International Research Journal of Environmental Sciences ISSN 2319–1414
Vol. **8(4),** 14-20, October **(2019)** *Int. Res. J. Environmental Sci.*

Ecological impact of destruction of mangrove vegetation on juvenile fish populations in Negombo lagoon

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Available online at: www.isca.in, www.isca.me
Received 27th November 2018, revised 5th July 2019, accepted 18th August 2019

Abstract

The present study was to assess the impact of destruction of mangrove on distribution of juvenile fish. The samples were collected during January 2015 to June 2015 at day time and low tide using a drag net. It was dragged in the water at the edge of the lagoon in two selected sites, Kadolkele (mangrove area) and Liyanagemulla (mangrove cleared area). Total of 102 juvenile fish were collected, belonging to 14 species representing of 11 families. Oryzias melastigma was the most abundant fish species (26.47%), followed by Hemiramphus marginatus (21.56%) and Atherinomorus duodecimalis (9.80%). Hemirhamphus marginatus was the most common species in both habitats. Oryzias melastigma was the most abundant species recorded from mangrove area followed by A. duodecimalis, and H. marginatus. Kadolkele site recorded 13 species while Liyanagemulla recorded 2 species. Diversity of fish associted with mangrove area was higher than that of the other area. This indicates that mangrove areas are the most preferable nursery habitats for juvenile fish. However, it has shown that there is an ecological impact of destruction of mangroves on the distribution of juvenile fish populations.The distribution and abundance of number of species and individuals are highly depend on salinity ($P\leq0.05$) of the water and the site ($P\leq0.01$). This study give the awareness for formulating management policies in future to protect Negombo lagoon especially to stop clearing the mangrove vegetation.

Keywords: Juvnile fish, mangrove destrucion, Negombo lagoon, nursery habitats, distribution.

Introduction

Estuaries and lagoons are among the most productive ecosystems in the world. Most of the fish populations inhabited in brackish water bodies are sustained by continuous migration from the sea and fresh waters. Mangroves enrich fish production through providing food and shelter. Mangrove leaf litter contribution is the more significant nutrient input into the estuaries and lagoons. Several researchers have indicated how it enters the food web in adjacent water[1,2]. Most consumers showed their dependancy on mangrove derived detrital carbon as an primary energy source[3]. Mangrove ecosystems provides spawning, nursing, and feeding grounds for a variety of economically important fish and crustaceans[4,5]. According to a study conducted in Moreton Bay, Australia[6] showed that mangrove sites play a more significant role and have a greater acceptance as nursery grounds than the nearby areas. Consideration of the significance of the mangrove habitats for juvenile fish indicates that there is a need to conserve these habitats.

The destruction of mangroves is a global issue due to numerous human requirements: clearing for development projects, or forestry uses and further use for aquaculture. With this important global loss, mangroves seems to be the one of the world's threatened most valued tropical environments[7]. With this global issue, at present there is an increasing concern on the sustainable management of mangrove ecosystems. Therefore, it is essential to recognize the relationships between mangrove habitat and the associated fish species[5,8].

One or more environmental factors such as current speed, turbidity, temperature, salinity, etc. and surrounding vegetation closely affect the distribution of fish species in a particular habitat. Estuarine fish populations came up with seasonal cycles that are related to the nursery functions and migratory activities[9]. Studies of subtropical estuaries[10,11] indicate that salinity may have an added influence on the seasonality of fish populations. Temperature and salinity are the main factors which influence the variability in the abundance of the fish species in the Volta estuary, Ghana. There is a strong correlation between all these variables and their influence on the species composition of this estuary[12]. Increase of number of marine species migrating into the estuary, coinciding with increasing salinities in the estuary[13]. Due to the differences in tolerance levels to salinity there is temporal and spatial variation take place in the distribution of the fish species in mangroves[14].

