

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/300166802>

Importance of Urban Biodiversity: A Case Study of Udaipur, India

Chapter · May 2014

DOI: 10.1007/978-94-017-8878-6_31

CITATIONS

6

READS

2,596

3 authors, including:



Satya Prakash Mehra

RSNH

27 PUBLICATIONS 93 CITATIONS

SEE PROFILE

Water Science and Technology Library

Basant Maheshwari
Ramesh Purohit
Hector Malano
Vijay P. Singh
Priyanie Amerasinghe *Editors*

The Security of Water, Food, Energy and Liveability of Cities

Challenges and Opportunities for
Peri-Urban Futures

 Springer

Basant Maheshwari · Ramesh Purohit
Hector Malano · Vijay P. Singh
Priyane Amerasinghe
Editors

The Security of Water, Food, Energy and Liveability of Cities

Challenges and Opportunities
for Peri-Urban Futures



RESEARCH
PROGRAM ON
Water, Land and
Ecosystems

 Springer

Part VI Future of Peri-Urban Landscapes

- 25 Implications of Labour Migration and Land Use Changes on Food Production in the Peri-urban Area of Rajsamand District of Rajasthan, India: A Case Study 327**
 P. S. Rao and D. C. Pant
- 26 Knowledge Assessment on Climate Change and Urban and Peri-urban Agriculture in Dakar, Senegal. 341**
 Mamadou Khouma, Yacine Ndour, Marie Sophie Ndong, Youga Niang, Mouhamadou Dial, Idy Niang, Mohamed O. Diagne, Jean Pierre Yvon Fall and Jon Padgham
- 27 Greenhouse Gas Emissions of Decentralised Water Supply Strategies in Peri-urban Areas of Sydney 355**
 Lu Aye, Bandara Nawarathna, Biju George, Sudeep Nair and Hector Malano
- 28 Opportunities and Challenges of Urban and Peri-urban Agriculture to Face Climate Change: A Critical Analysis of Policy and Urban Governance of Dhaka City 365**
 Shah Mohammad Ashraful Amin and Atiq Rahman
- 29 System Harmonisation of Land and Water Resources in Peri-urban Regions: Lessons from Western Sydney, Australia 383**
 B. Maheshwari and B. Simmons
- 30 Maintaining Landscape Functionality Under Land Use Change. 393**
 R. W. Vervoort
- 31 Importance of Urban Biodiversity: A Case Study of Udaipur, India 403**
 Satya Prakash Mehra, Sarita Mehra and Krishan Kumar Sharma
- 32 Perspective on Water and Biodiversity Issues in Peri-urban Landscapes: A Case Study of Keoladeo National Park, Bharatpur, India 419**
 Satya Prakash Mehra and Sarita Mehra
- 33 Developing Law and Governance Strategies for Peri-urban Sustainability. 435**
 Jacqueline Williams and Paul Martin

Recommended Citation

Chapter 31

Importance of Urban Biodiversity: A Case Study of Udaipur, India

Satya Prakash Mehra, Sarita Mehra and Krishan Kumar Sharma

Abstract Urban ecosystems are complex social-ecological systems with important functions. These man-made ecosystems have certain areas with high biological diversity, including both remnant species and species purposefully or unintentionally introduced by human actions. There can be important habitats and valuable corridors for both common and less common species within the urban sprawl. The main aim of this study is to respond to the call for integrative research by studying relationships between the anthropogenic activities and urban biodiversity of the cities from the southern part of Rajasthan, India. We observed that the local population was interested in biodiversity, especially phenological events, and benefited from it by getting aesthetic pleasure and information on seasonal changes. The cities, such as Udaipur have an artificially developed diversified habitat within urban limits which provides shelter and protection to a variety of flora and fauna species. Urban areas are often rich in species, particularly vascular plants and many groups of animals, especially birds. Further, urban green spaces in the form of artificial parks and agricultural fields have the diversity of flora, whereas artificial lakes are the sites of wetland species. The most eye-catching faunal group of birds was used to understand the importance of biodiversity for Udaipur. Bird diversity and abundance are indicators of the condition of watershed habitats, both terrestrial and wetland. The role of urban areas in functions, such as the provision of ecosystem services will largely be determined by patterns of biodiversity within that area. To keep these biological indicators healthy, watershed conditions should be

S. P. Mehra (✉) · S. Mehra

Rajputana Society of Natural History, Kesar Bhawan, 16/747, P.No.90,

Bid Saraswati Hospital, Ganeshnagar, Pahada,

Udaipur 313 001 Rajasthan, India

e-mail: drspmehra@yahoo.com

K. K. Sharma

Biodiversity Research Laboratory, Department of Zoology,

Maharshi Dayanand Saraswati University,

Ajmer 305 009 Rajasthan, India

managed to encourage bird survival and reproduction. Further, to support an integrative approach in urban green planning, both ecological and social research has to be incorporated in the planning process.

