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Pankaj Birnale
Dept of Marine Biology, KUPG Centre, Kodibag, Karwar, Karnataka, India

JL Rathod
Dept of Marine Biology, KUPG Centre, Kodibag, Karwar, Karnataka, India

Raveendra Durgekar
Dept of Marine Biology, KUPG Centre, Kodibag, Karwar, Karnataka, India

Correspondence
Pankaj Birnale
Dept of Marine Biology, KUPG Centre, Kodibag, Karwar, Karnataka, India

Impact of shrimp aquaculture on hydro biological parameters of Kali estuary, Karwar, West Coast of India

Pankaj Birnale, JL Rathod and Raveendra Durgekar

Abstract
The present study was carried out to determine the impact of shrimp aquaculture on hydro biological parameters of Kali estuary, West Coast of India, from 2016 to February 2017. The water parameters were studied and the result showed an increase in nutrients in the Shrimp culture area. Low level of Dissolved oxygen was also seen in the Shrimp culture area indicating some stress on the estuarine ecosystem. From the present study it is understood that aquaculture activities and the release of pond water into the estuarine body will have some impact on the water quality near the pond activities, which if left as it is, will also have an impact on the biotic and abiotic component in the future.

Keywords: shrimp aquaculture, hydro biological parameters, Kali estuary

Introduction
Aquaculture, which is the farming of aquatic animals, has been the foremost fishery industry in India, with the highest growth rate worldwide in the last four decades. From 1970 to 2008 the production of aquaculture organisms grew at a rate of 8.3% per year, compared to less than 2% of fisheries, and 2.9% of livestock (Porchas and Martinez-Cordova 2012) [12]. Shrimp aquaculture has been on a fast track growth in fishing industry because of significant increase in demand for fish and seafood throughout the world. It is growing more rapidly than any other segment of the animal culture industry (Gang. 2005) [8]. Aquaculture in India has a long history. There are references to fish culture in Kautilya's Arthashastra (321–300 B.C.) and King Someswara's Manasoltara (1127 A.D.) Since the 1990s, under the reform policies of Central and State government driven by the economic benefits, the rapid development in fresh water aquaculture, brackish water aquaculture and marine water aquaculture in India, has been the focus of the world trade. Now India is also one the world's largest fish producing country, a position it has maintained continuously after 1990s (Mynar Babu., 2018). Coastal Aquaculture in India is an important economic source, deriving from shrimp aquaculture with the target species *Litopenaeus vannamei.* Shrimp farming activities play a significant role in the national economy of the country. River Kali in Uttar Kannada is one of the pristine rivers in Karnataka with a rich biodiversity of flora and fauna. Shrimp aquaculture along the sides of the river in the estuarine waters have been practiced since a few decades with the introduction of *Penaeus Mondon* and now with *Litopenaeus vannamei* through semi-intensive methods. There is no study so far done on the impact of aquaculture on the estuarine ecosystem in river Kali till now. Hence, taking this in account this study was carried for seeing, if aquaculture activity practiced has any impact on the estuarine ecosystem.

Study Area
The study was undertaken during the period of 13 months from February 2016 to February 2017 to compare hydro biological parameters in aquaculture and non culturable regions. The Shrimp farming is carried out and is limited to three areas i.e., Sunkeri backwaters and Kadwad, Kanasgeri and Bandarwada where the shrimp ponds are located in maximum. Here semi -intensive type of shrimp aquaculture is being practiced without treating the water that is released in the open water of the river. Six stations were selected for present study to carry out the sampling, Stn 1 was near Siddar village which is around 5 km away from the shrimp pond in the upstream of the southern bank of river was taken as reference point.

And four station were selected where the main aquaculture activities were carried out at Stn 2 (Kinner), Stn 3 (Sunkeri) Stn 4 (Kanasgeri), Stn 5 (Bandarwada) and stn 6 (Kodibag) which is situated in the downstream of the river (Fig 1).

Fig 1: Map showing location of sampling sites along River Kali.

