Piscine-fauna diversity and composition in the Alaknanda river at Garhwal Uttarakhand

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ABSTRACT

Piscine-fauna are very important component for freshwater ecosystem. It also plays a vital role in local and rural people's life in terms of food resource. In Garhwal region of Uttarakhand, this is included in the primary protein rich food i.e available on low cost. In the present investigation, the river stretch has been divided into four zones. Spatial distribution, density and diversity of fishes has been identified of river Alaknanda at Garhwal region. A total of 21 fish species were found from 5 families as Cyprinidae, Cobitidae, Balitoridae, Sisoridae and Mastacembelidae. The most dominant fish species *Tor tor* was observed under Cyprinidae family in the selected river stretch. *Nemachelius rupicola* fish species from Balitoridae family noted as second dominant group among all species in the river. Different biodiversity indices were calculated by using biotic index to check the diverseness of river. It has been observed during the study period, river Alaknanda has slightly polluted by addition of domestic waste at the bank of river, construction of national highway and ghats on it. A very few anthropogenic activities also occurred as washing clothes, bathing and illegal fishing in the river. Although, Alaknanda river is a continuous fast flowing river that has self-purification capacity itself. This study recommended that continuous monitoring of piscine-fauna and their habitat characteristics is essential for fish conservation and sustainable development in the river.

Key Words: Piscine-fauna, Fish abundance, Water quality, Biodiversity Index, Alaknanda river

INTRODUCTION

Piscine-fauna are keystone species of an aquatic ecosystem, this biotic community completes and maintain the food chain of a fresh or marine water ecosystem (Shreshtha, 1993). Fish species are dependent upon the water body size, geographic location and water quality characteristics of a river or pond (Shahestan and Shastani, 2017). Anthropogenic factors has changed the aquatic habitat by releasing chemical pollutants, untreated sewage, domestic waste into the river, disturbing natural river flow by constructing the dams (Ali et al., 2017; Larke, 2015). Woefully, fish species are becoming threatened due to loss of natural aquatic ecosystem of riverine environment. Such human activities as illegal fishing, unscientific method of fishing like dynamiting, Ichthyotoxic plants, hammering and bleaching powder. Disturbing the migration route of fish species by degraded the natural water discharge that affect the spawning sites (Yasin et al., 2017). Nonpoint source pollution are also noted as responsible for fish mortality (direct inlet of untreated waste water into a river increases the rate of fish death),

land use pattern and agricultural water of irrigation practices also increases the nonpoint source pollutants (Naeem, Ishtiaq, and Naz, 2017; Shareef et al., 2017). Inappropriate land-use pattern increased organo-chemical, heavy metal and nutrient loadings in streams by producing atypical flow. These practices have negative effects on aquatic biota by demolish habitat and changed the pattern of essential abiotic factors of an aquatic body that increases the undesirable and exotic species in river (Lakra et al., 2010). The piscine-fauna of rivers are typically the top trophic level biotic species. A significant correlation exists between the river's abiotic characteristics and different type of fishes. The abiotic factors or environmental factors increase the loss in fish diversity by changing it's natural life cycle (Yasin et al., 2017). Piscine-fauna study has become very popular because of declining rate of fish species all over the world. Fish species are decreasing due to human interference with their habitat, which effect on ecosystem health (Vijaylaxmi et al., 2010; Tiwari, 2011). In India, approximately 930 fish species are found in freshwater ecosystem. Piscine-fauna is main component of an aquatic ecosystem, key role in nutrient cycling and energy flow (Ayappan and Birdar, 2004). Garhwal region of northern India is very rich in fish diversity, facing various man-made threats and change in climatic conditions increases biodiversity loss in this flora and fauna rich area or region (Gupta et al., 2015). Alaknanda river is a major stream of river Ganga. It receives many small rivers and streams on different locations of Garhwal Uttarakhand. These confluence points creates suitable aquatic environment for aquatic biota. The purpose of this study to evaluate and conservation of piscine-fauna diversity, density and distribution in this region and the reason of diversity loss at few locations.