The Muthurajawela marsh-Negombo lagoon coastal wetland has been named as a protected area for biodiversity conservation by the Wildlife Act, 1989[15]. Mangroves seems o be the main vegetation type bordering the Negombo Lagoon and seagrass are submerged in it. The mangroves cover an area of 3.5 km^2, mainly the narrow intertidal belt along the banks of the

Negombo lagoon[16]. The extent of mangrove has decreased by about 0.3 km^2 from 1985 to 1995[17]. Kadolkele is the largest single mangrove stand, which covers nearly 0.14 km^2 of the intertidal land in Negombo Lagoon.

In an investigations on Negombo lagoon[13], recorded 62 fish species belonging to 36 families. After more than ten years later from the same lagoon recorded 62 fish species belonging to 39 families[18]. Among them 16 species occurred in mangroves, six species only in seagrasses and 40 species common to both habitats.

High productivity of mangroves provides facilities for continuing of food chains throughout the brackish water ecosystems. Mangroves of Negombo lagoon is subjected to anthropogenic threats such as cutting of mangroves, waste water entering to the lagoon and accumulation of pollutants. This has mostly been caused by ignorance, and the poverty of neighbourhood and the unplanned and unscientific reclamation of land for development.

In the Negombo area, about 10% of mangrove forest cover has been cleared during the last decade. Due to the destruction of mangroves, niches of many fish species may either have been subjected to the changes or have been totally destroyed. Therefore, it is important to find out the present status of the diversity and abundance of juvenile fish populations in Negombo lagoon with respect to mangove areas and areas where destruction of mangroves took place.

The main objective of the present study was to identify the juvenile fish species associated with mangrove area and the mangrove destructed area. Further more to find out their abundance and diversity in this lagoon to assess the ecological impact of destruction of mangroves on distribution of juvenile fish.

Methodology

The study was conducted from from January 2015 to June 2015 in Negombo lagoon located in west coast (Latitude: 7°09N, and Longitude 79°51E). The lagoon opens to the sea at the north end and receives fresh water from two rivers; Dandugamoya and Ja-Ela at south end.

Monthly survey of juvenile fish abundance was undertaken at two sites, Liyanagemulla and Kadolkele (Figure-1) for a six month period from July 2012 to December 2012. These two sites were selected based on the presence and absence of mangrove vegetation.

The main feature of the Liyanagemulla site was the exposed boundary due to landfill for highway developments and destruction of mangroves along the edge of the lagoon. Kadolkele is the second site situated closer to upper estuary with an extensive mangrove cover along the boundary of the lagoon.

Monthly surveys were carried out, during day time at low tide. A drag net was used with opening of 1.5x1 m^2, length 5.5 m and mesh size of 0.9 cm. It was dragged in the water at the edge of lagoon, along 100m length (30 m three replicates). Fish samples were preserved in 5% formalin and later they were identified in the laboratory. Environmental parameters were taken in each sampling (water temperature, pH, salinity, light intensity). Standard length and wet weight of fishes were measured. Diversity of fish species was calculated using Shannon – Wiener diversity Index;

$$H = -\sum[(pi) \times \ln(pi)]$$

pi = proportion of total sample represented by species i/total number of samples.

Figure-1: Monthly survey sites, Negombo lagoon.

Results and discussion

The present study recorded 14 fish species belonging to 11 families: *Parambassis dayi* (Bleeker, 1874), *Ambassis urotaenia* (Bleeker, 1874), *Liza macrolepis* (Smith, 1846), *Liza dussumieri* (Valenciennes, 1836), *Hemirhamphus marginatus* (Forskal, 1775), *Zenochopterus dispar* (Valenciennes, 1846), *Oryzias melastigma* (Mc Cllelland, 1839, *Siganus vermiculatus* (Valenciennes, 1835), *Atherinomorus duodecimalis* (Valenciennes, 1835), *Caranx sexfasciatus* (Quoy & Gaimard, 1825), *Eleotris fusca* (Forster, 1801), *Leiognathos brevirostis* (Valenciennes, 1835), *Apogan thermalis* (Cuvier, 1829) and *Tachysurus caelatus* (Valenciennes, 1840) (Table-1).

Table-1: Check list of fish species collected.

