Biolife 3(4):820-826
AN INTERNATIONAL QUARTERLY JOURNAL OF BIOLOGY & LIFE SCIENCES
ISSN (online): 2320-4257
www.biolifejournals.com
BIOLIFE RESEARCH ARTICLE

Riparian Flora of Mahi River, Gujarat

Amita O. Sankhwal[1]*, Shruti D. Shah[2], Deepa J. Gavali[3] and Sumesh N. Dudani[4]

[1,2] *Gujarat Ecology Society, 3rd Floor, Synergy House, Subhanpura, Vadodara – 390023, Gujarat, India*
**Email: ami.sankhwal@gmail.com*

ABSTRACT

The rivers are important channels of materials and energy, which are constantly reeling under the impacts of human influences that often lead to problems in biodiversity conservation and ecosystem functions. The Mahi River in Gujarat is a west-flowing perennial river holding lot of ecological and religious importance. Hence, this study was carried out to document the floristic diversity in selected villages of Vadodara district falling in the riparian zone of the river. Total 328 species of flowering plants belonging to 230 genera and 73 different families was recorded from the study area, dominated by herbaceous plants indicating higher temperatures and lower rainfall gradient in the region. The grass family – Poaceae was dominant in the study region followed by families – Fabaceae, Asteraceae, Convolvulaceae and Euphorbiaceae which predominantly contain annual plants able to survive in diverse ecological conditions. The Jaccard's similarity cluster analysis of study sites based on similarity in the floristic composition revealed that Nandesari site was distantly related with sites Dodka and Rayka in sub-cluster A1 whereas Kotna site was distantly related to sites Fajalpur (S), Sindhrot and Angadh in sub-cluster B1. The significant presence of weeds in the flora of the study region points out to the waning state of the riparian vegetation, chiefly owing to the burgeoning anthropogenic pressures, especially industrial development. To maintain the ecological profile of this region and help rejuvenate the native biodiversity, it is imperative to conserve the existing biota, strictly check the disturbance factors and enhance the vegetation (principally incorporating native species) with the participation of local stakeholders.

Key words: Riparian flora, Mahi River, Conservation

INTRODUCTION

The Indian sub-continent is traversed by a large number of rivers, which have played a pivotal role in shaping the history of human civilizations and they've been used for various purposes like drinking, irrigation, transportation, etc. (Ramachandra *et al*., 2012). The transitional zone between these rivers and the land is known as the riparian zone. The riparian areas are considered to be one of the biodiversity rich ecosystems mainly as they act as transitional zones between the terrestrial and aquatic ecosystems, thereby serving as functional interfaces meditating energy and matter between these two ecosystems (Peterjohn & Correll, 1984; Gregory *et al*., 1987; Gregory *et al*., 1991). The potential of remnant riparian ecosystems as refugia of biodiversity in the fragmented landscapes is of paramount importance. The riparian corridors may shelter more number of species as compared to the adjacent landscapes (Gregory *et al*., 1991) and this

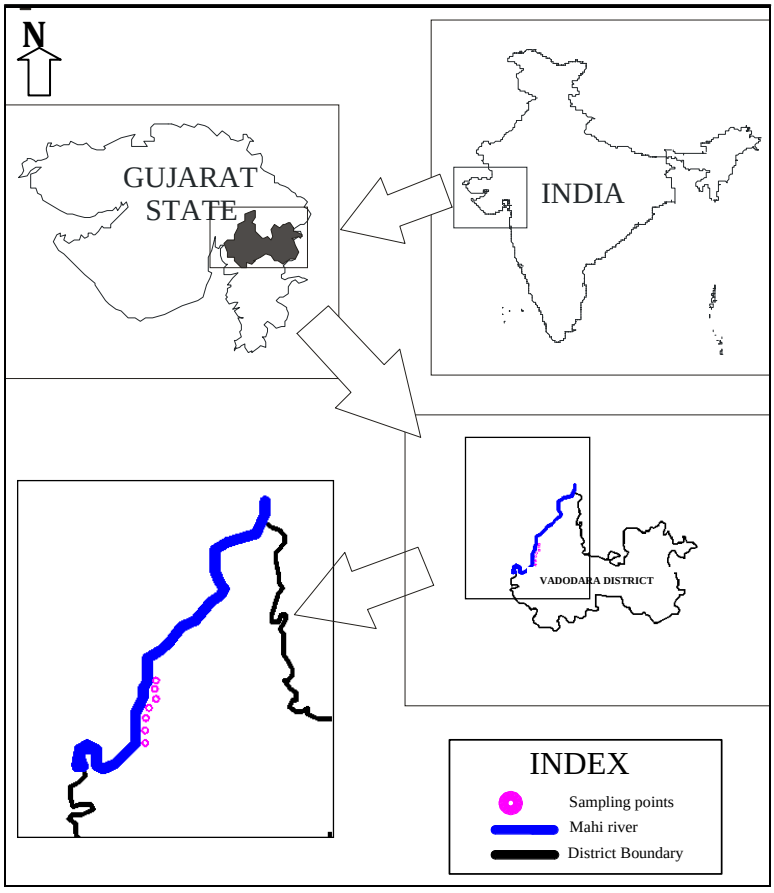
How to cite this article:
Amita O. Sankhwal, Shruti D. Shah, Deepa J. Gavali and Sumesh N. Dudani (2015). Riparian Flora of Mahi River, Gujarat. Biolife, 3(4), pp 820-826.