Fig 2: Close view of the Shrimp aquaculture ponds along the River Kali.

Materials and Methods

The study was carried out in the river Kali; Around 100 aquaculture ponds are present in this area of around 52 stakeholders. Data on species cultured management of ponds was collected and also Physico-chemical analysis of water in river Kali was carried out on a monthly basis from Feb 2016 to Feb 2017 (13 months). Four stations were selected near the shrimp culture area in the river, one reference point was upstream of river where there was no practice of the aquaculture and one downstream where there was no farming activity. Four station Stn 2, Stn 3, Stn 4 and Stn 5 which are affected directly by the release of pond water in the shrimp culture area were pooled and the average of water parameters were taken for further understanding to be depicted as Shrimp culture area in the results. The results were pooled seasonally. The analysis of atmospheric and surface water temperatures were done with the mercury thermometer. pH was measured using a pH meter, while salinity was analyzed by Mohr Kundsen $AgNO_3$ titration method (APHA, 1998). Dissolved oxygen was fixed immediately after collection and then determined by Winkler's method. Nutrients such as Phosphate, Silicate and Nitrate was analysed as per procedure by Strickland and Parsons (1968). The present objective was to see the effect of release of water from pond to on the estuarine hydro biological parameters.

Results

Shrimp aquaculture in the banks of river Kali was carried out, over a decade of time. The main species cultured during the start of the activities in early 1990's was *Peneaus mondon* and later due to recurrent infection of these shrimps by white spot diseases the activity of these species was slowed down. *Litopenaeus vannamei* is the most dominant species cultured in the Kali estuary and form of about 95% of the species cultured here; this species is cultured during the recent years in this estuary. Generally this species is cultured for about 90-110 days in this region, later harvested and marketed. It was noticed that other than two species of shrimp, no other species were cultured in this area during the present study period.

Presently, around 100 aquaculture ponds are actively carrying out aquaculture activities with around 52 stakeholders in around 115 hectares of land. Release of untreated water from these ponds into open waters of the river was seen during the period. The untreated water consists of chemicals (like Chlorine, lime etc) and left over feed in the open water. No effluent treatment is carried out along the entire stretch of the river. The present study was to see if any impact by the release of untreated pond water on the estuarine ecosystem.

Water Temperature: Minimum average water temp of 27.2 ºC was present during the Pre monsoon and maximum average water temp was during the Post monsoon of 31.7 ºC (Fig 3). Not much variation was noticed between the stations during different seasons indicating any impact by aquaculture activities on water temp.

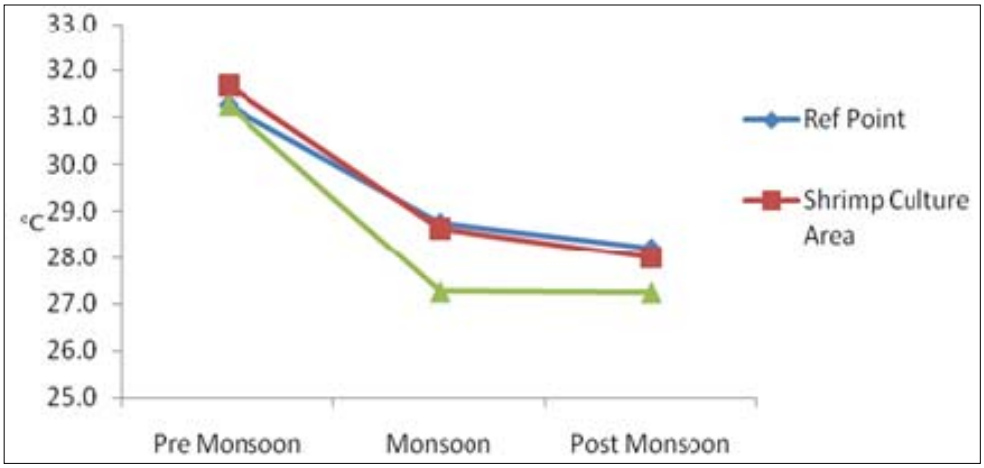

Fig 3: Seasonal Variation for water temp at different stations.