Keywords Urban ecosystem • Biodiversity • Urbanisation • Human activity • Bird population

31.1 Introduction

Worldwide urban areas are expanding both in size and number and this rapid urbanization is expected to continue. The beginning of the 21st century can be characterized by the tremendous growth of urban areas and associated processes of globalization and unification of urban environments. Although cities occupy just 2 % of the Earth's surface, their inhabitants use 75 % of the planet's natural resources (UNEP 2008). Urbanization is thus one of the reasons for the loss of global biodiversity (Garden et al. 2006). The decrease in the green cover due to urban invasion is causing fragmentation of the native vegetation resulting in the reduction of associated faunal species in the long term (Beissinger and Osborne 1982; Germain et al. 1998; Marzluff et al. 1998). On the contrary, it is undoubtedly true that urbanisation has introduced new food and habitats to particular sites (Blair 1996) and has developed complex social-ecological systems with important functions in the form of urban ecosystems. These man-made ecosystems have certain areas with high biological diversity and unaltered patterns of diversity, including both remnant species and species purposefully or unintentionally introduced by human actions. There can be important habitats and valuable corridors for both common and less common species within the urban sprawl (Blair 1999, 2004; Crooks et al. 2004; Li et al. 2010). Such characteristics of the urbanized areas have enhanced the approach of the Conservation Science workers to get involved in the studies related to urban biodiversity (McDonnell and Pickett 1990; Alvey 2006; Garden et al. 2006) and their dynamics especially avifauna which were otherwise overlooked before the 1990s (Botkin and Beveridge 1997; McDonnell et al. 1997). Cities are dependent on the ecosystems beyond the city limits, but also benefit from internal urban ecosystems (Bolund and Hunhammar 1999). The area of land *within* an urban settlement that is not built upon has been termed as "Greenspaces" which includes nature reserves, original and planted vegetation, river corridors, nature strips, parks and sporting grounds as well as individual trees, residential gardens and vacant land (Smith et al. 2005).

Rajasthan, the largest state of the Republic of India, has a wide variety of habitats due to the diverse range of climatic variations, edaphic characters, physiography, topography and geology. The Aravallis act as a division of the geographical area of the State with the dry western parts and wet eastern parts. These salient features can be seen in areas of human settlements which also may

be rural, urban or peri-urban. These diverse habitats, including greenspaces, of the state are home to more than 500 avifaunal species (Islam and Rahmani 2004) with habitats of the eastern and the southern regions harbouring 80 % of these. (Mehra et al. 2009, 2012; Mehra 2011a, b, 2012). As in other parts of the world, aquatic birds have attracted the attention of ornithologists, specialists on hunting management and hunters from the past to the present in the princely state of Rajasthan (Adam 1873; Barnes 1891; Oates 1899; Messurier 1904; Impey 1909; Whistler 1938; Prakash 1960; Kushlan 1993). Surface water plays a major role in providing breeding and resting grounds for aquatic birds depending on its characteristics with respect to the food availability and protection. Approximately 30 % of the total bird species of Rajasthan depend on the wetlands (Ali and Ripley 1968–1999; Grimmett et al. 1999). The surface water resources in Rajasthan are mainly confined to the central and eastwards side of Aravallis, thus providing aquatic habitats for the avifauna.

Known for the wetland ecosystem, “City of Lakes” or “Venice of the East”, Udaipur is one of the dream destinations of international tourists. The water bodies of the ‘lake city’ play an important role in several spheres of human interest: culturally, socially, scientifically and economically. After fish, birds are probably the most important faunal group that attracts people to wetlands. The present investigation was an attempt to highlight the importance of urban avifauna and its value for the community in view of the socio-ecological aspects. It also supports the view that the monitoring of water birds could provide valuable information on the status of wetlands (Custer et al. 1991; Kushlan 1993), and could be a key tool for increasing awareness of the importance of wetlands and conservation values among the local residents of Udaipur.

31.2 Methodology

31.2.1 Avifaunal Surveys

Avifaunal Surveys were conducted periodically on the selected sites with the participation of the trained local volunteers and focusing primarily on the wetlands and associated terrestrial green spaces. Although observations were a regular activity of teams since 1999 the present period included systematic observations for a period from 2004 to 2011. Different field methods were adapted, according to the species or species group in question (Bibby et al. 2000; Javed and Kaul 2002; Urfi et al. 2005). Sometimes, the approach was altered according to field conditions and available resources. Identification of the species was done with the help of field guide books such as Grimmett et al. (1999), Kazmierczak and van Perlo (2000) and Grimmett et al. (2004). Scientific names and classification were used, according to Manakadan and Pittie (2001).

The status of the bird species was assigned according to: R: Resident; R/LM: Resident with Local Movement; LM: Local Movement; R/WM: Resident with Winter Movement; R/WM/LM: Resident with Winter as well as Local Movement; WM: Winter Migrant; WM/PM: Winter Migrant with Passage Migration; WM/R: Winter Migrant with Resident; SM: Summer Migrant.

Urban Habitats and Urban Green Spaces—Urban habitats were broadly divided into—urban terrestrial and urban aquatic habitats. They were further categorized into sub-habitats for the ease of observations, referring to the work of Dunnett et al. (2002) and Manlun (2003) to some extent.

31.2.2 Urban Terrestrial Habitats (T)

These habitats were categorized into the following six sub-habitats:

- Protected Area (TPA)—Sajjangarh Wildlife Sanctuary
- Public Park (TPP)—Sajjan Niwas Garden
- Forest Fragments (TFF)—Baghdara, Khas Odhi and Moti Magri
- Agricultural Field (TAF)—fields of MPAUT and those present on the borders of Udaipur partially representing rural
- Institutional Green Spaces (TIGS)—Administrative campuses of universities (Mohanlal Sukhadia University and Maharana Pratap University of Agriculture and Technology)
- Constructed Areas (TCA)—denotes selected road and buildings within the city.