Family	Species
Ambassidae	*Parambassis dayi* (Bleeker, 1874)
	Ambassis urotaenia (Bleeker, 1874)
Mugilidae	*Liza macrolepis* (Smith, 1846)
	Liza dussumieri (Valenciennes, 1836)
Hemirhamphidae	*Hemirhamphus marginatus* (Forskal, 1775)
	Zenachopterus dispa (Valenciennes, 1846)
Cyprinodontidae	*Oryzias melastigma* (Mc Cllelland, 1839)
Siganidae	*Siganus vermiculatus* (Valenciennes, 1835)
Atherinidae	*Atherinomorus duodecimalis* (Valenciennes, 1835)
Carangidae	*Caranx sexfasciatus* (Quoy & Gaimard, 1825)
Eleotridae	*Eleotris fusca* (Forster, 1801)
Leiognathidae	*Leiognathos brevirostis* (Valenciennes, 1835)
Apogonidae	*Apogon Thermalis* (Cuvier, 1829)
Tachysuridae	*Tachysurus caelatus* (Valenciennes, 1840)

Among the 14 species, 13 species were recorded from mangrove area and *Tachysurus caelatus* was the only species not recorded from this site. Two species were recorded from mangrove cleared area (Table-2). *Hemirhamphus marginatus,* was collected from both areas.

The number of individuals in each site and their lengths were given in Table-2. According to the results all the individuals of fish recorded in this study are juveniles. Out of the 102 individuals collected from this study, 88 individuls recorded from mangrove area while 14 individuals collected from mangrove cleared area (Table-2).

Table-2: Number of individuals collected in each species in each site and their standard length.

Species	Length (cm)	Kadolkele (mangrove area)	Liyanagemulla (mangrove cleared area)
Eleotris fusca	4.3	1	-
Atherinomorus duodecimalis	1.2-1.7	10	-
Leiognathus brevirostis	4.9	1	-
Caranx sexfasciatus	1.6-10.5	7	-
Zenachopterus dispar	3.5-16.2	6	-
Hemirhamphus marginatus	1.4-16.8	9	13
Liza dussumieri	4.0-4.4	7	-
Liza macrolepis	3.4-5.3	3	-
Oryzias melastigma	1.1-2.9	27	-
Siganus vermiculatus	2.1-2.7	5	-
Parambassis dayi	3.9-8.0	7	-
Ambassis urotaenia	3.1-6.6	4	-
Apogon thermalis	2.5	1	-
Tachysurus caelatus	5.24	-	1

Maximum numbers (28) were recorded in month of March from Kadolkele site. In each month the number of individuals collected from Liyanagemulla site were always lower than that of Kadolkele site (Figure-2).

During the study period some fish species recorded only once: *Eleotris fusca*, *Atherinomorus duodecimalis*, *Leiognathus brevirostis*, *Siganus vermiculatus*, *Apogon thermalis*, *Ambassis urotaenia* and *Tachysurus caelatus*. *Hemirhamphus marginatus* was the most common species, reorded in four sampling occasions. *Oryzias melastigma* showed the highest relative abundance value and this followed by the *Hemirhamphus marginatus*. (Table-3).

The higher number of species (6) recorded in February and minimum number of species (3) recorded in May and june (Table-3). The number of species recorded in each month from Kadolkele site is higher than that of Liyanagemulla site (Figure-3).

Diversity of fish communities in each site showed that Kadolkele site having the highest diversity (2.20) than the Liyanagemulla site (0.26) (Table-4) . Highest wet weight was recorded for *Hemirhamphus marginatus* (146 grams) and second highest weight was recorded for *Parambassis dayi* (27.54 grams) and each other fish recorded less than 20 grams (Figure-4). Month of April showed the highest wet weight for both sites (Figure-5).