trend towards higher species richness could multiply rapidly as the anthropogenic factors intensify in the adjoining areas (Goforth *et al*., 2002). The riparian vegetation of rivers and streams support diverse ecosystem functions such as providing food and shelter for terrestrial and aquatic fauna, enriching and stabilizing the riverbanks, intercepting and sequestering contaminants, etc. The plant communities of the larger riverine ecosystems are often found to be the most productive and diverse ecosystems and usually support higher number of plant species arranged in more complex vegetation associations than the surrounding landscapes (Menges & Waller, 1983; Tockner & Stanford, 2002). The burgeoning human population has increased the pressure on freshwater ecosystems as most of the essential requirements of the people are met from these water resources. The major threats looming over the riverine ecosystems are diversion of water for irrigation, hydroelectric projects, deforestation, water pollution, etc. Due to these issues, the freshwater ecosystems are classified as one of the most threatened ecosystems in which the loss of biodiversity is more intense than any other habitat (Dudgeon *et al*., 2006; Clavero *et al*., 2010; Moyle *et al*., 2011). Gujarat state is galloping ahead on various developmental indices and with that the pressure has mounted significantly on the natural resources of the state. Nonetheless, Gujarat is an ecologically diverse state and is seventh largest in terms of the area covered in India. The rivers flowing in the state constitute the principal source of fresh water supply with major flow during the monsoon season. There are about 17 major rivers in Gujarat mainland, 71 in Saurashtra region and 97 in Kachchh region with the important perennial rivers being Narmada, Tapi, Mahi and Purna (http://india-wris.nrsc.gov.in/). The focal river of this study, Mahi River, is a west flowing river originating in the state of Madhya Pradesh. After flowing through the Vagad region of Rajasthan, it enters the state of Gujarat and flows out into the Arabian Sea covering a total distance of about 580 km. The river holds lot of religious importance and hence, is worshipped by a large number of people which is evident from the presence of lot of temples along its shoreline. Despite its importance, there has been a dearth of detailed studies on biodiversity associated with its riverine ecosystem. Hence, the current study was carried out with the aim to document the flowering plant diversity in selected villages located in the riparian zone of Mahi River.

MATERIALS AND METHODS

The Mahi River is a west flowing river originating in Minda village of Madhya Pradesh state and after

Figure-1. Map of the study area



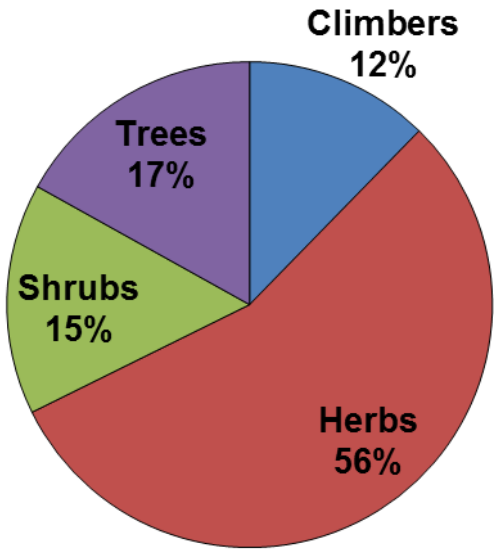
flowing through a small region in Rajasthan enters the Gujarat state. In Gujarat, it flows through the northern part in outskirts of Vadodara city and enters the sea through a wide estuary in Gulf of Khambhat.