31.2.3 Urban Aquatic (W) Habitats

These habitats were categorized into the following three sub-habitats:

- Urban Lakes (WUL)—Pichola, Saroop Sagar, Fatehsagar
- Peri-urban Lake (WPUL)—Udaisagar, Baghdarrah Lake
- Other Aquatic bodies (WOA)—Govardhan Sagar, Connecting Links (Ahar). Small temporary pools within terrestrial habitats of Khas Odhi, Sajjan Niwas and constructed areas.

31.2.4 Human Accessibility

Human accessibility was observed for a year (July 2005–June 2006) as adapted from the studies and observations that Mehra et al. (2011a, b, c) made on the different points for particular sites for assessment of the sub-habitats.

31.2.5 Disturbance Level

The disturbance level of the sub-habitats was based on the presence of human or other anthropogenic activities at the times of peak bird activities in the morning hours (the period between half an hour before sunrise to 4 h after sunrise):

- Low Disturbance (Rating-1)—activities or movements of humans for about one-fourth period at all the observation points or transect at a particular site in peak bird activity hours;
- Moderate Disturbance (Rating-2)—activities or movements of humans for about half period at all the observation points or transect at a particular site in peak bird activity hours;
- High Disturbance (Rating-3)—activities or movements of humans for all the observation points or transect at a particular site in peak bird activity hours.

31.2.6 Accessibility Level

The accessibility level for humans denotes the approach of the sub-habitats for general public. The assessment included three points: (a) nearness from residential area, (b) frequency of use by local residents, and (c) ownership of public property and/or permitted site for the common man. Based on these three criteria, a rating on human accessibility was given:

- All the sites of sub-habitat fulfils all the three points (Rating-1)
- All the sites of sub-habitat fulfils either points 'a' and 'c' or 'b' and 'c' (Rating-2)
- All the sites of sub-habitat does not fulfils point 'c' (Rating-3).

31.2.7 Importance Level

The assessment of the importance of the sub-habitats was made through interactions with at least 50 people per season found at particular sites of observation on the issues of direct or indirect benefits related to residence, education, recreation, economic and other:

Based on the use of local community

- Frequently used (Rating-1)
- Occasionally used (Rating-2)
- Rarely used (Rating-3).

Based on the use of global community

- Frequently used (Rating-1)
- Occasionally used (Rating-2)
- Rarely used (Rating-3).

31.2.8 Potential and Scope of Eco-Tourism

Through the analysis of the views of the locals and other parameters of characteristics required for developing tourism sites, potential and scope of the urban habitats for developing sites as eco-tourism, especially related to birding sites, were interpreted. A site was rated as:

- Could be developed as a hotspot for eco-tourism (Rating-1)
- Could be used as an alternative site for ecotourism (Rating-2)
- Least important for eco-tourism (Rating-3).

31.3 Observations and Results

In total, 248 species of birds belonging to 68 families were recorded in the urban habitats of Udaipur during the period July 2004–June 2011. Out of the total species of birds, 143 species, representing 42 families, were recorded in the terrestrial habitats, whereas 103 species, representing 26 families, were recorded in aquatic habitats. Two species, one each from terrestrial and aquatic habitats, were not directly recorded by the authors. Table 31.1 enlists species of global importance, including the two which were not directly sighted in this study, found in the urban habitats of Udaipur. Urban terrestrial habitats were surveyed into six heads, namely, Protected Area (TPA), Public Park (TPP), Forest Fragments (TFF), Agricultural Field (TAF), Institutional Green Spaces (TIGS) and Constructed Areas (TCA).

31.3.1 Terrestrial Bird Species: Occurrence

Around 143 species were recorded from different terrestrial habitats of the urban areas of Udaipur. One species was included due to the authentic information of another worker. Thus, 144 species showed their presence in the terrestrial urban habitats. The highest number of species was 137, recorded from the fragmented forest (TFF) areas lying in and around Udaipur. This was followed by the terrestrial habitats of the protected area (TPA), which harboured 121 species. Interestingly, over 90 bird species were recorded in the institutional campuses (TAF and TIGS). Other urban green spaces, viz., Sajjan Niwas Park (TPP), were home to 84 bird species. Almost 60 species found shelter in the close proximity of human settlements, i.e., constructed structures (TCA). Figure 31.1 presents species recorded from the urban terrestrial habitats.

Table 31.1 Bird species of global importance recorded during study period (2004–2011) from urban habitats of Udaipur

Sr. No.	Common Name	Scientific Name	Terrestrial habitats					Aquatic habitats																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
			TPA					TPP																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
			TPA	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
<i>Critically endangered</i>																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

31.3.2 Terrestrial Bird Species: Status

Maximum species (approximately 58 %) of the total recorded terrestrial bird species were local residents (R) of the study area whereas 16 % were resident with local movement (R/LM). Approximately 20 % of the total terrestrial species were winter migratory (WM). They were mainly from the three families, namely, Turdinae, Sylviinae and Muscicapinae. One species of each was showing local movement (LM), resident with winter movement (R/WM) and winter migration with resident (WM/R). Four species were winter migrant with passage migration (WM/PM) and two species were summer migrants (SM) recorded from the study area. Figure 31.2 is a graphical presentation showing the status of the terrestrial bird species recorded from the study area.

