An evaluation of the effect of structural properties of construction materials on the brush parks fishery in the Negombo Lagoon, Sri Lanka.

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Abstract

Negombo lagoon (3,164 ha) in the western coastal belt of Sri Lanka supports many species of fish and crustaceans which are important sources of livelihoods for the people around the estuary. Brush parks are a kind of traditional form of fishing method which are installed in shallow areas of the estuary using dense masses of mangrove twigs. In the present study, the effect of structural properties on sustainability and economics of periphyton based brush park fisheries production was evaluated. The duration between installation and harvesting of brush parks ranged from 3 to 89 days and nearly 28 % brush parks were harvested within 29-35 days after installation. Majority of brush parks (36.6%) had 51-75 mangrove twigs and diameter of brush parks varied between 2-12 m. The twig density, expressed as twig dry weight per unit volume of brush parks ranged from 0.02 to 21.03 kg $m^{-3}$with the average twig density (±SD) of 2.01 ± 3.09 kg $m^{-3}$and 76.1% of brush parks had twig density less than 2 kg m^{-3}. The mean monthly yield and catch value of fish and crustacean species were recorded 0.43 ± 0.69 kg m^{-2} $month^{-1}$ and Rs.1913 ± 1476 respectively. Significant negative relationship ($F = 36.95$; $P<0.001$) exhibited between yield and period between installation and harvesting. The relationship between catch value and twig density also showed significant ($F = 13.09$; $P < 0.001$) inverse relationship. The mean yield (0.48 kg m^{-2} $month^{-1}$and 0.47kg m^{-2} $month^{-1}$) of brush parks during the inter monsoon period (March-April and October-November) were significantly higher ($P < 0.001$) than the yield (0.36 kg m^{-2} $month^{-1}$and 0.44 kg m^{-2} $month^{-1}$) recorded during the monsoon period (May-September and December-February). The yield and its catch value of brush parks were related to the period since installation and twig density. Present findings suggest that to achieve maximum brush park yield, the optimal period since installation was about 30 days and the optimal twig density was about 2 kg m^{-3}.

Keywords: brush parks, traditional fisheries, mangroves, costal fisheries

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Introduction

The Negombo lagoon fishing activities are dominated by four major fishing gears as trammel net, drag net, brush parks, cast nets that are used within the estuary and stake net gear fixed at the mouth (Jayawardane *et al.* 2004). Brush parks are a kind of fish and shrimp aggregating device which are widely operated in the Negombo lagoon. The highest total fish catch of 21,668 kg/year came from brush parks, which accounted for about 29 - 41 % of the total landings in Negombo lagoon (Wijeyaratne and Costa, 1987). There were 2,200 brush parks, of a mean area of 51.8 m^2, cover totally 11.3 ha of the surface water of Negombo Lagoon (Welcomme, 2002). A comparatively higher yield of 12.46 t $ha^{-1}year^{-1}$ was reported in the lagoon during 1998 (Amarasinghe *et al.* (2002).

The brush park fishery offers a number of biological and economic advantages in management of small scale fisheries in coastal lagoons. However, brush parks could lead to environmental problems, due to requirement of large quantity of twigs mainly mangroves to construct and maintain brush parks. These environmental drawbacks could result in deforestation of mangroves, which would harmfully affect the fish population as well as fauna associated with mangrove ecosystem. Hence, it is important to quantify the minimum resource requirement for maximizing fisheries production of brush parks. Towards this goal, the present study examined the effect of twig density and number of days since installation on brush park yield and catches value.

Material and Methods

Data were collected from 205 brush parks in three major brush park fishing areas (Munnakkaraya, Katunayake and Dungalpitiya) in the Negombo Lagoon from 2014 - 2015 period. One hundred mangrove twigs in four size categories (0-1m, 1-2m, 2-3m and above 3 m length) from each species (*Rhizophora mucronata, Avicenia marina, Lumnitzera racemosa, Bruguiera gymnorrhiza, Excoecaria agallocha)* were used to measure mean diameter of mangrove branches. Length of each mangrove twig was measured to the nearest centimeter and diameter was measured nearest millimeter by using measuring tape and vernier caliper respectively.

Dry weight (DW in g) of mangrove twigs of *R. mucronata* and *A. marina* was determined by following allometric relationship described by Amarasinghe and Balasubramanium (1992).

For *Rhizophora mucronata*;In DW = 4.262+2.103 ln di

For *Avicenia marina*; In DW = 4.074+2.299 ln di

where, di the mean diameter (in cm) of mangrove twigs in each species and size category.

Dry weight of above ground plant component (branches and leaves) of *L. racemosa* and*B. gymnorrhiza* was determined by according to the relationships presented by Perera *et al.*, (2012).

For *Lumnitzera racemosa*;Above ground biomass = $0.114(dbh)^{2.523}$

For *Bruguiera gymnorrhiza*;Above ground biomass = $0.289(dbh)^{2.327}$

Dry weight (biomass)of mangrove twigs of *E. agallocha was* determined by the following allometric equation derived by Komiyama *et al.*, (2005).

$$Biomass = 0.251\ \rho\ (dbh)^{2.46}$$

where, dbh is the girth/diameter, ρ – density of wood

The brush park yield (Y in kg m^{-2} $month^{-1}$) of fin fish and crustacean species was estimated assuming the shape of the brush park to be cylindrical.

$$Y = (C \times 30) / (3.1416 \times (D^2/4) \times (N)$$

where, C is the total harvest in kg (fin fish and crustacean) from the brush park, D the diameter (m) of the brush park and N the period of installation of the brush park in number of days.

Dry weights of all mangrove twigs of each species were determined by assuming that different size categories of mangrove twigs hold the above mentioned relationships between dry weight and dbh. Total dry weight (W) was determined by sum of all dry weights of mangrove species in each brush park.