This study was carried out in the villages of Dodka, Rayaka, Fajalpur (S), Nandesari, Angadh, Kotna and Shindhrot falling in the riparian zone of Mahi of Vadodara district (Fig. 1). All the flowering plants growing wild in the study region was recorded based on field identifications and wherever necessary, lab-based observations following the regional flora (Cooke 1901-1908, Shah, 1978). Other details such as botanical names, family, vernacular names, habit of the plant and their distribution in the various sites is presented in tabular form.

RESULTS AND DISCUSSION

A total of 328 species of flowering plants belonging to 230 genera and 73 different families was recorded from the study area. Of these, the Monocotyledons were represented by 51 species belonging to 34 genera and 8 families; whereas the Dicotyledons were represented by 275 species belonging to 195 genera and 65 families.

Figure-2. Percentage composition of different plant habits in the study region



With respect to the plant habits, the herbs dominate the study region with 178 species (56%) followed by trees with 55 species (17%), shrubs with 50 species (15%) and climbers with 40 species (12%) (Fig. 2). The plant families namely Poaceae, Asteraceae, Fabaceae, Euphorbiaceae and Amaranthaceae contributed almost 50% of the herbaceous flora in the study region. The higher percentage of herbaceous flora in the study region can be attributed to the edaphic and climatic factors such as high temperatures and low rainfall. Most of the herbaceous plants were annuals and emerged only during the monsoon season. However some herbs like *Argemone mexicana, Solanum xanthocarpum, Alternanthera sessilis, Xanthium strumarium* and *Tridax procumbens* were found growing widespread throughout the year.

The most dominant family in the study region was Poaceae (Graminae) with 37 species and 27 genera. The members of Poaceae generally occur in open environments, are generally anemophilous and represent the principal component of grasslands worldwide (Londe & Silva, 2014). In the study area too, the grasses, along with other herbaceous plants, were growing in good numbers in the open canopy regions along Mahi River, otherwise dominated by agricultural landscapes. Such open canopy river and stream banks with the domination of herbs and grasses in suburban and agricultural landscapes are known to occur commonly throughout the world (Menninger & Palmer, 2007). The qualitative and quantitative dominance of grasses (Poaceae family) was also observed in the riparian vegetation along selected watercourses in Odra Valley, Poland (Syzmura *et al*., 2009). Family Poaceae was followed by families Fabaceae (27 species), Asteraceae (20 species), Convolvulaceae (18 species) and Euphorbiaceae (16 species) (Fig. 3). The dominance of these families was also observed in the riparian vegetation of Ganga River in the stretch between Gangotri to Haridwar (Gangwar and Gangwar, 2011). The members of Poaceae, Fabaceae and Asteraceae, dominating most of the sites, are predominantly seasonal plants (annuals) which produce large number of seeds with wide range of ecological tolerances and good dispersal efficiency (Good, 1974; Ghani & Khalik, 2005; Rajendra Kumar *et al*., 2011).

Among the plant genera, *Ipomoea* was found to be the most dominant with 11 species followed by *Cyperus* and *Euphorbia* genus (6 species each), *Cassia* and *Ficus* genus (5 species each) and *Alysicarpus*, *Corchorus*, *Crotolaria* and *Zizyphus* genus (4 species each) (Fig. 4). Similar observation was made wherein 11 species of *Ipomoea* were recorded (Maitreya, 2015b) in the riparian vegetation of Sabarmati riverside in Gandhinagar. The plant genus *Ipomoea* is the largest genus in terms of number of species in the family Convolvulaceae and it is distributed all over the world with about 500 species (Mabberley, 2008). Of the 11 *Ipomoea* sps recorded in the study area, distribution of *I. carnea* was the most prominent with its presence in six out of the seven sites followed by *I. triloba* present in five out of seven sites. *I. carnea* (syn: *I. fistulosa*) is among the most dominant and harmful weeds that have invaded the world's tropical and sub-tropical regions (Bhuyan *et al.,* 2008; Sharma & Bachheti, 2013). It is an evergreen, flowering shrub which was initially used to make fences but has now become very widespread species owing to its hardiness, high