31.3.3 Aquatic Bird Species: Occurrence

Urban aquatic habitats were surveyed into three heads, namely, Urban Lakes (WUL), Peri-urban Lake (WPUL), and Other Aquatic bodies (WOA). Aquatic bird species, categorized into wetland species and wetland dependent species, accounted for 103 from the study area. The inclusion of one species (Indian Skimmer) was based on records of other workers. Thus, 104 species showed their presence in the aquatic urban habitats. Eighty six species were wetland species whereas 18 species were wetland dependent. Aquatic habitats from the peri-urban areas (WPUL) harbored 103 aquatic species whereas 89 species were recorded from urban lakes (WUL). Surprisingly, small aquatic bodies and linking canals (WOA) were home for 46 aquatic species. Figure 31.1 presents a picture of the number of species in different aquatic habitats. Twelve aquatic species were also sighted in the terrestrial habitats of the study area.

31.3.4 Aquatic Bird Species: Status

Maximum species (approximately 46 %) of the total recorded aquatic bird species were winter migrants (WM) which showed their presence in the winter season. Approximately 33 % were resident showing local movement (R/LM) due to the decrease or absence of water in main aquatic bodies in summer seasons. The proportion of aquatic resident (R) species was only about 11 % of the total. Eight species were resident which showed winter movement (R/WM) and one species was resident showing both winter and local movement (R/WM/LM). Figure 31.2 is a graphical presentation showing the status of the aquatic bird species recorded in the study area.

31.3.5 *Species of Global Interest*

Nineteen bird species that are listed in the globally threatened species were recorded during the period of study from investigated habitats (Table 31.1). Eight of the total species are the terrestrial, whereas 11 species are wetland or wetland dependent species.

All the four critically endangered species of vultures, viz., Indian White-backed, Long-billed, Cinereous and Red-headed, showed their presence in the urban green spaces categorized as TPA and TFF, whereas the endangered species of vulture, viz., Egyptian, showed its presence in all types of terrestrial habitats. Two vulture species, namely Indian White-backed and Long-billed, had nesting colonies in Sajjan Niwas Garden and Sajjangarh WLS, whereas Red-headed was nesting in Sajjangarh WLS till the early 2000s. During the study period, the nesting of Long-billed was sighted in the cliffs of Aravallis in peri-urban sites. Records of the Cinereous vulture were rare and the sighting of this species was in the green spaces (Fragmented Forests) in its south and south-western parts of the Udaipur. The Egyptian Vulture was the only species of vulture which was sighted all around the urban habitats with the maximum numbers of individuals and nesting colonies in green spaces around the southern parts of human settlements.

The five vulnerable species were recorded mostly in the urban habitats (both terrestrial and aquatic) in the southern and western parts along with the peri-urban areas on the eastern side of Udaipur. Lesser Kestrel sightings were a rare occurrence, whereas Pied Tit had frequent sightings in Khas Odhi green spaces. Green Munia was a not so commonly found species but could be sighted regularly in Sajjangarh WLS and its adjoining green spaces towards the Bari lake side. Sarus Crane had been occurring in the aquatic habitats in peri-urban sites.

The nine species categorized as near threatened, showed their presence in the urban habitats under study. Eight species were aquatic, whereas one species was terrestrial. Two species, namely, Oriental White Ibis and Black-tailed Godwit, were recorded from all the categorized aquatic habitats and two species, namely, Darter, Painted Stork, Ferruginous Pochard and Black-bellied Tern, were recorded from all the major aquatic habitats, whereas two species, namely, Black-necked Stork and Lesser Flamingo, were only sighted in the peri-urban aquatic habitats. The only near threatened terrestrial species, viz. European Roller, showed its occurrence rarely in the open terrestrial habitats.

31.3.6 *Characteristics of the Urban Habitats*

On the basis of the importance of the categorized habitats in the local concern, TPP, TCA and WUL were maximally used and TPA, WOUL and WOA were least used by the local public. On the other side of the importance for global concern, TPA, WUL and WPUL were the maximally accepted sites and TPP, TFF, TAF, TIGS,

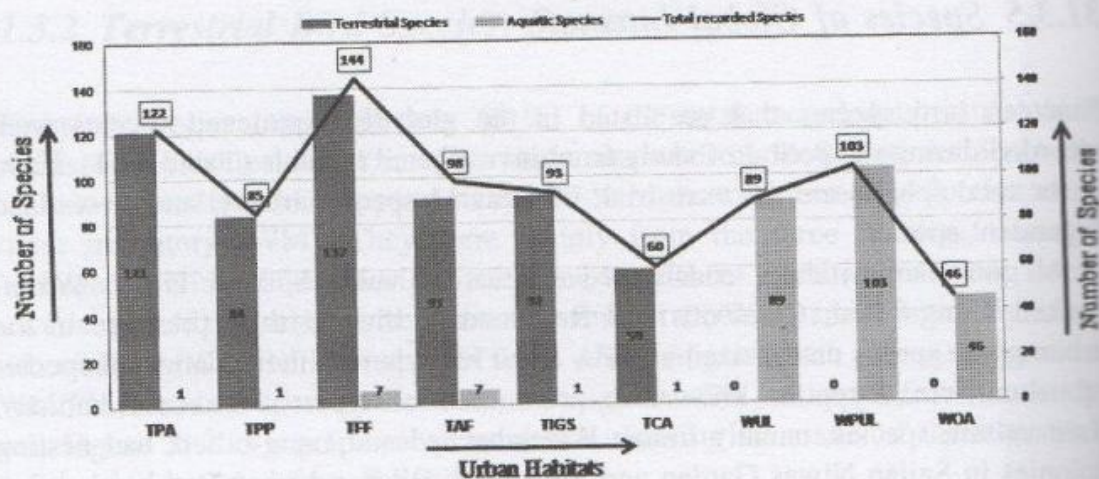


Fig. 31.1 Occurrence of bird species in urban habitats of Udaipur. Source Mehra et al. 2011c