Salinity: Minimum average salinity was low during monsoon season in all the stations. Minimum salinity recorded was 1.5 ppt in the reference area which is far away from the bar mouth of the river and maximum of 33.25 ppt in the bar mouth region during pre monsoon (Fig 4).

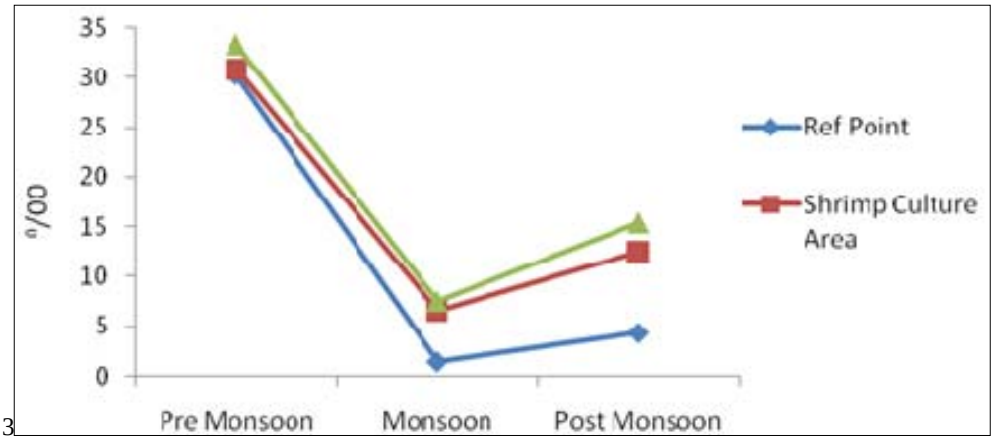

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Fig 4: Seasonal Variation in Salinity at different stations.

Dissolved oxygen: Minimum Dissolved oxygen of 4.04 mg/l in the area where aquaculture activity was carried out and maximum average dissolved oxygen was during the Pre-monsoon with 6.75 mg/l in monsoon in the reference area (Fig 5). Low levels of Dissolved oxygen was seen where aquaculture was dominant.

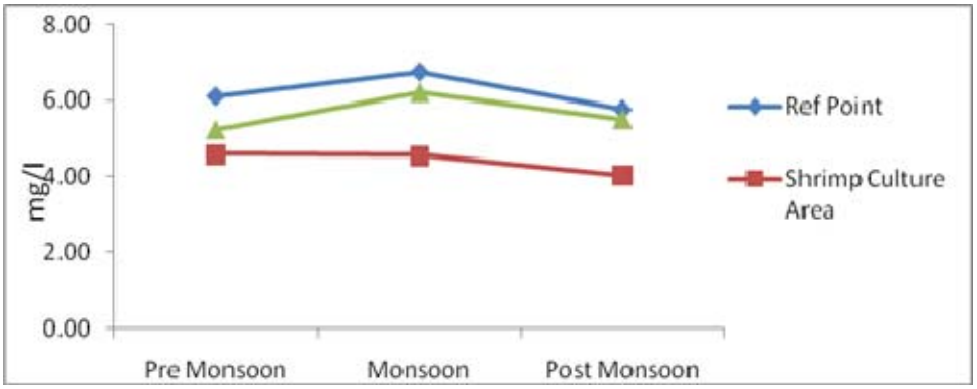

Fig 5: Seasonal Variation in Dissolved Oxygen at different stations.

pH: Minimum average pH of 7.8 during monsoon was recorded in the area where aquaculture activity was carried

and maximum average water temp was during the Pre-monsoon with 8.13 in the reference area (Fig 6). pH was lower in Culture area compared to other two stations.