MATERIALS AND METHODS

Alaknanda river originates from the convergence of Bhagirath Kharak and Satopanth glaciers at Uttarakhand (AHEC, 2011). This is one of the head stream of holy Ganga. The major river Alaknanda is located at 30°29'28" N 79°05'08" E of Northern India and an elevation of 161.27 km. Alaknanda river meets with Bhagirathi river at Devprayag by a distance travelled of 190 km and basin area is 10,882 km^2. There are four source streams Pinder, Nandakini, Mandakini and Bhagirathi joins river Alaknanda at panchprayags. Four sampling zones (two sites on every zone) had been taken for this study from a stretch of 172 km for a period of one year (2017-2018). Details of sampling locations on the river given in table-1 and study map shown the selected sites on river stretch in figure-1. The diversity of fish population was estimated by cast net of 1-2 m diameter with mesh size of 0.05 cm. The cast net knotted with heavy sinkers which allow rapid settling of the net at the bottom. In addition, scoop net (mesh size 0.25 cm) was also employed. The caught fishes were collected and preserved in 10% formalin solution. Fish finder model-GARMIN was helped to observe the fish species in different selected riverine stretches. Collected fish samples were identified on their morphological characteristics, with the help of taxonomy text books (Day, 1878; Jayaram, 2010). Relative abundance of individual fish species was calculated by the following formula:

RA= Number of sample of particular species / Total no. of samples × 100

Table- 1 Morphological and hydrological characteristics of study sites on river Alaknanda

Sampling station	Location	Latitude	Longitude	Elevation (m)	Substrate
Zone-A	Chamoli	30°29′	79°34′	1550 m	Mostly rocks
	Nandprayag	30°19′	79°19′	1475 m	Gravels, pebbles
Zone-B	Karanprayag	30°17′	79°11′	1230 m	Gravels, pebbles, cobles

	Rudraprayag	30°16′	78°58′	895 m	Mostly gravels, pebbles
Zone-C	Dharidevi	30°15′	78°52′	605 m	Pebbles, cobles, sand
	Chauras	30°14′	78°47′	530 m	Gravels, pebbles, cobbles, sand
Zone-D	Kirtinagar	30°12′	78°44′	515 m	Cobbles, sand
	Devprayag	30°08′	78°35′	1532 ft	Rocks, gravels

