Aquaculture-based Restoration and Stock Enhancement of Tiger Shrimps in the Philippines

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Abstract

In central Philippines, the Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD), with strong collaboration and support from the Research Institute for Humanity and Nature (RIHN) of Kyoto, Japan, has been looking into the stock enhancement of tiger shrimp *Penaeus monodon* in the New Washington Estuary (NWE), province of Aklan, central Philippines. The NWE was a productive fishing ground that has been suffering from degenerating brackishwater fisheries and estuarine environment. Average daily catch declined from 24 kg in 1970s to only 0.7 kg at present. Shrimp fisheries, the most important livelihood, declined in quality and quantity. Tiger shrimps were abundant in catch until the early 1990s when these were observed to decline in volume, replaced by smaller and cheaper species. This was coincidental with the rapid decline in mangrove cover for ponds and huge increase in fishing pressure. It is clear that crucial interventions are required to restore the tiger shrimp fisheries in the NWE in order to increase income of local fishers, while promoting reduction of fishing gears and restoration of mangroves. Stock enhancement of tiger shrimps shows good potential in answering these needs. Site-specific assessments were conducted to evaluate prospects of shrimp stock enhancement in NWE. Conservative simulations of capture of released stocks showed that fishers can increase income by 300%. To decrease fishing pressure in the area, number of gears per fisher may have to be reduced but shrimp catches will be relatively high-priced. Comparative experiments using aquaculture techniques were done to identify strategies especially in the delicate intermediate acclimation rearing. Aquaculture protocols like those for pond preparation were also adapted to be used in a mangrove pen nursery rearing system for shrimps. Supplemental feeding with formulated feeds increased carrying capacity of the culture area, while enhancing growth and survival of stocks. Culture experiments showed that shrimps grow to 0.5 g within 1 mo and >1g in 2 mo. High stocking density of 40-60 shrimps m^{-2} can be used for <2 mo rearing in a mangrove pen. Release experiments showed that 60-d old shrimps have higher chances of survival when released in the estuaries. With strong support from local communities, government and other sectors, together with effective management and law enforcement, aquaculture-based stock enhancement of tiger shrimps can be a viable intervention to restore livelihood and promote estuarine rehabilitation in the NWE.

Introduction

The Aquaculture Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD) with strong collaboration and support from the Research Institute for Humanity and Nature (RIHN) of Kyoto, Japan has been looking into the stock enhancement of tiger shrimp *Penaeus monodon* in the New Washington-Batan (NW-B) Estuary, Province of Aklan, central Philippines (**Fig. 1**). The NW-B Estuary used to be a productive fishing ground but has suffered from degenerating brackishwater fisheries and estuarine environment. Catch per unit effort (CPUE kg $gear^{-1}$ d^{-1}) declined by almost half in every decade since 1970 (**Table 1**). Specifically, shrimp fisheries which is the most important livelihood, declined in quality and quantity. Tiger shrimps were dominant in catch until the early 90s when these were observed to decline in volume, replaced by smaller and cheaper species like the greasy-back shrimp *Metapenaeus ensis* (Ingles *et al*., 1992).

This was coincidental with the rapid decline of mangrove cover where 76% has been converted to ponds by late 1990s (Altamirano *et al*., 2010). A great number of stationary fishing gears also proliferated increasing by 400% from two decades ago (Altamirano and Kurokura, 2010).

It is clear that crucial interventions are required to restore the tiger shrimp fisheries in the NW-B Estuary to increase the income of local fishers, and promote reduction of fishing gears and restoration of mangroves. Shrimp stock enhancement shows good prospects in answering these needs where fishers can potentially increase income by 400% and reduce fishing gears by 60% (Altamirano *et al*., 2015). Mangrove rehabilitation programs can then be conducted through education and information campaigns, emphasizing on the roles and functions of mangroves as nursery for fish and shrimps.

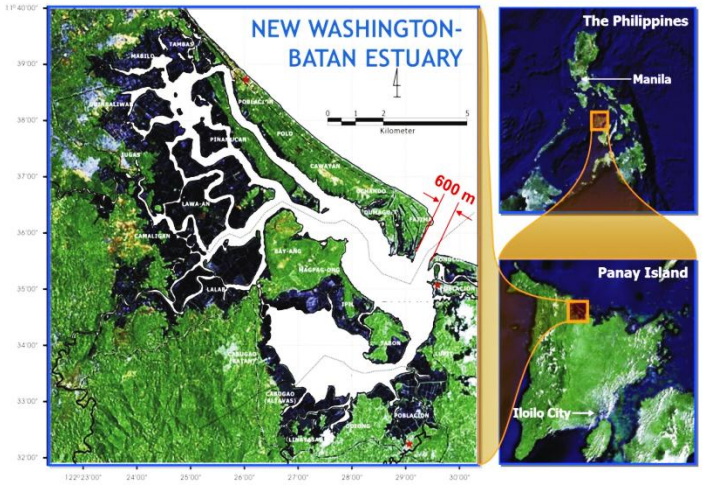

Fig. 1. Located at the northern coast of Panay Island, New Washington-Batan Estuary is a semi-enclosed lagoon and river system receiving seawater from a 600-m opening, while freshwater drains through various creeks and streams around the estuary

Activities Conducted

Baseline assessment

The project started during the last quarter of 2012 mainly focusing on preparation and networking with concerned partners like the local government units (LGUs) of the Municipality of New Washington, Aklan State University (ASU), and the resident fishing community, represented by the local people's organizations called the Pinamucan Small Fisherfolk Association (PSFA). Secondary data for both environmental and socio-economic aspects have been collected from literatures and government records. Collection of baseline information on the socio-economic status of fishers and actual catch was done since January 2013.

