

# Approaches in Rebuilding Sea Urchin and Sea Cucumber Populations in the Philippines

*Marie Antonette J. Meñez*

Marine Science Institute, University of the Philippines  
Diliman, Quezon City, Philippines  
email: annettemenez@gmail.com

## Abstract

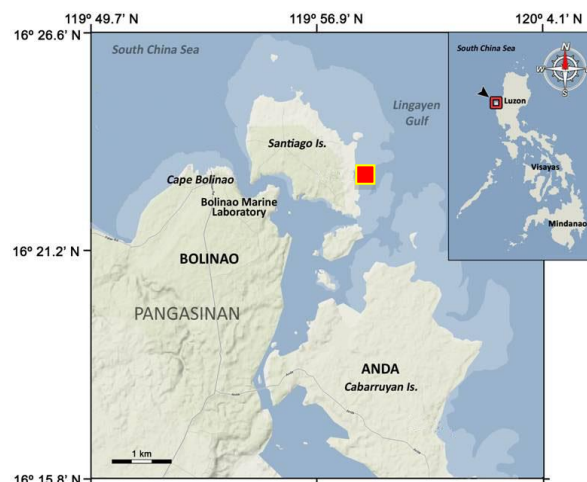
Sea urchins and sea cucumbers are among the most valuable and overexploited fishery resources. Culture and release of juvenile *Tripneustes gratilla* and *Holothuria scabra* have been undertaken to rebuild depleted populations and provide a supplemental source of income for fishers. In both cases an integrated socio-ecological approach was used. Studies on factors affecting growth and survival of released juveniles were conducted alongside active participation of local partners in site management and regular monitoring. For *T. gratilla*, community-based grow-out in sea cages complemented with restocking of protected areas helped in the recovery of a collapsed fishery. Gonad biomass and quality of sea urchins fed with *Sargassum* were high. These increased the value of the gonads and reproductive output of cultured sea urchins. In the case of *H. scabra*, release of juveniles in a communal sea ranch resulted in the build-up in density and biomass. Observations of regular mass spawning in the sea ranch established that a viable spawning population was maintained through selective harvesting. Both the sea urchin cage grow-out culture and sea cucumber sea ranch function as reproductive reserves and source of larval supply to adjacent suitable habitats. In addition, wild recruits in the sea ranch and in the vicinity of the sea urchin sea cages indicate that natural recruitment may be enhanced by the high density of conspecific adults. These models have demonstrated that both ecological and economic benefits can be realized through of responsible culture-based management interventions. The development of appropriate governance mechanisms is a critical consideration for sustainability.

**Keywords:** community-based grow-out, sea ranching, sea urchin, sea cucumber

## Introduction

Marine invertebrates are harvested for livelihood and sustenance by coastal communities. Some species are among the most highly valued marine food commodities. It is estimated that about 34% of global invertebrate fisheries are overexploited or have collapsed (Anderson *et al.*, 2010). This is the case for sea urchin and sea cucumber fisheries in many countries worldwide, including the Philippines (Andrew *et al.*, 2002; Choo, 2008). In the tropical Indo-Pacific, the pin cushion sea urchin *Tripneustes gratilla* is highly valued for its roe (*uni*) (Juinio-Meñez *et al.*, 1998) and *Holothuria scabra*, commonly known as sandfish, is one of the most expensive tropical sea cucumber species processed into “beche-de-mer” or *trepang* in the international market. It is currently the only tropical Indo-West Pacific species of sea cucumber that can be mass-produced and culture of this species is being undertaken in several countries at different scales (Purcell *et al.*, 2012). Populations of both species are depleted in many areas due to overexploitation given the high demand in the luxury seafood industry. This has resulted in the loss of a source of income and livelihood of many small fisher families. Culture and release of juvenile *Tripneustes gratilla* and *Holothuria scabra* have been undertaken to rebuild depleted populations and provide a supplemental source of

income for fishers. Culture production and management approaches for the two species were developed and implemented in Bolinao, Pangasinan, in northwestern Philippines (Fig. 1). In both cases, an integrated socio-ecological approach was used. Studies on factors affecting growth and survival of released juveniles were conducted alongside the active participation of local partners in site management and regular monitoring.



**Fig. 1.** Location of the U.P. Marine Science Institute' Bolinao Marine Laboratory where sea urchins and sea cucumbers are produced for culture-based resource management interventions on sea urchin grow-out culture and restocking, and sandfish sea ranching (indicated by square)

## Activities and Results

### Community-based Grow-out culture and Restocking of *T. gratilla*

*T. gratilla* was cultured in the hatchery and early juveniles (>1 cm) were used for community-based grow-out culture and restocking. To optimize survival to adulthood of the limited number of hatchery-reared seedstock, grow-out culture was developed to address ecological and socio-economic considerations while rebuilding the spawning populations (Juinio-Meñez *et al.*, 1998). Feeding and stocking experiments in sea cages were undertaken to optimize gonad quality and yield.

