Impact of shrimp-farming on mangrove ecosystems in Pambala, Chilaw

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Background

Mangroves are the coastal equivalent of tropical forests and hence of important ecological and environmental significance. In Sri Lanka, as in many other countries, conversion of mangrove forests to other uses has resulted in a considerable decline of these ecosystems. It is estimated that mangroves in Sri Lanka cover only 87 km^2, which amounts to around 0.2 % of th*e* total land area of the country (Legg and Jewell, 1995). One of the major factors that has led to their destruction in Sri Lanka is shrimp farming. Valietel *et al*. (2001) report that the conversion of mangroves to aquaculture ponds is responsible for about 38% of the total mangrove loss that has occurred in the country. In addition to the direct destruction of mangroves, shrimp farming has also caused the degradation of water quality in lagoons and the loss of biodiversity in the remaining patches of vegetation (de Silva and de Silva 2002; Wolanski *et.al*. 2000). In the present study we attempt to assess the impact of shrimp farming on mangroves in Pambala, Chilaw, an area where shrimp farming is extensively conducted, by assessing changes in the composition of mangrove flora and selected invertebrate taxa as well as through changes in water quality of the lagoon.

Methodology

The study was conducted from March to July 2011. Impacts were monitored in five mangrove areas located adjacent to shrimp farms that were currently in operation while three sites away from shrimp farms served as reference sites. No shrimp farms were located within a radius of 2 km of the reference sites. At each site, five quadrates of 5 m x 5 m were established using poles and ropes. All mangroves and associate species were identified and enumerated within these quadates. The regenaration capacity of the species was assesed by counting the seedlings and saplings within subquadrates of 1 m x 1m inside the main quadate. Crustaceans, ploychaetes and molluscs were also identified and enumerated within the subquadrates. Separate counts were taken for benthic fauna and epifauna. Seven water quality parameters, i.e . tempatature, pH, turbidity, salinity, diissolved oxygen, nitrate and phosphate, were assessed at five locations in the lagoon, at each of the eight sites, using standard protocols. The rate of sedimentation was also assessed using a simple gauge. For each parameter, the one way ANOVA and Tukey's tests were used to examine for significant differences between shrimp farming and reference sites.

Results

A total of 14 species of mangroves and eight species of mangrove associates were recorded during the present study which is lower than the numbers recorded in this area previously. Floral species richness in non-shrimp farming areas (18 $\pm$ 0.69) was significantly greater than that in shrimp farming areas (12 $\pm$ 0.36). Trends in abundance were similar with a significantly greater abundance being recorded in reference sites (shrimp framing sites - 84$\pm$ 0.76; reference sites - 114$\pm$ 0.69). Composition was also altered with certain species being present only in areas not affected by shrimp farms whilst others were more abundant in shrimp farming sites. In contrast, the Shannon-Weiner Diversity Index in shrimp farming sites and reference sites was not markedly different with the former and latter having values of 0.24 $\pm$ 0.005 and 0.28 $\pm$ 0.05 respectively. There was also no significant difference in the proportion of seedlings/saplings between shrimp farming and reference sites. Considering fauna, total species richness of molluscs, crustaceans and polycheates were similar in both reference and shrimp farming sites (Fig. 1) while for abundance the composition was significantly different between the them (Fig. 2). Oysters are shown as a separate group from the molluscs because of their greater abundance. Selected species (e.g., *Thalasina*) were also more abundant in sites affected by shrimp farms than in the reference sites.

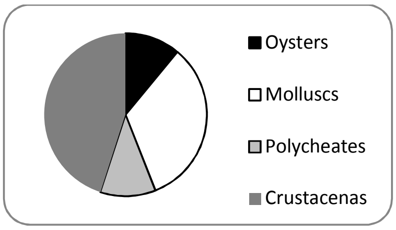
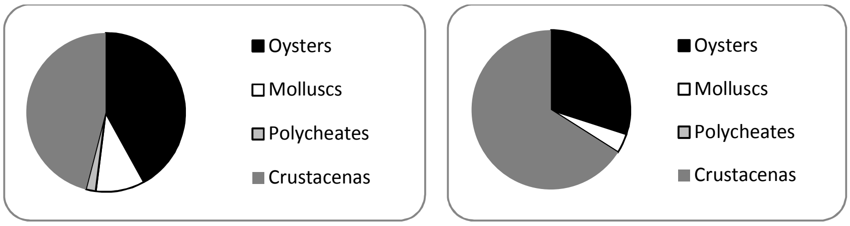