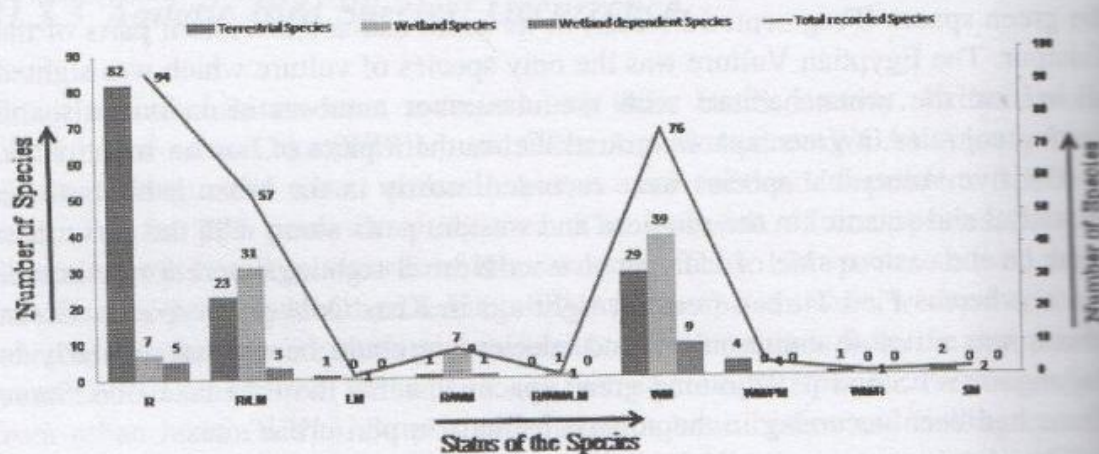


Fig. 31.2 Status of bird species recorded from urban habitats of Udaipur. Source Mehra et al. 2011c

TCA and WOA were the least important sites which were generally overlooked. From the above ratings and importance it can be inferred that, based on the potential for developing eco-tourism sites for the local and global communities, habitats such as TPA, TFF, WUL and WPUL can be on the top of the list.

Since the habitats under TPA and WPUL are already on the World Map these can be developed on socio-ecological grounds. The activities, such as Nature Tourism, which include Birding/Bird-watching, Herping/Snakes-Lizard exploring, Frogging/Frogs observations, Buterflying/Butterfly watching along with the local and indigenous vegetation involving local community, can be useful in improving the economic prospects of the locals as well as encouraging community participation. This would also be helpful in achieving the aims and objectives of Conservation Sciences.

Tables 31.2 and 31.3 provide a summary of the assessment of the terrestrial habitats of Udaipur which can be a source of socio-ecological aspects of research

and its implementation. The much needed analysis of the inclination of local communities in stepping up for the new global responsibility of employment generation through conservation is a demand of the time for the area.

31.3.7 Discussions

Urban biodiversity is heavily influenced by humans due to land use and construction along with economic, social and cultural dynamics of the area. Amidst the green cover of the Aravallis, human settlements in the form of the city of Udaipur were created in the 16th century by the then rulers (Tod 1920; Shyamaldas 1986). The green forests rich in wildlife was the characteristic feature within and across the city walls (Tod 1920). Until the mid-20th century, urban sprawling was limited within the city walls and after that time it cleared the green cover. Simultaneously, throughout that period there was development of the green space urban sprawls which were used by the faunal species as refuge. In more densely populated areas, biodiversity consists mostly of species that have adapted to the urban environment and live in close proximity to humans. The most important of these species are avifauna, such as pigeons. Less dense sites and those with a shorter history of human impact in the form of alterations of habitats, such as Khas Odhi and Sajjangarh still have important original natural areas and the species which are of global interest.

Mitchell (2006) described the management of urban ecosystems and urban biodiversity. Urban areas and the local human population play a crucial role in this management due to several reasons not only within urban settlements but across the limits of urban areas. Partly because nature in the urban context is accessible nature, and it has been proven that people need access to nature in order to foster concern for nature and support for environmental initiatives. The extent of human influence over urban landscapes means that we also determine the availability and suitability of habitat for other species. From nature reserves to the manicured parks, residential gardens and commercial centres to aquatic bodies, each land use within and around human settlements provides opportunities for some species. Which species and the amount of habitat humans exclude from urban landscapes may play an important role in the ability of cities to provide a liveable habitat for both human and non-human residents into the future. Urban biodiversity is much more than the visibility of animals and plants in our cities. It is becoming the symbol for the dependency of mankind on natural resources. Where landscapes provide habitat for species and their predators, there is a reduced likelihood of species becoming pests because natural predators control their population. The most fascinating and eye catching group of species are important with avifauna being the group which has interested and attracted humans all over globe.