Figure-3: Dominant plant Families in the study area

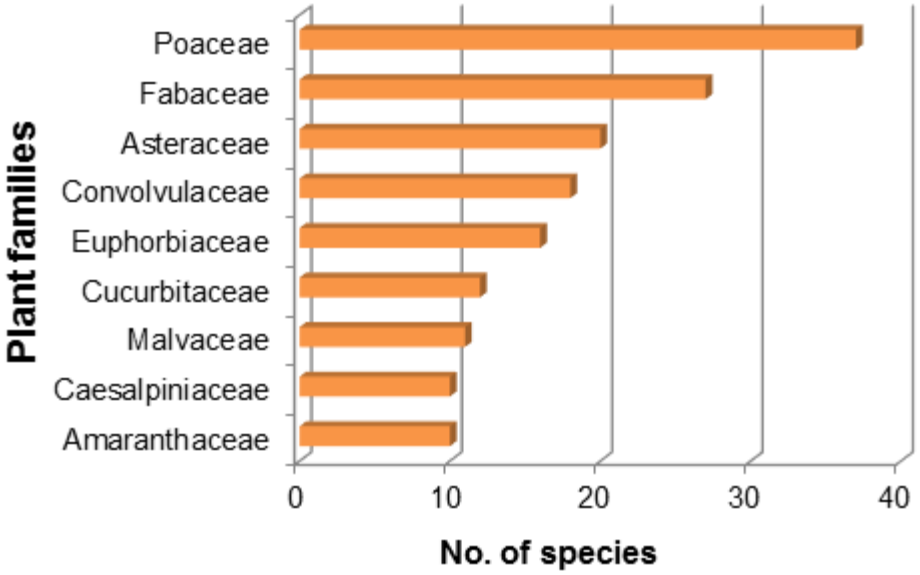
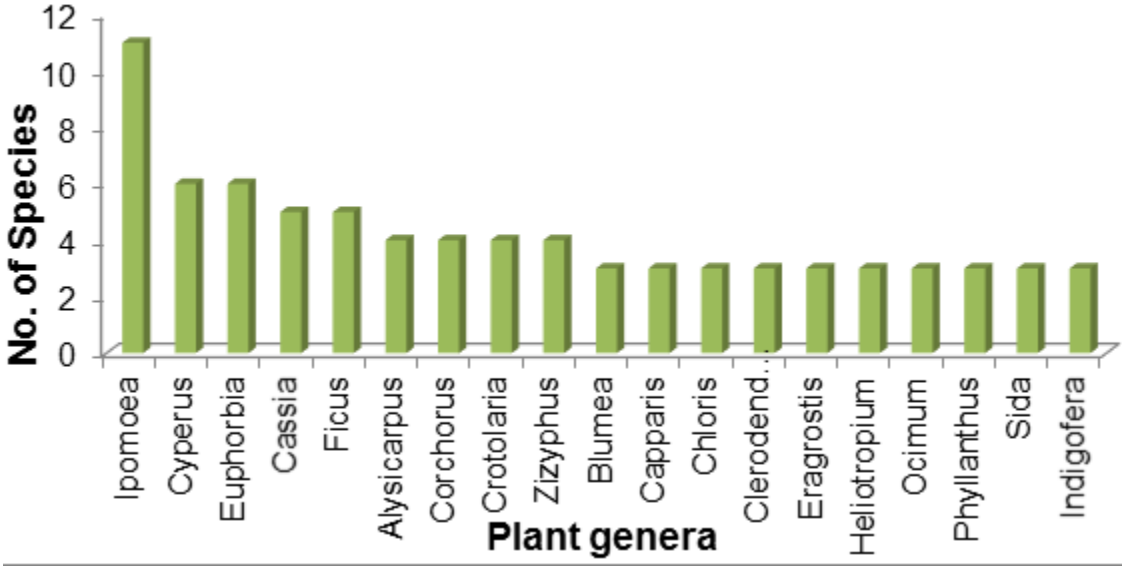


Figure 4: Dominant plant genera in the study area



reproductive success, and very fast rate of growth (Chari & Abbasi, 2005; Konwer *et al*., 2007). Its rampant colonization in different habitats is of great concern as it has deleterious effects such as biodiversity and nutrient loss as well as other forms of ecodegradation (Kumar *et al*. 2014).