Preparation

Local fishers, who are members of the local PSFA, participated in the stock enhancement activities and were successful in the construction and preparation of the intermediate nursery culture site using an abandoned pond in a mangrove area in the middle of the NW-B Estuary (**Fig. 2**). The fishers are also involved in monitoring of the shrimps during intermediate rearing, as well as maintenance of the nursery site. Additionally, other fishers and local traders are responsible in recording actual catch to aid in the assessment of impacts of the project.

Table 1. CPUE from fish corral or stake nets in NW-B Estuary from 1970 to 2013 (updated from Altamirano and Kurokura, 2010)

Year	CPUE (kg gear^{-1} d^{-1})	REFERENCE
1970	24.00	Altamirano & Kurokura (2010)
1980	10.00	Altamirano & Kurokura (2010)
1990	7.66	Ingles *et al*. (1992)
2000	5.00	Altamirano & Kurokura (2010)
2000	3.44	Babaran *et al*. (2000)
2006	1.65	Altamirano & Kurokura (2010)
2013	0.73	Current study

Site and Species-specific Experiments

Site-specific assessments were conducted to optimize the success in rearing and release of tiger shrimps for stock enhancement in NW-B Estuary. Comparative experiments using aquaculture techniques were done to identify the strategies especially in the delicate intermediate acclimation rearing. Aquaculture protocols like those used in pond preparation were also adapted in a mangrove pen nursery rearing site for shrimps. Supplemental feeding with formulated feeds especially at initial stage of rearing increased survival and growth of juvenile shrimps, while optimizing carrying capacity of the rearing area.

Intermediate Nursery Rearing

Intermediate rearing of shrimps for stock enhancement adapted various aquaculture techniques for rearing tiger shrimps in ponds. Four intermediate culture trials were conducted in 2014 to test site-specific requirements for rearing juvenile tiger shrimps in a mangrove pen. Parameters like stocking density and optimal time for release were tested experimentally. Based on best results from these four trials, another intermediate rearing run was conducted in April 2015 that was successful in releasing an estimated 250,000 shrimps (51% survival) of desired size (>0.5 g) after 30 days of rearing.

Release and Monitoring

Actual catch monitoring is being done since January 2013 with data on catch volume, and species composition forming part of the baseline data. As a representative, 20 fixed fishing stations are monitored regularly twice a month to detect impacts of release activities.

Lessons Learned

Species selection

In 1970s, tiger shrimps *P. monodon* composed the majority of shrimp catch of fishers (Ingles *et al*., 1992), indicating their natural historical abundance in the NW-B Estuary. The restoration and enhancement of tiger shrimps in the area augments the limitation of natural recruitment of the species, while environmental rehabilitation is in preparation. The selection of tiger shrimps as the target species is not only based on historical ecology of NW-B Estuary but is socially-driven as well. Based on validation interviews with local fishers, tiger shrimps turned out to be the top species of choice – being preferred by 82 out of 200 interviewees – for stock enhancement in the area because of its rarity and value; while white shrimp *Penaeus ensis* and grouper *Epinephelus* sp. were only preferred by 26 out of 200 fishers.

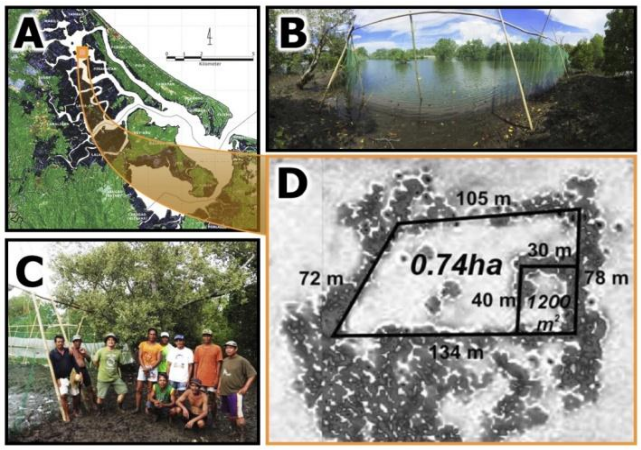

Fig. 2. The intermediate nursery area is in the upper estuary (A) where salinity and water temperature are conducive for young shrimp juveniles. Nets supported by bamboos (B) constructed by local PSFA members (C) were placed around an abandoned pond, surrounded by naturally regenerating mangroves, dominated by *Sonneratia alba* (D)

Source and Health of Stocks

In a stock enhancement program, it is crucial to maintain local genetic diversity. Therefore, it is important to refrain from the translocation of non-native populations. Fortunately in NW-B Estuary, at least four local shrimp hatcheries are operating within 20 km of the area, making use of only wild-caught local shrimp spawners collected from nearby seas. This assures that shrimp post-larvae and juveniles used in release activities at NW-B Estuary carry local genes. Similarly important is making sure that stocks are clean. So, screening and testing for bacterial and viral diseases were conducted periodically to ensure the health of stocks.