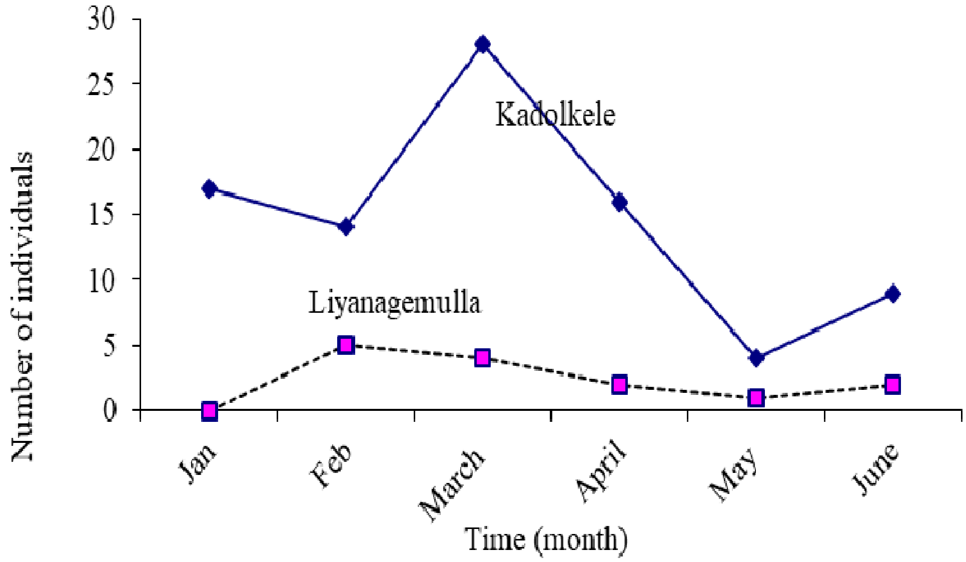

Figure-2: Number of individuals collected in each site in each month.

Table-3: Number of individulas of fish species collected in each month and their relative abundance values.

Species	Jan	Feb	Mar	Apr	May	June	Relative abundance
Parambassis dayi				5	2		0.07
Ambassis urotaenia				4			0.04
Liza macrolepis		1		2			0.03
Liza dussumieri		3				4	0.07
Hemirhamphus marginatus		5	4	7		6	0.22
Zenachopterus dispa		1	4			1	0.06
Oryzias melastigma		4	23				0.27
Siganus vermiculatus		5					0.05
Atherinomorus duodecimalis	10						0.1
Caranx sexfasciatus	5				2		0.07
Eleotris fusca	1						0.01
Leiognathos brevirostis	1						0.01
Apogon Thermalis			1				0.01
Tachysurus caelatus						1	0.01

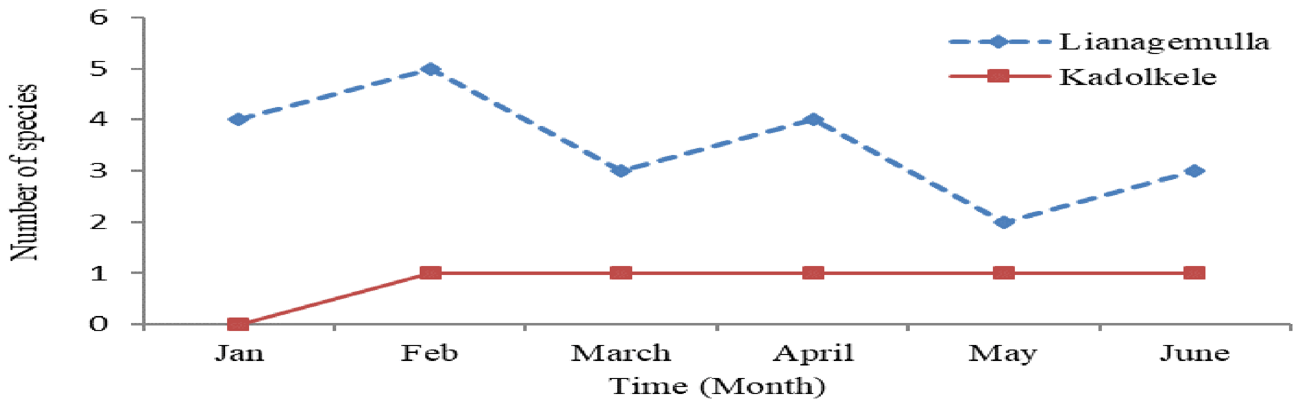

Figure-3: Number of species collected in each month in each site.