The grasses of *Cyperus* were also well represented and predominantly growing in the study area. These grasses were also found to be thriving well along the Sabarmati riverbed (Maitreya, 2015a). Among the different species of Cyperus, *C. compressus, C. esculentus* and *C. rotundus* were most prominent with their distribution in five out of the seven study sites. Of these, *C. rotundus* is known to occur as a weed in over 90 countries and is considered to be the world's worst invasive weed based on its distribution and effect on crops. Its complex underground network of tubers, bulbs, roots and rhizomes coupled with its ability to adapt to high temperatures, solar radiations and humidity have turned this weed into a serious problem in subtropical and even arid regions (Global Invasive Species Database). Other dominant genera in the study area – *Euphorbia*, among the six species of *Euphorbia* recorded in this study, *E. hirta* was most predominant by its presence in six out of the seven study sites. It is a hairy herb growing in open habitats and is considered as a pantropical weed. It is commonly known as Asthma weed owing to its traditional use for treatment of asthma and laryngeal spasm.

Other dominant species recorded was *Cassia tora* with its presence in all the seven sites. It has high stress tolerance ability allowing it to inhabit even dry soil conditions. It has been described as a valuable

medicinal plant with many different applications in the Ayurvedic and Chinese medicine (Shukla *et al*., 2013). The other dominant plant genera *Ficus* is a genus belonging to family Moraceae, collectively known as *Fig* and are mostly distributed throughout the tropical regions. Of the five species of *Ficus* in present study, *F. benghalensis* (Vad) and *F. racemosa* (Peepal) find their presence in five out seven sites and posses high socio-cultural value in the area. The species distribution of remaining plant genera include 10 genera represented by 3 species each, 35 genera consisting of 2 species each and 175 monospecific genera.

A total of 103 plant species (almost 32% of the total recorded plants) from the study area were classified as weeds (Naidu, 2012). Of these, 86 species (almost 83%) were herbaceous plants while 10 species were shrubs and 7 species were climbers. Most of the weeds present in study area are broad niche weeds distributed widely in different types of the landscapes in the surrounding region. The riparian vegetation is prone to colonization of weeds, which is facilitated by a number of factors. These include periodic flooding, excessive grazing, inputs of nutrients and weed propagules from agricultural land, roads and other disturbed sites, and the availability of moisture (Carr, 1993). These weeds are often found to out-compete the native species for resources such as space, light and nutrients (Askey-Doran *et al*., 1999). Besides, they are also found to have an impact on the soil and water conditions in the region, thereby largely affecting the riparian food web.

The spatial distribution showed that Sindhrot had the highest flowering plant diversity with 215 species followed by Fajalpur (S) (189 species), Angadh (166 species), Kotna (137 species), Rayka (129 species), Dodka (123 species) and Nandesari (117 species). Out of all the plants recorded, only fourteen species – *Abutilon indicum, Acacia nilotica, Achyranthes aspera, Azadirachta indica, Balanites aegyptica, Barleria prionitis, Caesalpinia* sp., *Cassia tora, Convolvulus microphyllus, Justicia diffusa, Launea procumbens, Ocimum basilicum, Pithecellobium dulce* and *Sida cordifolia* were distributed all across the seven villages. The Jaccard's Similarity cluster analysis was performed to analyze the similarity among the study sites based on the species distribution matrix (Fig.5). The seven sites were broadly divided into two sub-clusters – A1 and B1. In cluster A1, Dodka and Rayka were clustered together owing to more than 50 % of similar species occurrence while Nandesari had only about 40% of species composition similarity with these two sites. It is well known that the edaphic factors govern the vegetation and the soil characteristics of the Cluster A1 is Coarse-loamy mixed (calcareous) soils, Light brown, coarse loamy and well drained soil. Such soils have low water holding capacity and therefore there is low vegetation reported from this cluster. In cluster B1, Fajalpur and Sindhrot were clustered together owing to higher similarity in species occurrence (about 56%) while Angadh had about 48% of species similarity with these two sites. Kotna was distinguished from all other sites owing to the least similarity percentage of species occurrences. The soil of this cluster was fine-loamy to coarse-sandy loamy, mixed, Light brown, well drained soil and Aeoline deposits. Such soils are stabilized and with good moisture retaining capacity and therefore the vegetation here is rich and diverse.

