea-ranching sites** | | |
|---|---|---|---|
| | **Bolinao, Pangasinan** | **Anda, Pangasinan** | **Masinloc, Zambales** |
| Rights-holder | Association of small fishers | Co-managed by representatives of village council and a people's organisation | Members of the marine protected area council |
| Date of first release | Dec 2007 | Dec 2008 | May 2009 |
| Total number of juveniles released[a] | 14,300 (10 releases) | 18,749 (8 releases) | 21,272 (6 releases) |
| Mean weight (g) (size range 3–20 g) | 7.0 ± 4.7 | 5.8 ± 2.8 | 5.5 ± 1.9 |
| Maximum weight of sandfish harvested (g) | 630 | 560 | 500 |
| Estimated density (ind/ha) after 16–18 months | 1,119 | 86 | 90 |
| Highest estimated density of individuals >200 g (ind/ha) | 499 | 224 | 116 |
| Range of estimated survival of released juveniles (%) during the first six monitoring periods | 19–39 | 2–13 | 2–14 |
| Highest estimated biomass (kg) in entire sea ranch (5 ha) | 1,100 | 419 | 292 |

[a] Excluding juveniles released in the pens inside the sea ranch during the first year

Aside from natural disturbances, poaching reduces the potential economic returns to the sea-ranch rights-holders. All the sites have a round-the-clock rotational guarding scheme agreed upon by the sea-ranch managers to minimise opportunity costs (i.e. 2–3 days a month per household). The income share from the sea ranch was proportional to the time and effort invested by each member household. Consistency and commitment of members to adhere to guarding schedules varied among sites. Even in Bolinao, where the management has been exemplary, incidences of successful poaching have occurred. No major typhoon has affected the two other sites, and yet estimated survival rates in these sites were lower (Table 1). This may be due, in part, to poaching incidences of sandfish within the sea ranch. Poaching is a given socioeconomic constraint in open-access areas with many poor subsistence fishers. Thus, governance mechanisms to mitigate and manage social conflicts are crucial to the success of sea-ranching efforts.

Another factor that affects the harvestable biomass is movement of sandfish outside the sea-ranch area. This is determined by various environmental factors that affect habitat quality (including incidence of natural disturbances such as typhoons), and needs to be investigated more closely in the future.

### Sea ranching is part of an integrated fishery management framework

Communal sandfish sea ranching is a model that could be adopted to harmonise the need to rebuild depleted populations and, at the same time, provide economic incentive for rights-holders who invest in managing the areas. The community-managed 5-ha sea ranch demonstrates that release of sandfish in suitable and well-managed sites can establish viable spawning populations that should contribute to rebuilding depleted fishery stocks. An effective spawning population in the sea ranch can be maintained while optimising economic returns through programmed releases of juveniles and selective harvesting of sea cucumbers (e.g. >320 g). Harvesting animals larger than the average size at sexual maturity (~200 g) also increases economic returns since bigger sandfish fetch a higher price in the market.

However, sandfish sea ranching will not be feasible in many situations; for example, where there is no supply of cultured juveniles, in habitats that are not suitable for *H. scabra,* and where risks from natural disturbances and poaching are very high. In the Philippines, where management of nearshore waters is under the jurisdiction of local government units (LGUs), local-level management systems such as partnerships between small-scale fishers and LGUs are important. To promote sustainability of severely exploited and unmanaged multispecies sea cucumber fisheries in the country, the important components of an integrated fishery and sea-ranching management system include: implementation of a registry and permit system for fishers, processors and traders that is consistent with the provisions of national fisheries codes; minimum size limits for harvest and trade; and community-managed reserves such as the communal sandfish sea ranches discussed here.

## Acknowledgments

The establishment of the pilot sea-ranching area for sandfish was funded by the Australian Centre for International Agricultural Research (ACIAR), with complementary support from the Department of Science and Technology (DOST) of the Philippines. This work would not have been possible without the active engagement and wisdom of our primary research and development partners—the sea-ranch managers: Samahan ng mga Maliliit na Mangingisda ng Victory, Inc. (SMMVI); Sablig Barangay Multisectoral Association (SBMA) and its barangay council; Marine Protected Area Management Council of Panglit Island, Research and Development Committee; and the local government units of Bolinao and Anda in Pangasinan and Masinloc, Zambales.

