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ESTUARINE BIVALVES: CONSERVATION CHALLENGES AND OPPORTUNITIES

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ABSTRACT
Salinity reduction with the implementation of hydro-electric projects in the Sharavathi and the Kali river estuaries created a negative impact on bivalve diversity and its habitat. To restore the lost habitat and to see the possibilities of bivalve conservation, salinity changes in different periods were studied in the Kali estuary. Temporal salinity varies and fluctuating widely even in the similar kind of periods which, challenges the conservation. Though, high salinity at some period gives an opportunity for restoration of lost habitat and conservation of bivalve in the Kali estuary as of pre-hydel projects.

Key words: Dam, hydroelectric project, Karnataka, salinity, Uttara Kannada, west coast.

1.0 INTRODUCTION

The bivalves which include clams, mussels, and oysters are important entities of the estuary. They contribute to the livelihoods for many coastal people of India, particularly in Uttara Kannada district of Karnataka. Bivalves such as *Paphia malabarica* Chemnitz, *Meretrix casta* Chemnitz, *M. meretrix* Linnaeus, *Perna viridis* Linnaeus, *Polymesoda erosa* Solander, *Tegillarca granosa* Linnaeus, *Villorita cyprinoides* Gray *Crassostrea madrasensis* Preston, and *Saccostrea cucullata* Born are notable species of the district (Rao and Rao 1985, Rao et al. 1989, Alagarswami and Narasimham 1973, Boominathan et al. 2008, Boominathan et al. 2014).

Uttara Kannada district has four major river estuaries, namely Kali, Gangavali, Aghanashini, and Sharavathi. Of these Kali and Sharavathi river waters are used for hydroelectric power generation and other rivers Gangavali and Aghanashini are in near pristine condition. Due to hydel projects salinity reduction in the estuary and the consequential disappearance of bivalves such as *M. meretrix* and *M. casta* in the Sharavathi estuary has been documented in detail (Boominathan et al. 2014). Loss of original habitats due to lowered salinity caused by water releases from upstream hydel projects in Kali River created shrinkage in the original habitats of several bivalve species, which shifted more toward the river mouth seeking appropriate, species-specific higher salinity zones. The species, thus affected included *M. meretrix*, *M. casta*, *Paphia malabarica*, and *V. cyprinoides* (Boominathan et al. In press). The current study is the outcome of observations on stresses and strains the bivalve community of Kali estuary has undergone since the commissioning of a series of hydel projects and to explore the possibility of bivalve conservation and habitat restoration by modulating and monitoring the threats so as to keep them within reasonable bounds.

2.0 MATERIALS AND METHODS

The Kali estuary situated in the Uttara Kannada district of Karnataka State, in the central west coast of India,

was chosen for the study. The Kali River originates in the Joida Taluk near the village Diggi and runs through the Western Ghats for about 184 km towards the Arabian Sea. Its confluence with the sea is about three km north of Karwar town. A series of hydroelectric projects, namely Supa, Nagjhari, Kodashalli and Kadra were executed between 1980 and 2000 on the river. The freshwater after power generation ultimately reaches the estuary, a process that has been continuously going on, which is expected to reduce estuarine salinity.

The surface water salinity in the estuary was measured using EXTECH EC400 salinity meter in February 2012, December 2013, and February 2014, all measurements taken after the complete cessation of monsoon rains by mid-October. A picture of salinity of pre-hydroelectric projects was obtained from a study conducted in 1978 by Nair et al. (1984). The study area map showing sampling stations (Figure 1) was created in QGIS version 2.2.0 (Quantum GIS Development Team, 2014). A line graph to show the salinity changes among various periods (Figure 2) was prepared using statistical software R version 3.0.2 (R Core Team 2013).

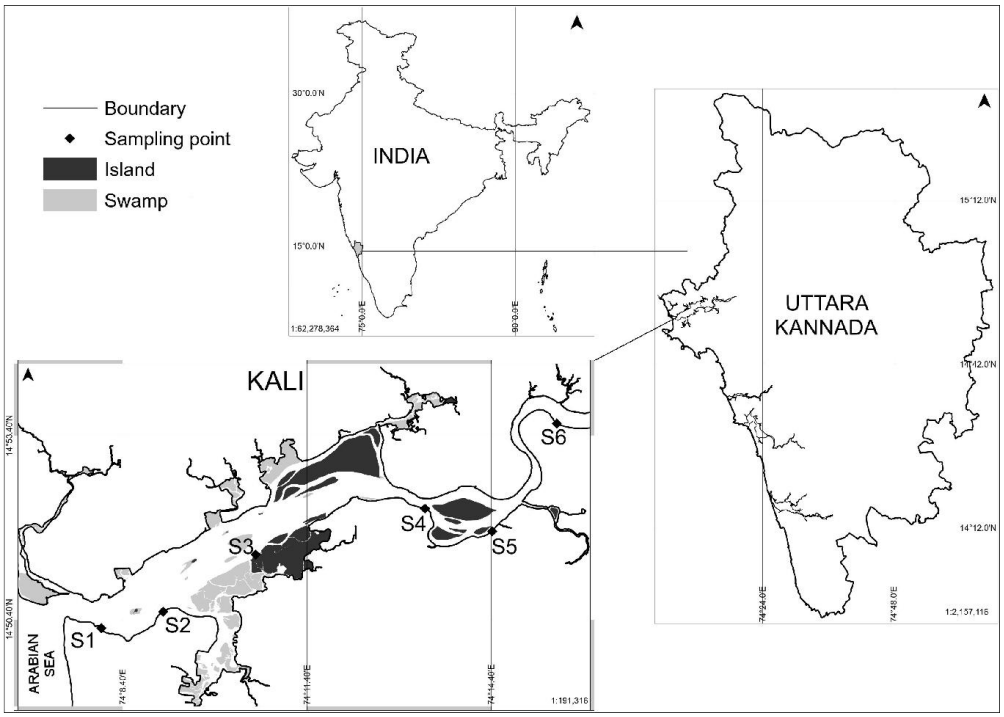

Figure 1: Kali estuarine salinity sampling stations.