The riparian vegetation has been the pillars of human civilizations as they have been the epicenters of human settlements since the very beginning of mankind on earth. Till date, this ecosystem is of prime importance owing to its numerous ecological, cultural and socio-economical applications. However, currently they can be seen in wane conditions owing to the unplanned developmental activities and humongous population growth. In our study region, we found that some significant anthropogenic pressures such as land conversions, grazing and industrial pollution hampered the growth of native vegetation by altering its phenology. Many studies have established the direct role of riparian plants in vital ecosystem functions and processes and hence, any change in the floristic diversity would lead to significant and sometimes, irreversible changes in the riparian ecosystems. Hence, improving the vegetation of this riparian region, especially incorporating the native tree species, will have positive impacts on the overall biodiversity and help in battling the spread of invasive species.

CONCLUSION

The importance of riparian vegetation as food zone and shelter for terrestrial and aquatic ecosystems as well as for multitude of other ecological functions has been realized globally and efforts have stepped up to conserve the same. For a river as important as Mahi in Gujarat, this study comes as the only detailed inventorization of the riparian flora highlighting its significance as an abode for 323 species of flowering plants distributed in seven riverine villages in Vadodara district of Gujarat. Clearly the dominance of herbaceous plants, with many of them being weeds, indicate the wane state of riparian vegetation which is burdened by pressures such as uncontrolled resource utilization, extensive grazing, land conversion for various purposes and industrial pollution. There's a dire need to develop strong conservation and restoration measures for the riparian vegetation which can in turn enhance the overall ecology of the riparian zone.

Conflict of Interests:

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

1. Askey-Doran, M., Pettit, N., Robins, L. and McDonald, T. 1999. The role of vegetation in riparian management. In Lovett, S. and Price, P. (eds), Riparian Land Management Technical Guidelines, Volume One. Principles of Sound Management, LWRRDC, Canberra, pp. 97 – 120.
2. Bhuyan, M., Mahanta, J.J. and Bhattacharya, P.R. 2008. Biocontrol potential of tortoise beetle (*Aspidomorpha milliaris*) (Coleoptera: Chrysomelidae) on *Ipomoea carnea* in Assam, India. Biocontrol Science and Technology. 18(9): 941 – 947.
3. Carr, G.W. 1993. Exotic Flora of Victoria and its Impact on Indigenous Biota. In: Flora of Victoria, D.B. Foreman & N.G. Walsh (eds) Inkata Press, Melbourne, pp. 256 – 298.
4. Chari, K.B. and Abbasi, S.A. 2005. A study on the fish fauna of Oussudu – a rare freshwater lake of south India. International Journal of Environmental Studies. 62: 137-145.
5. Clavero, M., Hermoso, V., Levin, N. and Kark, S. (2010), BIODIVERSITY RESEARCH: geographical linkages between threats and imperilment in freshwater fish in the Mediterranean Basin. Diversity and Distribution. 16:744–754.
6. Cooke, T. (1901-08), The flora of the Presidency of Bombay Vol. I, II and III. London (Reprinted edition 1958, Botanical Survey of India, Calcutta).
7. Dudgeon, D., Arthington, A.H., Gessner, M.O., Kawabata, Z., Knowler, D.J., Leveque, C., Naiman, R.J., Prieur-Richard, A., Soto, A, Stiassny, M.L.J. and Sullivan, C.A. (2006) Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Reviews. 81: 163–182.
8. Gangwar, R. and Gangwar, T. 2011. Status of Riparian Floral Diversity Along River Ganga: Riparian Floral Diversty along river Ganga in Garhwal Himalaya of India. LAMBERT Academic Publishing, p. 116.
9. Ghani, M.A. and Khalik, N.A., 2005. Floristic diversity and phytogeography of the Gebel Elba National park, Southeast Egypt. Turkian Journal of Botany. 30: 121-136.
10. Goforth, R.R., Stagliano, D., Lee, Y.M., Cohen, J. and Penskar, M. 2002. Biodiversity analysis of selected riparian ecosystems within a fragmented landscape. Report prepared for Michigan Great Lakes protection fund and Michigan Department of Environmental Quality, Office of the Great Lakes.
11. Good, R., 1974. The Geography of the Flowering Plants. Fourth Edition. Longman Group Limited, London, pp. 574.
12. Gregory, S.V., Lamberti, G.A., Erman, D.C., Koski, K.V., Murphy, M.L. and Sedell, J.R. 1987. Influences of forest practices on aquatic production. In: E.O. Salo and T.W. Cundy (Eds), Streamside Management: Forestry and Fishery Interactions. Proceedings of a Symposium, College of forest resources. University of Washington, Seattle, WA, pp. 234 – 255.
13. Gregory, S.V., Swamson, F.J., McKee, W.A. and Cummins, K.W. 1991. An ecosystem perspective of riparian zones. BioScience. 41: 540-551.
14. Konwer, D., Kataki, R. and Saikai, M. 2007. Production of solid fuel from *Ipomoea carnea* wood. Energy Resources, Part A: Recovery, Utilization Environment Efficiency. 29(9): 817-22.
15. Kumar M.R., Tauseef, S.M., Abbasi, T. and Abbasi, S.A. (2014), Control of amphibious weed ipomoea (*Ipomoea carnea*) by utilizing it for the extraction of volatile fatty acids as energy precursors. Journal of Advanced Research. 6(1): 73-78.
16. Londe, V. and da Silva J.C. (2014), Characterization of Poaceae (grass) species as indicators of the level of degradation in a stretch of riparian forest in Matutina, Brazil. Acta Botanica Brasilica. 28(1): 102-108.
17. Mabberley, D.J. 2008. Mabberley's Plant book: A portable dictionary of Plants, their classification and uses. Third edition, Cambridge University Press, Cambridge.
18. Maitreya, B.B. 2015a. Cyperaceae of Sabarmati River, Gandhinagar district, Gujarat state, India. Paripex – Indian Journal of Research. 4(5): 345-346.
19. Maitreya, B.B. 2015b. Convolvulaceae Plant Family as Riparian Vegetation at Gandhinagar of Gujarat State, India. Global Journal for Research Analysis. 4(5): 263-265.
20. Menges, E.S. and Waller, D.M. 1983. Plant strategies in relation to elevation and light in floodplain herbs. The American Naturalist. 122: 454 - 473.
21. Menninger, H.L. and Palmer, M.A. 2007. Herbs and grasses as an allochthonous resource in open-canopy headwater streams. Freshwater Biology. 52: 1689-1699.
22. Moyle, P.B., Katz, J.V.E. and Quinones, R.M. 2011. Rapid decline of California's native inland fishes: a status assessment. Biological Conservation. 144: 2414–2423.
23. Naidu, V.S.G.R. 2012. Handbook on Weed identification. Directorate of Weed Science Research, Jabalpur, M.P., pp. 354.
24. Peterjohn, W.T. and Correll, D.L. 1984. Nutrient dynamics in an agricultural watershed: observations on the role of a riparian forest. Ecology. 65: 1466-1475.