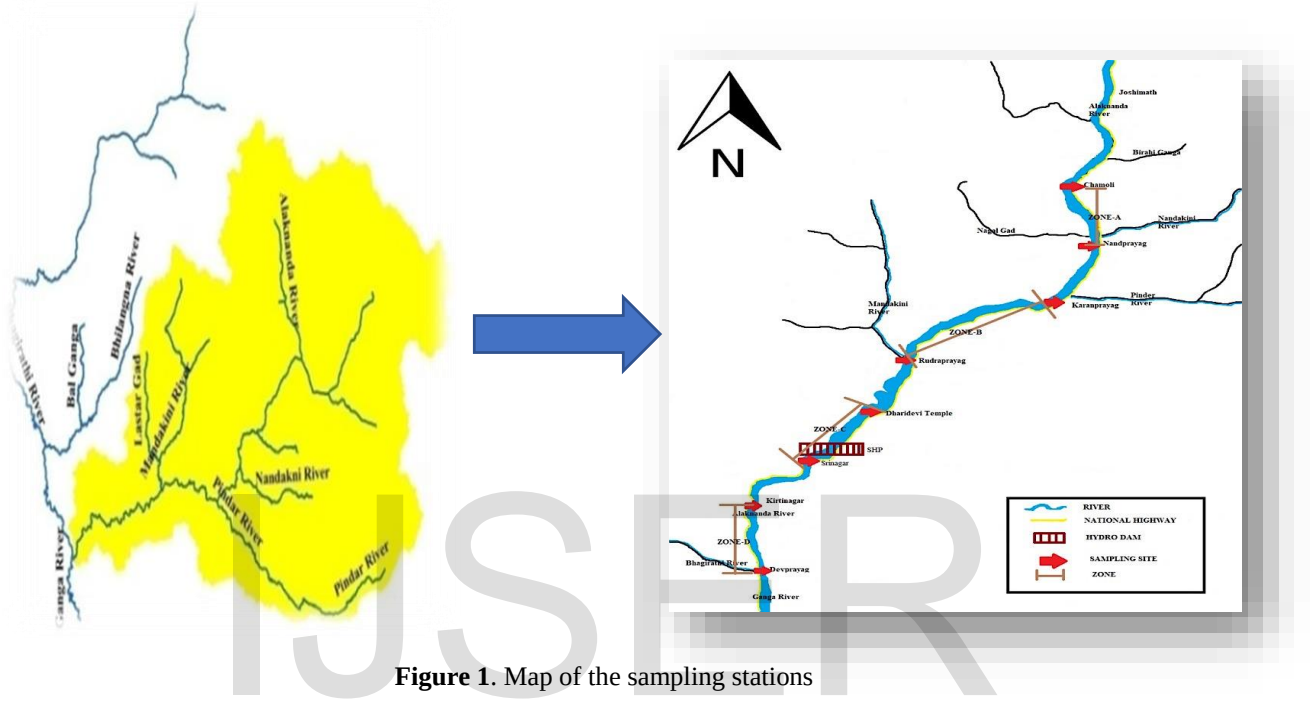

Figure 1. Map of the sampling stations

RESULT AND DISCUSSION

Species diversity

Piscine-fauna was found a total of 21 genera of 5 major families as Balitoridae, Cyprinidae, Mastacembelidae, Cobitidae and Sisoridae at all sites, identified species are given in table-2 and Figure. Cyprinidae family was recorded dominant among all other groups of fishes in the river Alaknanda. Bhattacharya, (2018) also recorded the dominant Cyprinidae group in water bodies of Bankura district. *Schizothorax richardsonii, S. plagiostomus, S. curvifrons, S. niger, Tor tor, T. putitora, Garra gotyla gotyla, Labeo gonius, Barilius bendelisis, Catla catla* and *Labeo rohita* fish species were noted in the river. The dominant species of this family were reported *Schizothorax richardsonii* 173 sp. at zone-B. *S. curvifrons* was collected with highest number of 33 at zone-D. Tor *Tor* genera and *T. putitora* were reported 59 sp. and 50 sp. respectively at zone-A. *Tor tor*, *Tor-putitora* and *Schizothorax richardsonii* species were also reported dominant in their study of Kumaun Himalayan rivers and Bhagirathi river Singh, (1990) and Sharma *et al.*, (2018). Similar distribution of *Schizothorax plagiostomus* was recorded dominant in Assiganga river along with *Schizothorax richardsonii* and *Tor tor* by Singh and Aggarwal, (2014). *Barilius bendelisis* was collected minimum at zone-C and maximum at zone-D for the whole study duration. *Labeo rohita* was counted to be highest 22 at zone-D and lowest no. 15 of

individuals reported from the river at zone-B for 2017-2018. The icthyo-fauna was comprised with 4 groups of genera from Balitoridae family as *Nemachelius rupicola*, *N. beavani*, *N. zonatus* and *N. montanus* recorded at all sampling locations in the river. *Nemachelius rupicola* was identifies as dominant species of balitoridae family. 77 fish species belonged to the *Mastacembelus armatus* genera were identified in the river. *Botia Dario* species of Cobitidae family were collected on all sampling stations of river Alaknanda for a period of one year study. The piscine-fauna of 5 different genera as like *Glyptothorax pectinopeterus*, *G. cavia*, *Bagarius bagarius* and *Pseudechenies sulcatus* belonged to the family Sisoridae identified in the river during year 2017-2018. *Glyptothorax pectinopeterus* was noted dominant species among all genera of sisoridae family.

Table 2. Classification of fishes in the Alaknanda River

Code	Species	ZA	Z B	ZC	ZD	Predilection habitat
	Balitoridae					
F1	*Nemachelius rupicola*	12	10	7	15	High mountain streams, Loaches
F2	*N. beavani*	8	9	4	12	Bottom-dwellers
F3	*N. zonatus*	8	7	4	9	Freshwater streams, rivers
F4	*N. montanus*	6	7	2	9	Snow-fed clean water
	Total	32	33	17	45	
	Cyprinidae					
F5	*Schizothorax richardsonii*	37	75	28	33	Hilly streams, snow fed rivers
F6	*S. plagiostomus*	27	87	22	17	High velocity water
F7	*S. curvifrons*	27	22	14	33	Clear water, bottom dwellers
F8	*S. niger*	15	11	7	13	Rapid streams
F9	*Tor tor*	59	47	44	45	Rocky bottom
F10	*T. putitora*	50	42	26	31	Hilly and rapid streams
F11	*Garra gotyla gotyla*	9	17	6	20	Fast flowing, bottom dwellers
F12	*Labeo gonius*	18	14	8	22	Freshwater ecosystem
F13	*Barilius bendelisis*	24	30	20	34	Hilly streams with rocky substrates
F14	*Catla catla*	17	14	9	20	Clear water rivers, streams
F15	*Labeo rohita*	21	15	12	22	Freshwater rivers, streams
	Total	302	373	196	288	
	Mastacembelidae					
F16	*Mastacembelus armatus*	16	21	11	29	Hilly clean water streams
	Cobitidae					
F17	*Botia Dario*	12	9	4	14	Clear mountain stream
	Sisoridae					
F18	*G. pectinopeterus*	8	11	4	12	Rocky stone sustratum river
F19	*G. cavia*	8	9	4	10	Freshwater streams
F20	*Bagarius bagarius*	7	11	2	14	Clear water
F21	*Pseudechenies sulcatus*	14	13	9	22	Snow-fed mountain rivers
	Total	37	44	19	58	
	Grand Total	387	471	243	420	