Table-4: Diversity of fish communities in each site.

Shannon – Wiener diversity Index	Kadolkele	Liyanagemulla
H = -∑[(pi) × ln(pi)]	2.20	0.26

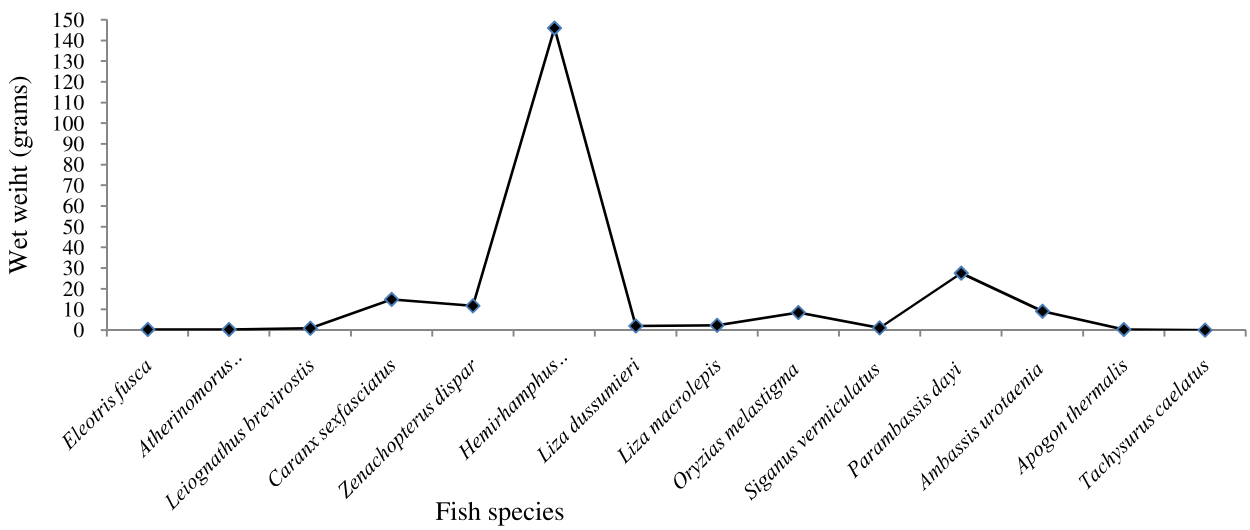

Figure-4: Total wet weight of each fish species.