Udaipur also marks its presence on the global map when it refers to avifauna due to the presence of a wide variety of green spaces. The habitats of Udaipur are home to approximately 250 bird species, though, there was a great variation in the

avifaunal composition throughout the period of urban sprawling. Hume (1878) pioneered the aquatic avifaunal explorations in southern Rajasthan and documented important species of water birds from Jaisamand (Dhebar) Lake and Kankroli *Talao* from Udaipur. Since then no major work has been done, although a few records of the water birds were found in some books related to hunting of animals by the princely family members (e.g. Tanwar 1956). Such types of documentation only present the group of water birds—not the species—so it is hard to assess the bird species of the respective period.

After a long gap, scientific documentation was done by Tehsin (1989) in which he reported 66 wetland birds from Udaipur Lake Complex. Sharma (1998) documented some of the wetlands birds around Sajjangarh Wildlife Sanctuary. Sharma and Tehsin (1994) then published the avifaunal checklist of southern Rajasthan. With these detailed listings, the reporting of individual species related to wetlands from different parts was also continued (Tehsin 1987, 1997, 1999). The work of Sharma (2002), Mehra et al. (2010), and Mehra (2011a, b, c, 2012) tried to cover and document almost all the birds of southern Rajasthan whereas Islam and Rahmani (2004) made an attempt to document all the sites of southern Rajasthan which are important with respect to birds of global interest listed by Birdlife International (2001). Udaipur Lake Complex, Sei Dam, Jaisamand Lake and Baghdarrah were important sites with respect to birds of international concern and were identified as Important Bird Areas (IBAs) (Islam and Rahmani 2004). Thus, urban lakes and Sajjangarh WLS were marked as important birding sites. Maintaining source habitats and protecting them from human induced threats is the key to ensuring the survival of many regional species.

Remnant species and source habitat cannot be simply replaced by new plantings. The complexity and age of these habitats gives them value far greater than habitats created by humans (Lindenmayer et al. 2003). The agricultural landscapes of Udaipur were home to threatened species such as Green Munia (Banerjee 1996) which was locally extinct from the urban limits (Mehra and Mehra 2008) and reappeared recently in 2011 from urban terrestrial habitats (Sajjangarh WLS and adjoining green patches near Badi). Similarly, urban habitats in the form of fragmented forests, such as scrub forests of Khas Odhi harbored threatened species White-naped Tit (Mehra 2004, 2012) which need immediate attention from the community and concerned departments. By volunteering or supporting environmental groups and programs that act to restore, monitor and maintain both natural and urban habitats, urban communities can make a positive contribution to urban biodiversity now and in the future. It is worth quoting the successful example achieved in urban habitats of Abu Hills where community participation contributed to increasing the population of threatened bird species (Mehra and Sharma 2004; Mehra et al. 2005; Mehra 2012). Despite the fact that urbanisation affects negatively upon the species richness, the study concludes that with effective management and community involvement an urbanized world can be sustainably managed for many of the species, especially birds, on economic grounds.

Table 31.2 Assessment and rating of urban habitats of Udaipur

Habitats →	Terrestrial habitats	Aquatic habitats								
Characteristics ↓	TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA	
Bird species	Terrestrial	121	84	137	91	92	59	0	0	0
	Aquatic	1	1	7	7	1	1	89	103	46
	Total	122	85	144	98	93	60	89	103	46
	Globally threatened	6	0	5	4	2	1	7	10	2
Disturbance level	1	2	1	2	2	3	2	1	2	
Accessibility level	1	1	1/3 ^a	3	3	1	1	2	2	
Importance level	Local	3	1	2	2	2	1	1	3	3
	Global	1	3	3	3	3	3	1	1	3
Potential and scope	1	2	1	2	3	3	1	1	2	

Source Mehra et al. 2011c

^a Represents one of the sites, Khas Odhi, which is private property rich in terrestrial avifauna

Table 31.3 Bird species recorded during study period (2004–2009) from urban habitats of Udaipur

Habitats →	Terrestrial habitats	Aquatic habitats								
	TPA	TPP	TFF	TAF	TIGS	TCA	WUL	WPUL	WOA	
Bird species (number)	Terrestrial	118	84	136	91	92	59	0	0	0
	Aquatic	1	1	7	7	1	1	87	102	46
	Total recorded	119	85	143	98	93	60	87	102	46
	Threatened	3	0	5	4	2	1	7	10	2

31.4 Conclusions

There is always a conflict between the protection of habitats and human involvement. Uncontrolled urbanization has forced both wetland habitats and biodiversity into a situation where both are struggling for their existence. There is a need to bring the concept of conserving these habitats as well as biodiversity. Community based nature conservation that is coming up very successfully in many parts of the globe can also be used in Udaipur. This can be an income generating source providing employment to the local residents and the mass involvement to conserve the diversity from an ecological point of view. Udaipur is already on the World Tourism Map due to its scenic beauty and historical importance and the natural heritage of the area is still an unexploited source of income generation in

the urban areas. The coordinated and integrated approach of different government departments as well as academic research is required for the sites to achieve their potential for Nature Tourism.