Twig density in brush park (kgm^{-3}) was estimated as

$$\text{Twig density} = W / (3.1416 \times (D^2/4) \times (H))$$

Where; *H* is the height of the brush park (m).

The effect of twig density and number of days since installation on brush park yield and catch value were determined using linear regression analysis. As fish yield is generally known to be log-normally distributed (Gulland, 1983). Since do not conform to a normal distribution, Mann-Whitneynon-parametric test was employed to compare brush park yields during the two seasons (monsoon and inter-monsoon period). Statistical package MINITAB software (release 16) and MS office Excel (2013) were used to carried out all statistical analyses.

Results

The duration between installation and harvesting of brush parks ranged from 3 to 89 days and about 28% brush parks were harvested within 29-35 days after installation. Majority of brush parks (36.6%) had 51-75 mangrove twigs and diameter of brush parks varied between 2and 12 m. The twig density, expressed as twig dry weight per unit volume of brush parks ranged from 0.02 to 21.03 kg m^{-3}, average twig density (± SD) was 2.01 ± 3.09 kg $m^{-3}$and 76.1 % of brush parks had twig density of less than 2 kgm^{-3}. The mean monthly yield and catch value of all species were recorded as 0.43±0.69 kgm^{-2} $month^{-1}$ and Rs.1913 ± 1476 respectively. There was a significant negative relationship ($F=36.95$, $P < 0.001$) between yield and period between installation and harvesting of brush parks. There was also a negative significant relationship between catch value and twig density ($F=13.09$, $P < 0.001$). Positively correlated relationship was observed between catch value and period between installation and harvesting of brush parks ($F=8.8$, $P < 0.05$). Results of Mann-Whitney test showed that significantly higher mean yield (0.48kg m^{-2} $month^{-1}$ and0.47kg m^{-2} $month^{-1}$) of brush parks were reported during inter monsoon period than the yield (0.36 kg m^{-2} $month^{-1}$and 0.44 kg m^{-2} $month^{-1}$) during the monsoon periods ($P < 0.001$).

Discussion

The yield of the brush parks (acadjas) in Dahomey, West Africa increased exponentially with the number of days between implantation and harvesting and also logarithmically with increasing density of branches in the brush parks (Welcomme, 1972). However; such relationships were reported as second order polynomial by Amarasinghe et al. (2002) in Negombo estuary ?. Yield of brush park decreased with the time of installation to an optimum

level (around 30 days) and either stabilized or declined in the present study. This pattern can be interpreted as an increase in population density as fish that are attracted to the park for food and shelter, reaching a maximal level after which they may decline as the quality of the park deteriorates after about a month in the water (Amarasinghe et al. 2002). Brush park fishing takes place year-round whenever favourable weather conditions prevail, except occasional windy days and heavy rains during monsoon seasons.Emigration of fish from brush parks due to high wave action and high water level may have resulted in lower yield during the monsoon season than inter monsoon period.

Though positive relationship revealed between yield and twig density, significantly less catch value ($P<0.001$) was observed with high twig density (more than 2 kg m^{-3}).The reason may be due to assemblage of low trophic level fish species such as *Oreochromissp.,Etroplus suratensis*. *Scatophagus argus, Siganus jarvus* and fishes of family Mugilidae with less economic value possibly due to high abundance of periphyton that served as a food source for such fish. Amarasinghe et al. (2002) also indicated that high crustacean yields were reported in brush parks with less dense twigs.

Present findings suggest that to achieve maximum brush park yield, the optimal period since installation was about 30 days and the optimal twig density was about 2 kg m^{-3}. As such, for effective management of brush parks fisheries in the Negombo Lagoon, appropriate mangrove twig density could be used to reduce environmental degradation (mangrove deforestation)while ensuring maximum economic returns for sustainable livelihoods of fisherman.

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References

Amarasinghe, U. S., Amarasinghe, M. D. and Nissanka, C. 2002. Investigaton of the Negombo estuary Sri Lanka) brush park fishery, with an emphasis on community – based management. *Fisheries Management and Ecology*. **9**: 41-56.

Amarasinghe, M.D., .and Balasubramaniam, S. 1992. Structural properties of two types of mangrove stands on the north-western coast of Sri Lanka. *Hydrobiologia*, **247**: 17-27

Gulland, J.A. 1983. Fish Stock Assessment. A Manual of Basic Methods. Wiley, Chichester, UK.

Jayawardane, P. A. A. T., Amarasiri, C., Mclusky, D. S. and Tytler, P. 2004. Shrimp fishery in the Negombo lagoon on the west coast of Sri Lanka. *Indian Journalof Fisheries*, **51**(2): 215-226.

Komiyama, A., Poungparn, S.&Kato, S. 2005. Common allometric equations for estimating the tree weight of mangroves. *Journal of Tropical Ecology***21**:471- 477.

Perera, K. A. R. S., Sumanadasa, W. A. and Amarasinghe, M. D. 2012. Carbon retention capacity of two mangrove species, Bruguiera gymnorrhiza (L.)Lamk. and Lumnitzera racemosa Willd. In Negombo estuary, Sri Lanka. Journal of the Faculty of Graduate Studies, University of Kelaniya, **1**:56-70.

Welcomme, R. L. 1972. An evaluation of the Acadja method of fishing as practiced in the coastal lagoons of Dahomey (West Africa). *Journal of Fish Biology***4**:39-55.

Welcomme, R. L. 2002. An evaluation of tropical brush and vegetation park fisheries.*Fisheries Management and Ecology*, **9**:175–188

Wijeyaratne, M. J. S. and Costa, H. H. 1987. On the management of finfish fishery of Negombo Lagoon, Sri Lanka. *Indian Journal of Fisheries***34**: 41-47.