Biodiversity Index

Diversity index is calculated to measure the ecosystem diverseness, dominance and similarity of individuals among the species of a community, calculated biotic index values given in table-3. A theoretical model shows that the two central measures of biodiversity of the number of species in a system and the number of genetic variants within a specific species responds similarly to changes in their environment (Shannon and Weaver, 1963). Different biodiversity indices were calculated for identified piscine-fauna of Alaknanda river. Shannon index (H) value calculated maximum 3.053 at zone-D, the calculated value of Shannon index is more than 3 that indicates good biodiversity at this zone. It may be due to the suitable habitat and nutrient enrichment of confluence zone. Lowest value 2.803 of H was calculated at zone-C that indicates medium diversity at this sampling zone. Simpson index (1-D) was calculated 0.9327 at zone-A, 0.9178 at zone-B, 0.9199 at zone-C and 0.9473 at zone-D for 2017-2018. Dominance index (D) was found to be highest 0.0822 at zone-B and lowest 0.0527 was found at zone-D in the river. The evenness index value was noted to be lowest 0.6873 at zone-C and highest 0.8829 was found at zone-D in the river Alaknanda. Brillouin index values were calculated highest to be 2.940 at zone-D and lowest 2.637 was found at zone-C. Margalef index was recorded maximum 4.151 and minimum 3.692 at zone-C and zone-B respectively for years 2017-2018. Equitability index (J) was found maximum 0.9608 at zone-D and lowest 0.8820 was found at zone-C. Panja *et al.*, (2020) was found in the eastern Himalayan streams study, same Shannon and Margalef indices values are indicating that the functional and rich biotic variation in ecological parameters are the strength of the river. Barrange and Pirre, (2009) published the richness, abundance and dominance indices of fish species in the American coastal water bodies. It was examined by many researchers in their study findings that few of anthropogenic factors (domestic waste, tourist generated waste, sewage, construction of hydropower plants etc.) and natural climatic process (heavy rainfall, unwanted change in water temperature due to climate change etc.) cause habitat destruction, biodiversity loss and change water quality of a freshwater ecosystem (Zainudin et al., 2013; Casatti, Rocha, and Pereira, 2005). Some fish species can tolerate adverse water quality conditions also. In this study evaluation, Cyprinidae family was found dominant, *Garra gotyla gotyla and Barilius bendelisis* species of this group are pollution indicator species. Although, clear water species (*Schizothorax richardsonii, S. plagiostomus, S. curvifrons, S. niger, Tor tor, T. putitora)* were present in maximum numbers in the river that shows good water quality of river.

Table 3. Temporal and spatial variation in diversity indices of piscine-fauna during 2016-2018

Biodiversity Index	**ZA**	**Z B**	**ZC**	**ZD**
Taxa_S	24.0	24.00	24.00	24.00
Individuals	421.0	508.0	255.0	460.0
Dominance_D	0.0673	0.0822	0.0801	0.0527
Simpson_1-D	0.9327	0.9178	0.9199	0.9473
Shannon_H	2.926	2.819	2.803	3.053
Evenness_e^H/S	0.7769	0.6984	0.6873	0.8829
Brillouin	2.808	2.719	2.637	2.940
Menhinick	1.170	1.065	1.503	1.119
Margalef	3.806	3.692	4.151	3.751
Equitability_J	0.9206	0.8871	0.8820	0.9608
Fisher_alpha	5.521	5.234	6.494	5.381
Berger-Parker	0.1401	0.1713	0.1725	0.0978

