ENHANCING THE RECOVERY OF DEPLETED *TRIPNEUSTES GRATILLA* STOCKS THROUGH SEA RANCHING AND RESTOCKING

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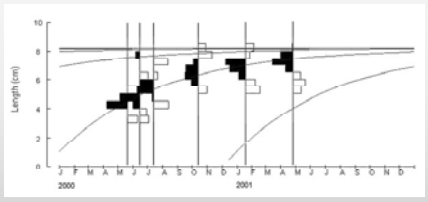
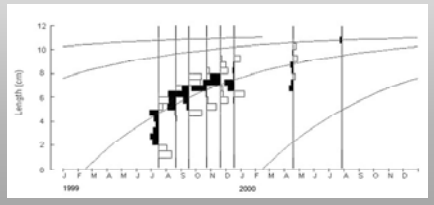
The reef flats of the coastal municipality of Bolinao, Pangasinan was a prime sea urchin fishing area for *Tripneustes gratilla* in the 1970s through the late 1980s. At its height, the fishery generated multimillion peso earning annually providing a source of livelihood to hundreds of coastal families and traders. Unregulated harvesting precipitated in the collapse of the fishery in 1992. Efforts to culture the species were initiated with the goal of reestablishing breeding populations to enhance the recovery of the fishery in Bolinao. Larval dispersal modeling studies indicated that, the population in Bolinao serves a source of larvae for areas north of Lingayen Gulf as far as the Ilocos region during the SW monsoon and conversely as a settlement area for larvae during the prevalence of the NW monsoon because of the monsoon-driven reversing currents along NW Luzon. Allozymes analysis indicated no significant genetic structuring among four populations along the NW coast from Ilocos to Batangas. These suggest that populations along NW Luzon were tightly linked and that rebuilding of sea urchin population in Bolinao would be strategic for the NW Luzon sea urchin stock.



PISALAYAN
(restructured data)
L_{oo} = 8.20
K = 1.700
R_n = 0.920
Z = 2.33
mortality = 90.3 %



QUEZON IS., HINP
(restructured data)
L_{oo} = 11.29
K = 1.300
R_n = 0.960
Z = 4.99
mortality = 99.3 %

Fig. 1. Size frequency analysis of reseeded *T. gratilla* in two sites in Pangasinan, Philippines.

In 1994, the life cycle of the species was closed in the hatchery and scaling up of seedstock production commenced in 1996. At that time seed stock production was only about 10,000 juveniles per year. To optimize survivorship of the limited numbers of hatchery reared seedstock to adulthood, community–based grow-out culture was developed as an adaptative resource management tool to address both ecological and socio-economic considerations while rebuilding the spawning population. This approach built on the practice of some fishers in Nalvo Sta. Ana, Ilocos Sur who traditionally collected small sea urchins and raised them to marketable size in bamboo cages on the reef flat. Large fresh sea urchins are a highly prized local delicacy in the area. Members of some people's organizations, state colleges and fisheries government agencies in other localities became partners in refining sea urchin grow-out culture. Various experiments were conducted to determine optimal conditions for grow-out culture including site suitability, stocking density, feeding, to enhance growth and gonad yield, and thus, reproductive output. From 2000 to the present, 50,000- 80,000 seedstock were used annually for reseeding in selected protected areas alongside grow-out culture in Bolinao, Ilocos and La Union. Growth rates of sea urchins in grow out cages varied with sites but were comparable and in some cases better than estimated growth rates of reseeded sea urchins. The 2 cm TD seedstock attained sexual maturity in 6 to 7 months at an average size of 6.0 cm TD. However, estimated natural

mortality of reseeded sea urchins estimated from length frequency analysis in two sites was 90% and 99% (Figure 1). In comparison, the survivorship of sea urchins cultured in sea cages ranged from 60 to 87% depending on grow-out site. In addition, grow-out culture provided a supplemental source of income for fishers and fostered community participation in resources management.

After the Bolinao fishery collapsed in 1992, monitoring of populations in Lucero which is a major collection area, showed no natural recruitment during the next six years. In 1999 a few juveniles were observed and densities began to increase. By 2003, a number of fishers began gathering sea urchins in the area again. During the last quarter of 2004, a strong recruitment pulse was noted clearly indicating recovery of the natural population in the area. This was further boosted by an even stronger recruitment during the first quarter of 2006 (Figure 2). A survey of 7 locations (14 sites) along NW Luzon in January 2006 showed recruitment in all sites except in one. All populations had a similar modal size class of 3 to 5 cm TD. This suggests that the recruits in these sites were from the same cohort of larvae spawned during the previous 3 to 4 months.

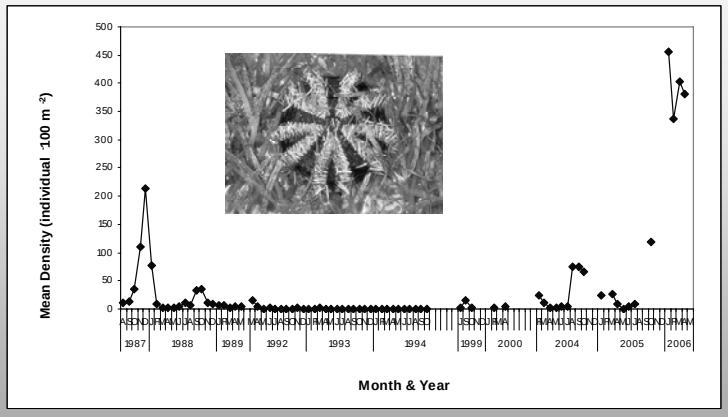


Fig. 2.Mean densities of *Tripneustes gratilla* in Lucero, Pangasian.

Interestingly, the highest densities among all sites was found in Lucero were densities reached about 4 individuals per m^2, exceeding densities recorded prior to the collapse of the fishery. In the past two years, three other sites in Bolinao in addition to Lucero were monitored and much higher densities of juveniles < 40 mm TD were always observed in the latter site. Comparison of the habitat, and management interventions in the different sites suggest that the presence of a higher density of adults in the protected area including broodstock in the grow-out cages in Lucero and possibly hydrographic features that may entrain larvae enhance recruitment in this site. After ten years of relatively small-scale but continuous efforts of restocking and sea ranching, the fishery stocks in Bolinao seem to have recovered. What is most important now is to manage the fishery to forestall another collapse. Aside from the traditional closed seasons and size limits, community-based grow-out and reseeding of protected areas to enhance spawning biomass using wild or hatchery reared seedstock have been demonstrated as viable options to enhance the recovery and productivity of the sea urchin fishery in NW Luzon.