Acknowledgments We are thankful to Rajputana Academy of Natural History, Rajputana Society of Natural History, Udaipur and Laboratory of Biodiversity, M. D. S. University, Ajmer for the help and support provided in the present investigation. We acknowledge all those people who directly and indirectly helped us in providing information on the presence of avifauna of global interest in their nearby habitats. Special thanks to Mr. G. K. Mehra for his comments and inputs in the write up. It is worth mentioning the contribution of Mr. Himmat Ram Kumhar who assisted the authors in carrying out the surveys all around the State.

References

- Adam RM (1873) Notes on birds of Sambhar Lake and its vicinity. *Stray Feathers* 1:361–404
- Ali S, Ripley SD (1968–1999) Handbook of the birds of India and Pakistan, vol 10. Oxford University Press, Mumbai
- Alvey AA (2006) Promoting and preserving biodiversity in the urban forest. *Urban For Urban Green* 5(4):195–201
- Banerjee A (1996) Some observations on avifauna with respect to habitat in Udaipur District, Rajasthan. *Indian Forester* 122:1961–1964
- Barnes HE (1891) Nesting in western India. *J Bombay Nat Hist Soc* 6(3):285–317
- Beissinger SR, Osborne DR (1982) Effects of urbanization on avian community organization. *Condor* 84:75–83
- Bibby C, Burgess ND, Hill DA, Mustoe SH (2000) Bird census techniques, 2nd edn. Academic Press, London, pp xvii + 302
- BirdLife International (2001) Threatened birds of Asia: the birdlife international red data book. BirdLife International, Cambridge
- Blair RB (1996) Land use and avian species diversity along an urban gradient. *Ecol Appl* 6(2):506–519
- Blair RB (1999) Birds and butterflies along an urban gradient. *Ecol Appl* 9(1):164–170
- Blair RB (2004) The effect of urban sprawl on birds at multiple levels of biological organization. *Ecol Soc* 9(5):2
- Bolund P, Hunhammar S (1999) Ecosystem services in urban areas. *Ecol Econ* 29(2):293–300
- Botkin DB, Beveridge CE (1997) Cities as environments. *Urban Ecosyst* 1:3–19
- Crooks KR, Suarez AV, Bolger DT (2004) Avian assemblages along a gradient of urbanization in a highly fragmented landscape. *Biol Conserv* 115:451–462
- Custer TW, Rattner BA, Ohlendorf HM, Melancon MJ (1991) Herons and Egrets proposed as indicators of Estuarine contamination in the United States. In: Proceedings of the international ornithological congress, vol 20, pp 2474–2479
- Dunnett N, Swanwick C, Woolley H (2002) Improving urban parks, play areas and green spaces. Department of Landscape, University of Sheffield, Department for Transport, Local Government and the Regions, London, pp 214
- Garden J, McAlpine C, Peterson A, Jones D, Possingham H (2006) Review of the ecology of Australian urban fauna: a focus on spatially explicit processes. *Austral Ecol* 31:126–148
- Germaine SS, Rosenstock SS, Schweinsburg RE, Richardsdson WS (1998) Relationships among breeding birds, habitat, and residential development in Greater Tucson, Arizona. *Ecol Appl* 8:680–691
- Grimmett R, Inskipp C, Inskipp T (1999) Birds of the Indian subcontinent. Oxford University Press, New Delhi