Results showed that feeding sea urchins with *Sargassum* spp. resulted in better growth and gonad quality than when fed the seagrass. Significant increases in catch per unit effort, as well as in the density of recruits were observed after restocking and sea cage culture interventions (Juinio-Meñez *et al.*, 2008). The higher density of recruits in sites with grow-out culture further indicated that the high density of adult conspecifics in the cages enhanced local recruitment (Juinio-Meñez *et al.*, 2009).

### Communal *H. scabra* sea ranch

Sea ranching of sandfish *H. scabra* is being developed as a means to enhance natural stocks and provide sustainable supplemental livelihood for fishers. The management framework for communal sea ranching of sandfish ensures that benefits accrue to both the “rights holders” and other community members (Juinio-Meñez *et al.*, 2013). Field surveys showed that sandfish, which used to be a major species collected in the area, was rare and very low in density in the landed catch.

A 5-hectare subtidal area on the southeastern coast of Santiago Is. in Bolinao (**Fig. 1**) was chosen for the establishment of the pilot sea ranch. Aside from habitat suitability, the presence of an active people’s organization with experience in coastal resources management and support of the local government were primary considerations in the selection of the sea ranching site. Multiple releases totaling about 10,000 juveniles (>3 g) per year were undertaken in the sea ranch starting 2008.

Quarterly monitoring was conducted to estimate population growth rate based on size frequency analysis. The abundance of sandfish increased from 416 to 5,562 individuals with a

*Thalassia hemprichii*. Histological analysis of gonads showed that gonadal development of sea urchins in the cages were highly synchronous and had lunar periodicity. Together with the high reproductive output due to gonad quality, synchrony in spawning will increase fertilization success and larval supply, which can contribute to natural recruitment. The sea cages served as de facto reproductive reserves prior to harvesting. Fishery dependent (*i.e.* landed catch) and fishery independent (*i.e.* regular field surveys) monitoring were undertaken to evaluate the impact of interventions and determine recruitment strength in the wild.

Population genetic studies showed that there is very high genetic exchange and connectivity among *T. gratilla* populations in the northwestern part of Luzon (Malay *et al.*, 2002; Casilagan *et al.*, 2013). This indicates that the sustainability of the fishery stock is dependent on maintaining viable spawning populations in various locations across the northwestern region of Luzon.

corresponding increase in biomass from 7 to 221 kg ha<sup>-1</sup> over the 19-month period. Apparent survival was estimated at 20-30%. The estimated density of adults in the sea ranch reached up to 500 individuals ha<sup>-1</sup> (Juinio-Meñez *et al.*, 2013).

While sandfish attain sexual maturity at around 180 g, only sandfish > 320 g are harvested since prices are dependent on size. As such, a viable spawning population has been maintained at the sea ranch for over seven years. Mass spawnings of sandfish have been regularly observed in the sea ranch and wild recruits were found during most monitoring periods.

Landed catch monitoring showed a significant increase in the volume of sandfish harvested in adjacent areas. Local collectors attribute the increase in the catch to the sea ranch, which is the source of larvae and recruits in their fishing areas.

Recent population genetic studies showed high genetic variability in *H. scabra* populations throughout the Philippine archipelago (Ravago-Gotanco *et al.*, manuscript in prep). Thus restocking of cultured juveniles produced from broodstock obtained from a different genetic stock should be avoided.

## Lessons Learned

For *T. gratilla*, community-based grow-out in sea cages complemented with restocking of protected areas helped in the recovery of a collapsed fishery. Gonad biomass and quality of sea urchins fed with *Sargassum* were high. These increased the value of the gonads and reproductive output of cultured sea urchins. In the case of *H. scabra*, the release of juveniles in a communal sea ranch resulted in the build-up of density and biomass.

Observations of regular mass spawning in the sea ranch established that a viable spawning population can be maintained through selective harvesting. Both the sea urchin cage grow-out culture and sea cucumber sea ranch function as reproductive reserves and sources of larval supply to adjacent suitable habitats while providing additional sources of income to small fishers. The cooperators gain direct benefits from exclusive harvest rights and the spill-over

## Way Forward

Culture-based resource management interventions have become imperative due to widespread depletion of fishery stocks. However, these involve considerable investment and high associated risks, and in order to be effective, these should be science-based; there should be regular monitoring, evaluation and feedback to stakeholders and resource managers; and adherence to responsible sustainability practices. To scale up both ecological and economic impacts, these interventions should be incorporated within an integrated capture fishery management program.

Management should be undertaken at the level of local municipalities, as well as at broader management systems to maintain the natural bio-physical and genetic connectivities of the fishery stocks.