25. Rajendra Kumar, S., Joshi, P.N., Joshua, J., Sunderraj, S.F.W., Kalavathy, S. and Ragunathan, P. 2011. Importance and conservation values of disturbed lands of the North Gujarat Region (NGR), Gujarat, India. Plant Sciences Feed. 1(8): 121-141.
26. Ramachandra, T.V., Subash Chandran, M.D., Joshi, N.V., Sreekantha, Kumar, R., Rajinikanth, R., Desai, S.R. and Subash Babu 2012. Ecological profile of Sharavathi River Basin. Sahyadri Conservation Series 22, ENVIS Technical Report: 52, November 2012, Energy & Wetlands Research Group, Centre for Ecological Sciences, Indian Institute of Science, Bangalore.
27. Shah G.L. 1978. Flora of Gujarat state Vol. I-II. Sardar Patel University Press, Vallabh Vidyanagar, pp. 1074.
28. Sharma, A. and Baccheti, R.K. 2013. A review on *Ipomoea carnea*. International Journal of Pharmaceutical and Biological Sciences. 4(4): 363 – 377.
29. Shukla S.K., Kumar A., Terrence M., Yusuf J., Singh V.P. and Mishra M. 2013. The probable medicinal usage of *Cassia tora* : An overview. Online Journal of Biological Sciences. 13(1), 13-17.
30. Syzmura, M., Syzmura, T., Dunajski, K. and Wolski, K. 2009. Grasses (Poaceae) in Riparian Vegetation of Watercourses in Agriculture Landscape. Polish Journal of Environmental Studies. 18(6), 1217-1223.
31. Tockner, K. and Stanford, J.A. 2002. Riverine flood plains: present state and future trends. Environmental Conservation. 29: 308-330.

DOI:
https://dx.doi.org/10.5281/zenodo.7306479
Received: 3 October 2015;
Accepted; 18 November 2015;
Available online : 5 December 2015