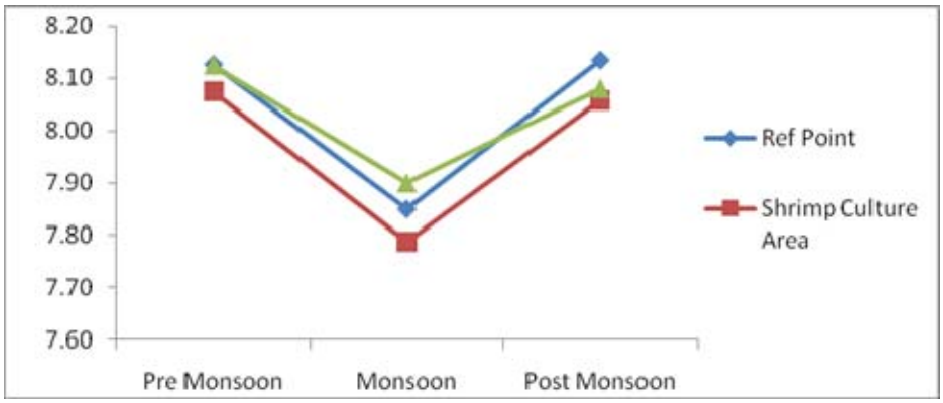

Fig 6: Seasonal Variation in pH at different stations.

Total Dissolved Solids: Minimum average total dissolved solids in water were 337 mg/l in post monsoon in the reference area where aquaculture activity was not carried out and maximum average water temp was during the Pre-monsoon with 800.1 mg/l in the shrimp aquaculture area (Fig 7). TDS was higher in the water body where shrimp aquaculture activities were in full swing in all the three seasons compared to other two areas.

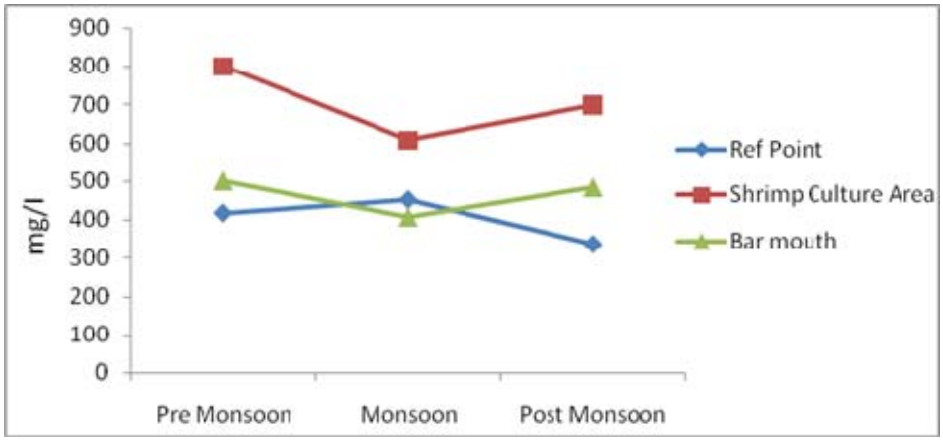

Fig 7: Seasonal Variation in Total Dissolved Solids at different stations.

Phosphate: Minimum average of Phosphate in river was found in Pre monsoon in the reference area of the river with 0.02 mg/l and maximum average of phosphate was found in Shrimp culture area with 0.22 mg/l (Fig 8). Phosphate during the study period was found in maximum concentration in the aquaculture active area when compared to other two stations.

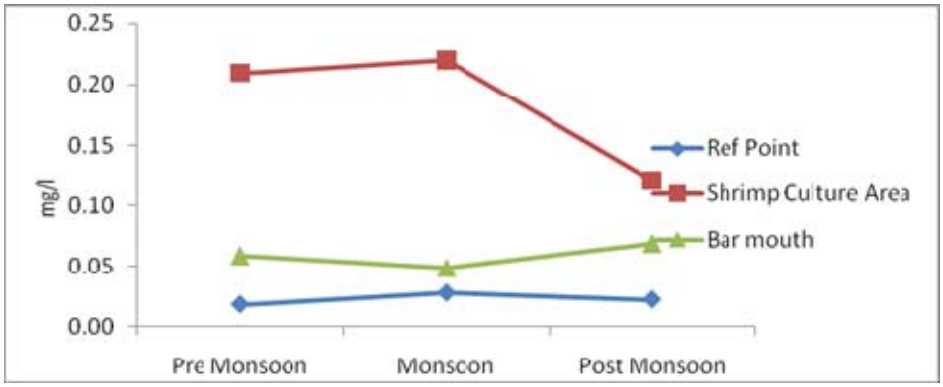

Fig 8: Seasonal Variation in Phosphate at different stations.