Intermediate Acclimation Rearing

Specifically for shrimps, an intermediate nursery phase is necessary to increase the chances of survival when released, considering that postlarvae from the hatcheries are too small (<1.0 cm total length) and predation could be very high when released directly to estuaries. Moreover, these hatchery-bred individuals are accustomed to feed on artificial diets and clean environment in tanks. A transitional or intermediate nursery culture phase is therefore needed to condition and acclimate the postlarvae in a natural estuarine environment. Experiments conducted for this study was able to establish some optimal conditions for intermediate rearing. Location of the rearing site must be at the upper river areas with optimal salinity of 15-25 ppt for young shrimp juveniles. Age of shrimps to be released is optimal at 60 days old, so 20-30 day-old postlarvae from hatcheries need to be reared in intermediate acclimation nurseries for about 30 more days. At this age, body weight postlarvae should ideally be ~0.5 g with ~20 mm carapace length. At this particular site in NW-B Estuary, optimal stocking density is 40-60 juvenile shrimps per m^2 for ~30 days culture duration. In addition, considering that the site is affected by seasonal storms, the best time for rearing and release at the NW-B Estuary is from April to June when typhoons are expected to be minimal.

Initial Impacts of Stock Enhancement

Immediate increase in catch after rearing and release activities can clearly be seen even with the small-scale monitoring of 20 fixed gears (**Fig. 2**). In 2013, average catch from all 20 stations was only 1 tiger shrimp per month. The first rearing trial in Jul 2013 suffered very high mortality but possible escapees caused a slight catch increase of 3-4 pcs per month in August and September.

Super Typhoon Haiyan in November 2013 caused an immediate decline in catch in December because most gears were destroyed. Another corresponding increase in catch (6 pcs mo^{-1}) was recorded in January and February 2014 when fishing gears where repaired and fishing operations resumed. Successful rearing and releases in April and Jul 2014 caused a steady increase in tiger shrimp catch from May (2 pcs mo^{-1}) to Aug 2014 (20 pcs mo^{-1}). Typhoons in November and early December 2014 caused another unsuccessful rearing and stocks to escape, thereby increasing catch in December (13 pcs mo^{-1}). Incorporating all best practices and optimal protocols from previous 4 trials resulted in the most successful rearing and release run in April and May 2015. This also resulted in the highest *P. monodon* catch (28 pcs mo^{-1}) recorded in June 2015; while another failed rearing with escapees in July still reflected some increased catch in August 2015.

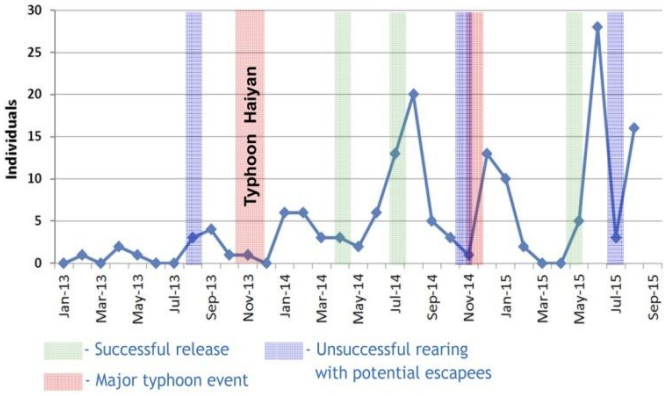

Fig. 3. Monthly total catch of tiger shrimps from 20 fixed gears from Jan 2013 to Aug 2015. Months of rearing and release activities (green and blue), as well as major typhoon events (red) are highlighted

Conclusion and Recommendations

Fisheries Management

The stock enhancement activities in the NW-B Estuary showed a clear impact in shrimp fisheries (**Fig. 3**). However, increased catch immediately after release activities indicated very active and strong fishing pressure in the area. In all of these cases, good catch were not sustained and steep decline in tiger shrimp harvest were clearly evident afterwards. This result suggests that some fisheries management intervention in terms of catch regulations must be considered and implemented in the area. With strong support from local communities, government and other sectors, together with effective management and law enforcement, aquaculture-based stock enhancement of tiger shrimps could be a viable intervention to restore livelihood and promote estuarine rehabilitation in the NW-B Estuary.

Key ingredients for success

The following are recommended key points to consider for best chance of success for a stock enhancement program:

- ❑ Partnership with a local community with strong leadership
- ❑ Sufficient social preparation and capacity building
- ❑ Active community participation from planning to implementation
- ❑ Diversification of activities and livelihood for community
- ❑ Accurate, reliable and science-based baseline information
- ❑ Site-specific and species-specific assessments and studies
- ❑ Multi-institutional/sectoral collaboration
- ❑ Establishment of legal framework and agreements among collaborators

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