3.0 RESULTS AND DISCUSSION

The study shows uncertainty in the post-monsoon salinity conditions of Kali estuary. The highest salinity in station 1, in November-December 1978, barely two months of the cessation of the rainy season, prior to the commissioning of the hydel projects, was about 33.44 ppt (Nair et al. 1984), almost equaling that of the sea water. Whereas, the same station in February 2014, even after four months since passage of the rains, recorded merely 11.75 ppt, just one third the level of 1978. Surprisingly December 2012 salinity in station 1 was higher at 28.74 ppt than that of February. In February 2013 also salinity was fairly high at 27.80 ppt in station 1. All the upstream stations tended to show much lower salinities than their respective 1978 levels, when salinity was measured in February of 2012 and 2013. In the west coast estuaries of India salinity is expected to rise steadily after the rainy season, due to lower input of freshwater, as is the typical case with Aghanashini. In this estuary, where salinity was monitored during 2011-12 by Bhat et al. (2014b) on a monthly basis, in the station 1, in the downstream closer to river mouth salinity shot up from zero ppt in August to 30 ppt by October and fluctuated

between 30-35 ppt until May. In the mid estuary, it rose to 15 ppt in October and fluctuated between 15-28 ppt thereafter. Aghanashini being comparable to Kali in size this finding leads to the conclusion that salinity fall due to dam impact is evident in Kali estuary, and its impact has created shrinkage and shifting in the habitat zones of various commercial bivalves. In Aghanashini, on the contrary, such shift in occupation zones of commercial bivalves have not happened (Boominath et. al. In *press*). Therefore, such an inexplicable post-monsoon rise and fall in salinity could be explained only on the basis of upstream hydel projects, which release water in unpredictable quantities, a situation commanded by power needs of the time and the water storage position. A near total collapse of salinity status since the execution of upstream hydel projects, resulting in major subversion of estuarine conditions, particularly upsetting tidal and salinity regimes and affecting the entry of typical marine fish into the Sharavathi River estuary of Uttara Kannada, has been brought out by Bhat et al. (2014a).

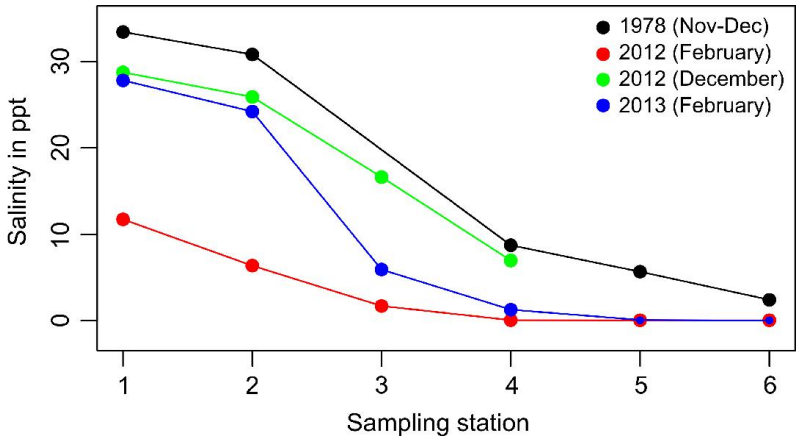

Figure 2: High tide salinity (ppt) of Kali estuary in 1978 (Nair et al. 1984), 2012 and 2013 (this study).

Apart from dam related release of freshwater into the estuary of Kali, it has been also undergoing severe anthropogenic pressures over the last few decades due to the heavy extraction of sand, which disturbed estuarine bottom adversely affecting benthic organisms, especially filter feeders like bivalves. Though, unlike Sharavathi estuary where almost all bivalves disappeared due to lower salinity, except *Polymesoda erosa* (Boominathan, et al. 2014), Kali had all commercial bivalves of Uttara Kannada district (Boominathan et al. in press). Furthermore, high salinity during December 2013 creates hope that if power generation from the hydel projects is regulated to certain uniform limits, avoiding excessive spurts of freshwater into the estuary, there could be every chance of fishery restoration, especially based on bivalve community.

A multi-disciplinary approach in estuarine studies and management is strongly desirable to sustain the ecology of the estuaries, ranked among the highest productive ecosystems of the planet. Any major human intervention in the estuary, say in the form of a developmental project, should not lead towards the collapse of the ecosystem which is ever in dynamic balance with the tides of the ocean and freshwater from the land mingling with it, a system that is self-sustaining and perpetually serving humanity with goods and services without any inputs from the latter, within the bounds of resiliency. The stresses and strains that the commercial bivalve community of Kali have been experiencing ever since the execution of hydro-electric projects and rampant extraction of sand from the estuary should not be transgressed ecological principles of sustainability so as to ensure livelihood and nutritional security of the dependent human communities.

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