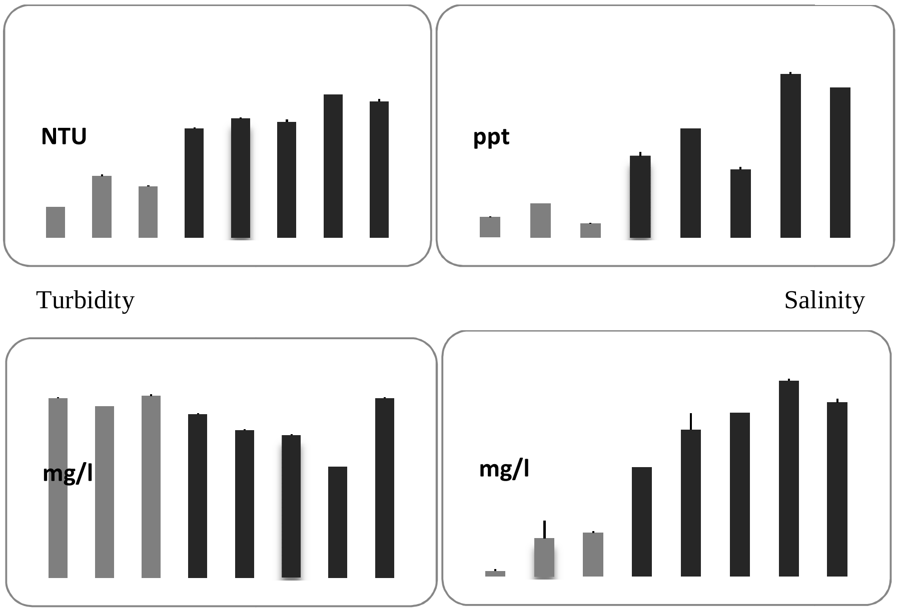
Fig 1: Species richness (as a percentage of the total species richness) of invertebrate fauna in both reference and shrimp farming sites in the Pambala area.



(a) Reference sites (b) Shrimp farming sites

Fig 2: Composition of invertebrate fauna (as a percentage of the total abundance) in the (a) reference and (b) shrimp farming sites in the Pambala area.

Water quality in sites near shrimp farms was markedly different to that of reference sites (Fig. 3) and with the exception of phosphate, the differences between shrimp farming and non-shrimp farming sites were significant. The turbidity in shrimp farming sites (28.6 NTU$\pm$1.73) was double that of reference sites. Similarly, salinity levels in shrimp farming sites (16.8 mgl$^{-1}\pm$1.46) were five fold higher than that in reference sites (3.33 mgl^{-1} $\pm$ 0.43). Salinity was generally low because of the considerable rainfall during the sampling period. Water temperature in shrimp faming sites was 26.3 ^{o}C, whilst that in non-shrimp farming sites was 28.8 ^{o}C. Shrimp farming sites were also less acidic (7.2 - 7.8) than the reference sites (6.2 - 6.7). Dissolved oxygen values of 5.6 ($\pm$0.23) and 6.7-($\pm$ 0.05) were recorded for the shrimp farming sites and reference sites respectively. Plant nutrients were also much greater in shrimp farming sites (nitrate 0.08 - 0.28 mgl^{-1}, phosphate 0.2 - 0.36 mg l^{-l}) than in reference sites (nitrate 0.02 - 0.03 mgl^{-1}, phosphate 0.01 - 0.08 mg l^{-l}). No significant differences in sedimentation were noted over the duration of the study although there were signs of sediment accrual.



Turbidity Salinity

Nitrate Phosphate

Fig. 3: Four water quality parameters in eight sampling sites in the Chilaw lagoon (A – C: Reference sites: D – H – Shrimp farming sites)

Conclusions

The present study has shown that the rapid growth of shrimp farms in the Chilaw area has serious negative impacts on the mangrove ecosystems and the lagoon. This was evident through its impacts on both biotic and abiotic components of this ecosystem. The composition and diversity of flora and selected faunal taxa were seriously altered in the vicinity of shrimp farms in comparison to that of the reference sites. Despite the constant flushing, water quality of the lagoon has deteriorated as apparent by the greater levels of nutrients and turbidity (suggesting higher sediment loads), implying risks of eutrophication and the potential toxicity to mangrove flora and fauna. If the current trends continue it may have serious implications for biodiversity conservation and ecosystem integrity as well for the aquaculture industry itself.

References

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