- Grimmett R, Inskipp T, Mehra SP (2004) Uttar Bharat Ke Pakshi. Bombay Natural History Society, Mumbai (in Hindi)
- Hume AO (1878) A lake in Oodeypore. *Stray Feathers* 7(1-2):95-99
- Impey L (1909) Duck shooting in Rajputana. *J Bombay Nat Hist Soc* 19(3):750-751
- Islam MZ, Rahmani AR (2004) Important bird areas in India: priority sites for conservation. Indian Bird Conservation Network: Bombay Natural History Society and BirdLife International, UK, pp xviii + 1133
- Javed S, Kaul R (2002) Field methods for bird surveys. Bombay Natural History Society, Department of Wildlife Sciences, Aligarh Muslim University, Aligarh and World Pheasant Association, South Asia Regional Office (SARO), New Delhi
- Kazmierczak K, van Perlo B (2000) A field guide to the birds of India. New Delhi, Om Book Service
- Kushlan JA (1993) Colonial waterbirds as bioindicators of environmental change. *Colon Waterbirds* 16:223-251
- Li P, Ding P, Feeley KJ, Zhang J, Jiang P (2010) Patterns of species diversity and functional diversity of breeding birds in Hangzhou across an urbanization gradient. *Chin Birds* 1(1):1-8
- Lindenmayer D, Claridge A, Hazell D, Michael D, Crane M, MacGregor C, Cunningham R (2003) Wildlife on farms: how to conserve native animals. CSIRO Publishing, Collingwood
- Manakadan R, Pittie A (2001) Standardised common and scientific names of the birds of the Indian subcontinent. *Buceros* 6(1):ix + 37
- Manlun Y (2003) Suitability analysis of urban green space system based on GIS. Ph.D. thesis, International Institute for Geo-Information Science and Earth Observation, Enschede, The Netherlands, p 100
- Marzluff JM, Gehlbach FR, Manuwal DA (1998) Urban environments: influences on avifauna and challenges for the avian conservationist. In: Marzluff JM, Sallabanks R (eds) *Avian conservation: research and management*. Island Press, Washington, DC, pp 283-296
- McDonnell MJ, Pickett STA (1990) Ecosystem structure and function along urban-rural gradients: an unexploited opportunity for ecology. *Ecology* 71:1232-1237
- McDonnell MJ, Pickett STA, Groffman P, Bohlen P, Pouyat RV, Zipperer WC (1997) Ecosystem processes along an urban-to-rural gradient. *Urban Ecosyst* 1:21-36
- Mehra S (2012) The avifauna of southern Rajasthan with special emphasis on threatened species and bioacoustic applications in their identifications and monitoring. Ph.D. thesis, M. D. S. University, Ajmer, p 256
- Mehra S, Mehra SP, Sharma KK (2012) Importance of aquatic avifauna in southern Rajasthan, India. In: Rawat M, Dookia S (eds) *Biodiversity of aquatic resources*. Daya Publishing House, Delhi, pp 159-183
- Mehra, S, Mehra, SP, Sharma KK (2011a) Aquatic avifauna: its importance for wetland conservation in Rajasthan, India. In: Mathur SM, Shrivastava VK, Purohit RC (eds) *Conservation of lakes and water resources management strategies*. Himanshu Publications, Udaipur, pp 179-190
- Mehra S, Mehra SP, Sharma KK (2011b) Aquatic avifauna of Aravalli Hills Rajasthan, India. In: Gupta VK, Verma AK (eds.) *Animal diversity, natural history and conservation*, vol I. Daya Publishing House, Delhi, pp 145-167
- Mehra SP, Mehra S, Sharma KK (2011c) Urban avifaunal biodiversity in context of Udaipur, Rajasthan, India. In literature (personal observations)
- Mehra S, Mehra SP, Sharma KK (2010) Aquatic avifauna: its importance for wetland conservation in Rajasthan, India. In: *Proceedings of conservation of lakes and water resources: management strategies*, 19-20 February 2010, pp 202-214
- Mehra SP, Mehra S, Gautam P (2009) Avifaunal diversity of Keoladeo National Park: a review (Abstract). In: Mathur VB, Sivakumar K, Singh B, Anoop KR (eds) *A bibliographical review for identifying research gap areas: Keoladeo Ghana National Park—a world heritage site*. Wildlife Institute of India, Dehradun, p 45
- Mehra S, Mehra SP (2008) Observations on green munia from Abu Hills. In: Verma A (ed) *Conserving biodiversity of Rajasthan*. Himanshu Publications, Udaipur

- Mehra SP, Mehra S, Mathur R (2005) Munias of Mount Abu (Rajasthan, India) with special emphasis on green avadavat *Amandava formosa*. Indian birds 1(4):77–79
- Mehra SP, Sharma S (2004) Additional site records of green avadavat *Amandava formosa* (Latham) from Mt. Abu, Sirohi. Newslett Ornithol 1(6):84–85
- Mehra SP (2004) Sighting of White-naped Tit *Parus nuchalis*. Udaipur Newslett Ornithol 1(5):77
- Messurier AL (1904) Game, shore, and water birds of India. W. Thacker and Co, London
- Mitchell B (2006) Life in the suburbs: urban habitat guidelines for the ACT. Natural Heritage Trust, Government of Australia, Melbourne, p 25
- Oates EW (1899) A manual of the game birds of India. In: Water birds, vol 2. Messrs. A.J. Combridge & Co., Bombay, pp 506 (2 vols)
- Prakash I (1960) Shikar in Rajasthan. Cheetal 2(2):68–72
- Sharma SK (1998) Avian Fauna of Sajjangerh wildlife sanctuary. Newslett Birdwatchers 38(2):25–27
- Sharma SK (2002) Preliminary biodiversity survey of protected areas of southern Rajasthan. Unpublished report, pp 1–23
- Sharma SK, Tehsin R (1994) Birds of southern Rajasthan. Newslett Birdwatchers 34(5):109–113
- Shyamaldas (1986) Veer Vinod (History of Rajputana states up to 1884), Part I–IV. Motilal Banarsidas, Delhi (in Hindi)
- Smith R, Gaston K, Warren P, Thompson K (2005) Urban domestic gardens (V): relationships between landcover composition, housing and landscape. Landscape Ecol 20:235
- Tanwar DT (1956) Shikari aur Shikar (in Hindi). Udaipur, Mewar
- Tehsin R (1987) Migrating demoiselle cranes *anthropoides virgo*. Tigerpaper 14(4):26
- Tehsin R (1989) Faunal history of Fatehsagar Lake. In: Vyas LN, Garg RK (eds) Wetland conservation. Environment Community Centre, Udaipur, pp 109–117
- Tehsin RH (1997) Little green Heron *Butorides striatus* and white-eared Bulbul *Pycnonotus leucogenys* sighted in southern Rajasthan. Newslett Birdwatchers 37(5):91
- Tehsin RH (1999) Threetoed Kingfisher *Ceyx erithacus* sighted at Panarwa. J Bombay Nat Hist Soc 96(1):142–143
- Tod J (1920). Annals and antiquities of Rajasthan, vol I. Motilal Banarsidas Publishers Private Limited, New Delhi (Reprint 1994)
- UNEP (2008). www.unep.org/urban_environment/index.asp. Accessed 21 April 2008
- Urfi AJ, Sen M, Kalam A, Meganathan T (2005) Counting birds in India: methodologies and trends. Curr Sci 89(12):1997–2003
- Whistler H (1938) Ornithological survey of Jodhpur state. J Bombay Nat Hist Soc 40:213–235