## References

Akamine J. 2001. Holothurian exploitation in the Philippines: continuities and discontinuities. Tropics 10(4), 591–607.

Akamine J. 2002. Trepang exploitation in the Philippines: updated information. SPC Beche-de-mer Information Bulletin 17, 17–21.

Bartley D.M. and Bell J.D. 2008. Restocking, stock enhancement, and sea ranching: arenas of progress. Reviews in Fisheries Science 16(103), 357–365.

Bell J.D., Bartley D.M., Lorenzen K. and Loneragan N.R. 2006. Restocking and stock enhancement of coastal fisheries: potential, problems and progress. Fisheries Research 80, 1–8.

Bell J.D., Rothlisberg P.C., Munro J.L., Loneragan N.R., Nash W.J., Ward R.D. et al. 2005. Restocking and stock enhancement of marine invertebrate fisheries. Advances in Marine Biology 49, 1–370.

Blankenship L. and Leber K. 1995. A responsible approach to marine stock enhancement. American Fisheries Society Symposium. 15, 167–175.

Casilagan I.L. and Juinio-Meñez M.A. 2007. Documentation report of the National Forum on Sea Cucumber Fisheries Management, Dagupan, Pangasinan, Philippines, 6–9 June 2007.

Conand C. 1990. The fishery resources of Pacific island countries. Part 2: holothurians. FAO Fisheries Technical Paper No. 272.2. Food and Agriculture Organization of the United Nations: Rome.

Conand C. and Byrne M. 1993. A review of recent developments in the world sea cucumber fisheries. Marine Fisheries Review 55(4), 1–13.

Domantay J.S. 1934. Philippine commercial holothurians. The Philippine Journal of Commerce 10(9), 5–7.

Gamboa R., Gomez A.L. and Nievales M.F. 2004. The status of sea cucumber fishery and mariculture in the Philippines. In 'Advances in sea cucumber aquaculture and management', ed. by A. Lovatelli, C. Conand, S. Purcell, S. Uthicke, J.-F. Hamel and A. Mercier. FAO Fisheries Technical Paper No 463, 69–78. Food and Agriculture Organization of the United Nations: Rome.

Juinio-Meñez M.A., de Peralta G., Dumalan R.J.P., Edullantes C.M. and Catbagan T. 2012. Ocean nursery systems for scaling up juvenile sandfish (*Holothuria scabra*) production: ensuring opportunities for small fishers. In 'Asia–Pacific tropical sea cucumber aquaculture', ed. by C.A. Hair, T.D. Pickering and D.J. Mills. ACIAR Proceedings No. 136, 57–62. Australian Centre for International Agricultural Research: Canberra. [These proceedings]

Lorenzen K. 2008. Understanding and managing enhancement fisheries systems. Review of Fisheries Science 16(1-3), 10–23.

Montilla J.R. and Blanco G.S. 1952. Minor commercial marine products of the Philippines. Commerce 49(13), 54–56.

Olavides R.D., Edullantes C.M. and Juinio-Meñez M.A. 2010. Assessment of sea cucumber resource and fishery in the Bolinao-Anda reef system. Science Diliman 22, 1–12.

Olavides R.D., Rodriguez B.D. and Juinio-Meñez M.A. 2011. Simultaneous mass spawning of *Holothuria scabra* in sea ranching sites in Bolinao and Anda municipalities, Philippines. SPC Beche-de-mer Information Bulletin 31, 23–24.

Shelley C. 1985. Growth of *Actinopyga echinites* and *Holothuria scabra* (Holothuroidea: Echinodermata) and their fisheries potential (as beche-de-mer) in Papua New Guinea. Proceedings of the Fifth International Coral Reef Congress 5, 297–302.

Surtida M.B. and Buendia R.Y. 2000. A glimpse into some sea cucumbers in Panay, Philippines. SEAFDEC Asian Aquaculture 22(3), 20–21.

Trinidad-Roa M.J. 1987. Beche-de-mer fishery in the Philippines. Naga – the ICLARM Quarterly, October 1987, 15–17.

Warren J.F. 1985. The Sulu zone: the dynamics of external trade, slavery, and ethnicity in the transformation of a Southeast Asian maritime state. New Day Publishers: Quezon City, Philippines. [Originally published by Singapore University Press, 1981].