Nitrate: Minimum average of Nitrate in river was found during Pre monsoon in the Bar mouth area of the river with 0.92 mg/l and maximum average of phosphate was found in area with 34.93 mg/l in Post monsoon (Fig 9). Nitrate during the study period was found in maximum concentration in the aquaculture active area when compared to other two stations.

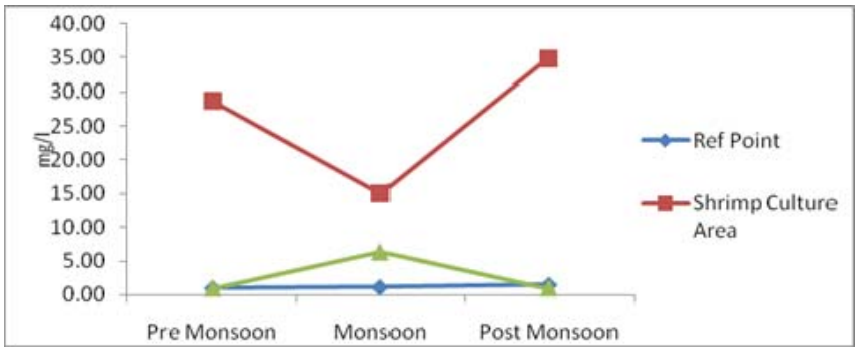

Fig 9: Seasonal Variation in Nitrate at different stations.

Ammonia: Minimum average of Ammonia in river was found in Monsoon in the reference area of the river compared to before the Shrimp culture area in the river with 0.16 mg/l and maximum average of phosphate was found in shrimp culture area with 0.22 mg/l in Pre monsoon (Fig 10). Ammonia during the study period was found in maximum concentration in the shrimp aquaculture active area when compared to other two stations.

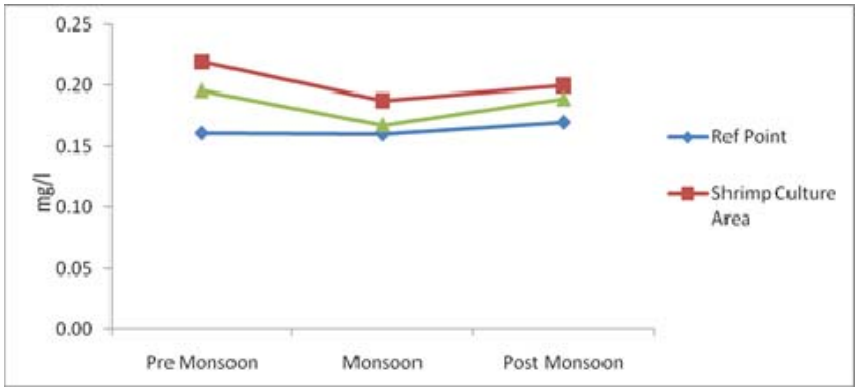

Fig 10: Seasonal Variation in Ammonia at different stations.

Discussion

The current study was carried out along the river Kali where there is intensive activity of culture of shrimp in the estuarine area. The activity was confined up to 10 km from the bar mouth of the river. Around 100 farms are actively involved in the culture of *Litopenaeus vannamei*. This study was to see if there is any impact by release of pond water used in aquaculture into estuary on the hydro biological properties of the river. Four stations were taken near the creek of the river, in the aquaculture area. One reference point was taken before the station of the pond activity and one near the bar mouth of river, and in the region where the pond water is released.