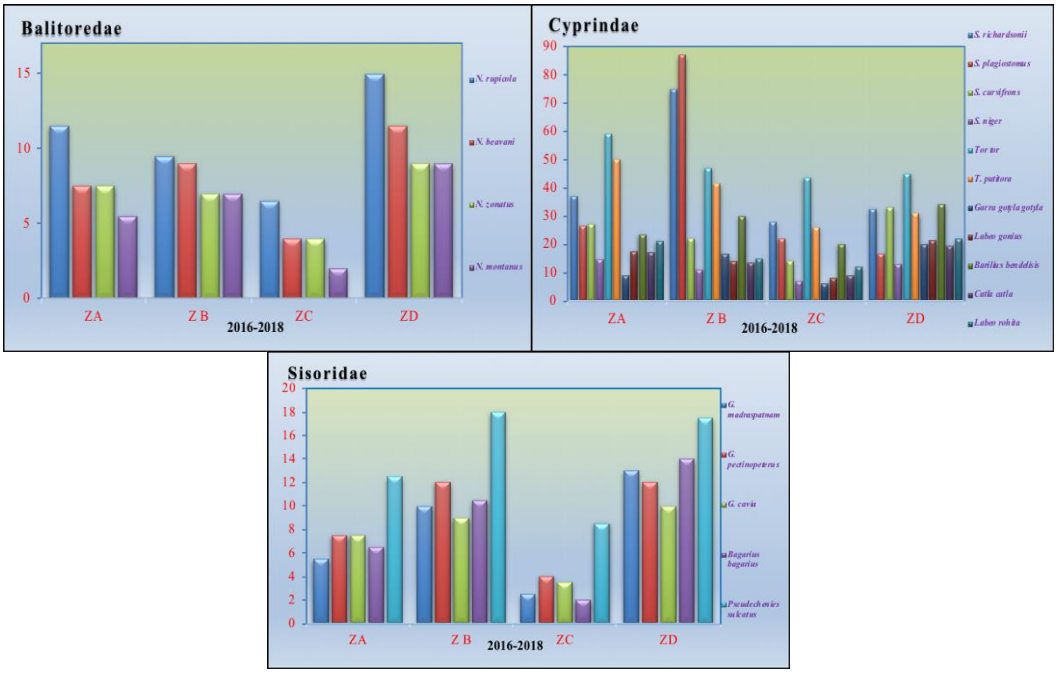

Figure 2. Piscine-fauna at river Alaknanda during 2017-2018

CONCLUSION

Present study concluded that piscine-fauna of river Alaknanda was recorded maximum at zone-B followed by zone-A and zone-D. The lowest number of fish species were noted at zone-C, it may be attributed to the disturbance with natural lotic system of river converts into lentic zone by dam construction on it. Change in river water flow and water quality characteristics enhance the density and diversity loss in freshwater ecosystem. Cyrinidae family group species were identified dominant on the selected sampling stretch of river. The highest diversity of piscine-fauna in these sampling locations of Alaknanda river is attributed to suitable water quality and favourable aquatic habitat for biotic species. Among fish species, class Cyprinidae showed the maximum abundance (83%) followed by Ballitoridae (9%) and Cyanophyceae (8%) in the River Alaknanda.

ACKNOWLEDGMENTS

The author is gratefully acknowledged to the Department of Science and Technology, New Delhi (IN), National Institute of Hydrology, Roorkee and Department of Zoology and Environmental Sciences, G.K. (Deemed to be University), Haridwar for their support to this research work.

REFERENCES

AHEC (2011) Study on assessment of cumulative impact of hydropower projects in Alaknanda and Bhagirathi basins up to Devprayag. Ministry of Environment and Forest, New Delhi, India, Chapter 7: 1-13.

Ali, S.S.; Ijaz, N.; Aman, N.; Nasir, D.A.; Anjum, D.I.A. and Randhawa, D.I.A. (2017) Clinical waste management practices in District Faisalabad. Earth Sciences Pakistan, 1(2):1-3.

Ayappan, S. and Birdar, S.R. (2004) Enhancing Global Competition. Survey of Indian Agriculture (The Hindu), 132pp.