## Acknowledgements

The studies summarized in this article were undertaken through the efforts of various research personnel and local collaborators particularly the people's organization in Victory (*Samahan ng Maliliit na Mangingisda ng Victory, Inc.*) with funding from the Philippines' Department of Agriculture- Bureau of Agricultural Research and the Department of Science and Technology – Philippine Council for Marine and Aquatic Resources Management. Funding for sandfish sea ranching was also provided by the Australian Center for International and Agricultural Research (ACIAR FIS/2003/059 and FIS/2010/042), with counterpart support from the University of the Philippines Marine Science Institute and the hatchery facilities at the Bolinao Marine Laboratory. Travel support for the presentation of this paper was provided by SEAFDEC/AQD.

benefits of the spawning populations benefit many other fishers. The presence of wild recruits in the sea ranch and in the vicinity of the sea urchin sea cages indicates that natural recruitment may be enhanced by the high density of conspecific adults in these managed areas. These models have demonstrated that both ecological and economic benefits can be realized through responsible culture-based management interventions. The development of appropriate local governance mechanisms is a critical consideration for the sustainability of the initiatives. Active engagement with local stakeholders facilitated awareness raising and development of local capabilities in coastal resources management. Local cooperators who participated in these efforts were very effective in fishery management information and education campaigns and supported the passage of local regulations on harvest size limits.

The long term goal is to rebuild a productive and sustainable capture fishery independent of the release of hatchery-cultured juveniles. To conserve genetic diversity and ensure the resilience of local stocks to environmental changes, cultured juveniles should be released only in areas with similar genetic stock.

Given the high genetic diversity in the Philippines, the development of hatcheries to increase production using discrete stocks in different regions is important. Scaling up through involvement of different stakeholders (*e.g.* commercial hatcheries, fisher organizations, government agencies) could be facilitated through the development of low-cost ocean nursery and grow-out systems accessible to many small fishers, and enhanced management of marine invertebrate resources.

## References

- Anderson S.C., J.M. Flemming, R. Watson, H.K. Lotze. 2011. Rapid Global Expansion of Invertebrate Fisheries: Trends, Drivers, and Ecosystem Effects. *PLoS ONE* 6(3): e14735. doi:10.1371/journal.pone.0014735
- Andrew, N. L., Y. Agatsuma, E. Ballesteros, A. G. Bazhin, E. P. Creaser, D. K. A. Barnes, L. W. Botsford, A. Bradbury, A. Campbell, J. D. Dixon, S. Einarsson, P. Gerring, K. Hebert, M. Hunter, S. B. Hur, C. R. Johnson, M. A. Juinio-Meñez, P. Kalvass, R. J. Miller, C. A. Moreno, J. S. Palleiro, D. Rivas, S. M. L. Robinson, S. C. Schroeter, R. S. Steneck, R. I. Vadas, D. A. Woodby, and Z. Xiaoqi. 2002. Status and management of world sea urchin fisheries. *Oceanogr. Mar. Biol. Annu. Rev.*, 40: 343–425
- Casilagan, I.L., M.A. Juinio-Meñez, E.D. Crandall. 2013. Genetic diversity, population structure, and demographic history of exploited sea urchin populations (*Tripneustes gratilla*) in the Philippines. *J. Exp. Mar. Biol. Ecol.*, 449, 284-293
- Choo, P. S. 2008. The Philippines: a hotspot of sea cucumber fisheries in Asia. In: *Advances in sea cucumber aquaculture and management*. FAO Fisheries Technical Paper 463: 57-68
- Juinio-Meñez, M.A., N.D. Macawaris H.G. Bangi. 1998. Community-based sea urchin (*Tripneustes gratilla*) grow-out culture as a resource management tool. In: G.S. Jamieson and A. Campbell (Eds.) *Proc. of the North Pacific Symposium on Invertebrate Stock Assessment and Management*. *Can. Spec. Publ. Fish. Aquat. Sci.* 125: 393-399
- Juinio-Meñez, M.A., D. Pastor, H. G. Bangi. 2009. Indications of recruitment enhancement in the sea urchin *Tripneustes gratilla* due to stock restoration efforts. *Proc. of the 11<sup>th</sup> International Coral Reef Symposium*, Ft. Lauderdale, FL USA, 1017-1021
- Juinio-Meñez, M.A., J.C. Evangelio, R. D. Olavides, M.A. Paña, G. M. de Peralta, C. M. Edullantes, B. D. Rodriguez, I.L. Casilagan. 2013. Population dynamics of cultured *Holothuria scabra* in a sea ranch: Implication for stock restoration. *Rev. Fish. Sci.* 21 (3-4): 424-432
- Juinio-Meñez, M.A., H.G. Bangi, M. Malay, D. Pastor. 2008. Enhancing the recovery of depleted *Tripneustes gratilla* stocks through grow-out culture and restocking. *Rev. Fish. Sci.* 16 (1-3): 35-43
- Malay, M.C.D., M.A. Juinio-Meñez, C.L. Villanoy. 2002. Population genetics of the sea urchin *Tripneustes gratilla*. *Proc. of the 9<sup>th</sup> International Coral Reef Symposium*, Bali, Indonesia, vol. 1:107-112
- Purcell, S. W., C. A. Hair, D. J. Mills. 2012. Sea cucumber culture, farming and sea ranching in the tropics: Progress, problems and opportunities. *Aquaculture* vols. 368-369:68-81. doi:10.1016/j.aquaculture.2012.08.053