The result obtained from the study showed no much variation in water temperature in aquaculture area and reference area, showing hardly any impact by the activities on the temperature. The study showed that water temperature during Post monsoon was low because of strong land breezes, fresh water influx and precipitation. High value during Pre monsoon could be attributed to high solar radiation (Govindasamy *et al*., 2000) [10]. The surface temperature may be influenced by the intensity of solar radiation, evaporation, fresh water influx, cooling and flow from adjoining neritic waters (Govindasamy *et al*., 2000, Saravanakumar *et al*., 2008) [10], [16]. As observed by several workers like Desai, (1992) [4], Arthur (2000) [1] Saravanakumar *et al*., (2008) [16] in the west coast of India, the present work also showed summer peaks and monsoonal troughs in air and water temperature. Salinity also showed a decrease during monsoon and also in the upper regions of the river. The Dissolved oxygen was studied and it was found that the level of oxygen in water was lower in the shrimp culture area compared to the other two areas in different seasons. Earlier study by Huai-dong ZHOU. 2011 showed similar trend and his study showed that combined effects of residual bait, excreta, metabolites, and organisms. Too much organic matter decomposition consumes a lot of dissolved oxygen in the water, coupled with a dramatic increasing consumption of biological oxygen demand from high-density aquaculture, which leads to the reduction of dissolved oxygen in the reservoir.

Total dissolved solids were also studied and there was also an increase of them, in the shrimp culture area when compared to other two stations which are away from the pond activity. This trend was seen during different seasons indicating some direct impact by aquaculture activities. pH showed a decrease in pond culture area when compared to other two stations which are away from the pond culture area.

Nutrients of water was studied for Phosphorus, Nitrate and Silicate in the estuary, All the nutrients were much higher in the samples taken near the release of pond water when compared to water taken in the reference point which is away from the aquaculture activities Earlier reports by workers said that nutrient discharge from fish farming operations is organic and comes from two sources, fish excrement and uneaten feed that drifts into the water column. Both types of discharge contain nitrogen and phosphorus which are biodegradable. Excretion from farmed fish, like that of wild fish, tends to degrade rapidly and is helped by proper sighting of farms. Arguments are made that waste from fish farms may foul the

area under the farm, making it unsuitable for native organisms. Earlier workers have also opined the same point stating the discharging effluents can reduce the dissolved oxygen in the river, increase sedimentation load, and cause changes in the benthic communities (Flaherty and Karnjanakesorn *et al*., 1995; Dewalt *et al*., 1996; Flaherty *et al*., 2000) [6, 7]. It was seen that farmers usually expose their cultured organisms to medication regimes, for different purposes such as avoiding disease outbreaks and improving growth performance. However, monitoring studies have detected low or high levels of a wide range of pharmaceuticals, including hormones, steroids, antibiotics, and parasitic ides, in soils, surface waters, and groundwater's (Boxall. 2004) [3]. These chemicals have caused imbalance in the riverine ecosystem (Naylor, *et al*., 2000, Gonzalez-Ocampo *et al*., 2006 and Shelton and S. Rothbard *et al*, 2006) [13, 9]. There are reports that the construction of shrimp farms in the river beds has modified the hydrological patterns in many regions of the world with the consequent impacts on the regional ecosystems and the local weather (Paez-Osuna, 2001) [15].

Conclusion

From the present study a clear picture that emerges shows that the aquaculture activities and the release of pond water into the estuarine body will have some impact on the water quality near the pond activities, which if left as it is, will also have an impact on the biotic and abiotic component in the future. It is better that the waste water be treated and released into open waters so as to reduce the impact on the ecosystem. In conclusion, aquaculture is also responsible for diverse problems related with the environmental problems, however the new strategies proposed in developed nations during the last decade have proven that it is possible to reach a sustainable aquaculture, but such strategies should be supported and proclaimed by the different environmental agencies. Only under such scenario, aquaculture will be a sustainable practice. Fortunately, there are reports of some aquaculture farms along the world with sustainable practices.

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