Barange, M.; Perry, R.I. (2009) Physical and ecological impacts of climate change relevant to marine and inland capture fisheries and aquaculture. *FAO Fisheries and Aquaculture Technical Paper*, 5(30): 7-106.

Bhattacharya, M. (2018) Assessment and modelling of fish diversity related to water bodies of Bankura district, West Bengal, India, for sustainable management of culture practices. *Environment, Development and Sustainability*, 1-14pp.

Casatti, L.; Rocha, F.C. and Pereira, D.C. (2005) Habitat use by two species of Hypostomus (pisces loricariidae) in Southeastern Brazilian streams. Biota Neotropica, 5(2): 1-9.

Day, F. (1878) The fishes of India, being a natural history of fishes known to inhabit the seas and freshwater of India, Burma and Ceylon. Text and atlas in 4 parts. London, 1-198pp.

Gupta, N.; Sivakumar, K.; Mathur, V.B. and Chadwick, M.A. (2015) Terrestrial Protected Areas and Managed Reaches Conserve Threatened Freshwater Fish in Uttarakhand, India. PARKS, 21(1): 89-101.

Jayaram, K.C. (2010) The freshwater fishes of the Indian region (2nded.). K.C. Jayaram (ed.). New Delhi, India: Narendra Publishing House 170pp.

Lakra, W.S.; Sarkar, U.K.; Kumar, R.S.; Pandey, A.; Dubey, V.K., and Gusain, O.P. (2010) Fish diversity, habitat ecology and their conservation and management issues of a tropical River in Ganga basin, India. The Environmentalist, 30(4): 306-319.

Larke, S.J. (2015) Conserving freshwater biodiversity: The value, status and management of high quality ditch system. Journal for Nature Conservation, 24: 93-100.

Naeem, M.; Ishtiaq, A., and Naz, S., (2017) Influence of dietary protein on proximate composition of mori, Cirrhinusmrigala (hamilton). Matrix Science Pharma, 1(2): 1-5.

Panja, S.; Podder, A. and Homechaudhuri, S. (2020) Evaluation of aquatic ecological systems through dynamics of ichthyofaunal diversity in a Himalayan torrential river, Murti. *Limnologia*, 8(2): 1-10.

Shahestan, M.J.O. and Shastani, S.O. (2017) Evaluating environ- mental considerations with checklist and delphi methods, case study: Suran City, Iran. Environment Ecosystem Science, 1(2): 1- 4.

Sharma, R.C. and Singh, S. (2018) Nainital lake Water quality and phytoplankton diversity of high-altitude wetland, Dodi Tal of Garhwal Himalaya, India. *Biodiversity International Journal*, 2(6): 284-293.

Shannon, C.E. and Wiener, W. (1963) The mathematical theory of communication. University of Illinois Press, Urbana. 130pp.

Shrestha, T.K. (1993) Chronology of early development and life history of the golden mahseer in the inter gravel environment of the Himalayan streams in Nepal. In: Singh H.R. (Ed.). Advances in Limnology. Narendra Publishing House, Delhi (India), 253- 270pp.

Singh, S. (1990). The lotic water fisheries of Kumaun Himalaya. In: Himalayan Environment, Resources and Development (Ed). Shah, N.K. Shree Almora Book Depot. Almora, India. 1-284 pp.

Singh, G. and Agarwal, N.K. (2014) Fish assemblage structure and habitat use of the snow fed stream Assiganga- a major tributary of river Bhagirathi in Central Himalaya (India). *International Journal of Aquatic Biology*, 2(6): 305-312.

Vijaylaxmi, C.M. and Rajshekhar, V.K. (2010) Freshwater fish- es distribution and diversity status of Mullameri River, a minor tributary of Bheema River of Gulbarga District, Karnataka. Int J Syst Biol, 2: 1-9.

Yasin, M.; Shahzad, A.; Abbasi, N.; Ijaz, U., and Khattak, Z., (2017) The use of stratigraphic section in recording quagmire of information for the fluvial depositional environment-A worked example in District Poonch, Jammu & Kashmir. Pakistan Journal of Geology, 1(2): 1-12.

Zainudin, Z.; Ansari, A.H. and Baharudin, H. (2013) Riparian zone management and rehabilitation in Malaysia through restorative justice. Adv Environ Biology, 7: 3264-3270.