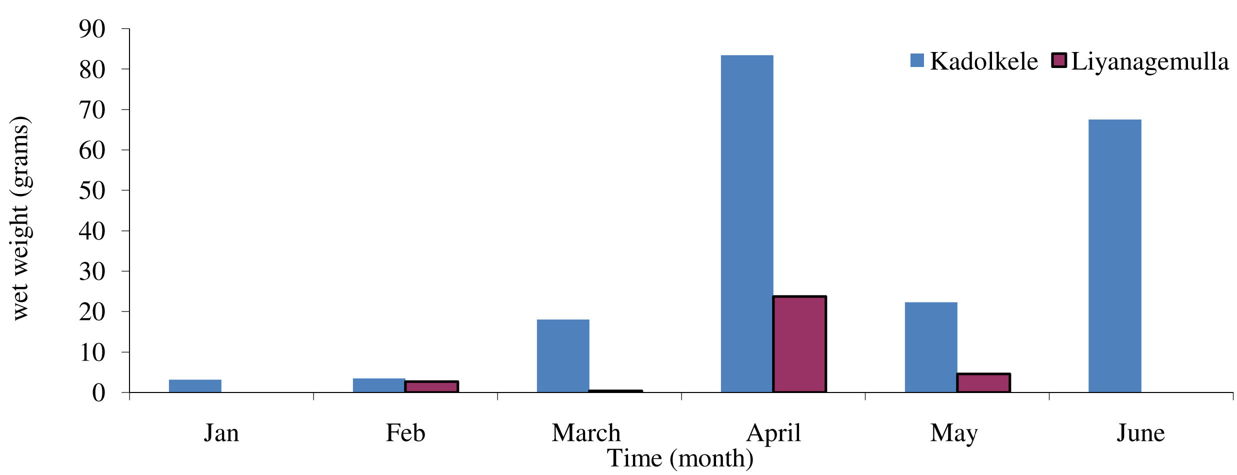

Figure-5: Total wet weight of all fish species within six months period.

Table-5: Correlation coefficient (r) of bivariate analysis of environmental parameters and other important factors on the number of individuals and the species of fish.

	pH	Salinity ppt	Water temperature (^{0}C)	Month	Site	Water height (meter)
Number of individuals	0.478	0.754*	-0.019	-0.256	0.753**	-0.296
Number of species	0.485	0.582*	-0.242	-0.223	0.879**	-0.326

*Significant at P≤0.05 level, ** significant at P≤0.01 level.

Table-5 showed the correlation coefficient (r) of bivariate analysis of environmental parameters and other factors on number of individuals and the species. It showed that the number of individuals and number of species are highly depend on the salinity of the water (P≤0.05) and the site (P≤0.01).

Discussion: The present study recorded 14 species belonging to 11 families while in an earlier investigation conducted in the Negombo lagoon[18], recorded sixty two species belonging to thirty six families during a two year period. In earler study in same lagoon[13], recorded 62 fish species from brush piles during one year period. Forty eight species listed in 1996 [18] and 58 species listed in 1979[13], were not recorded in this study. The significant difference in species numbers in the present study with compared to the above studies was due to the variation of the study period, number of sampling sites and the collection methods.

The present study, surveyed only two sites during a six month period and recorded 11 fish families: Mugilidae, Athrinidae, Leiognathidae, Carangidae, Cyprinodontidae, Siganidae. Apogonidae, Tachysuridae, Ambassidae, Eleotridae and Hemirhamphidae.

The higher number of species (13), (92.86%) and higher number of individuals (88), (86.27%) were recorded in mangrove sites than mangrove cleared area (two species-4.29% and 14 individuals -13.73%). In Negombo lagoon 56 species (90.32 %) were reported[18] from mangrove sites. Similarly a study conducted in Moreton Bay, Australia also showed that mangrove sites play a more significant role and have a greater acceptance as nursery grounds than the nearby areas. It was reported in 1993[19] that about four months after the massive destruction of mangroves, the number of fish species and individuals dropped significantly. Therefore, clearing the boundary vegetation (mangroves) may misplace the habitats of more juvenile fish which preferably inhabit such areas. Therefore, mangroves must be conserved to safeguard the continued sustainability of fishery resources in Negombo lagoon.

To enrich the biodiversity of lagoons mangroves play a major role by providing the nutritional and physical benefits. Further, the mangrove vegetation provides shelter for many estuarine fauna, facilitating them to avoid predation. Mangroves are not only providing habitats for fishes but also to each trophic level of estuarine food web: primary producers: algae and phytoplankton associated with on mangrove trees, soils or in the water column, mangrove crabs, prawns, filter feeding bivalves, oysters, molluscs and crustaceans[20].

As emphasized in 2007[8], "mangroves are still being lost at an unacceptable rate and there is an urgent need for studies to support the prevention of destruction and provide arguments that the value of retaining mangrove ecosystems (from ecological, economical, and human safety point of view) exceeds the value of their destruction". Therefore, it is necessary to develop the conservation practices to ensure biodiversity and sustainability of estuarine systems and their valuable fishery resources.

Conclusion

To protect the ecological integrity of estuarine water bodies and conserve the habitats of fish, we need to protect the marginal vegetation, specially mangroves.

Acknowledgement

This project was funded by the Faculty of Natural Science, The Open University of Sri Lanka.

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