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DIVERSITY, DISTRIBUTION AND CONSERVATION OF FISHES IN LAKES OF POKHARA VALLEY, NEPAL

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ABSTRACT

Present study deals with fish diversity along with management aspects of lakes in Pokhara Valley. It was conducted during September 2009 to February 2010. Monthly fish sampling was done using gill net with the help of experienced fishermen. Altogether 34 species of fishes were recorded in the present study. The population status of important fish species viz., *Tor Tor* (Hamilton-Buchanan) was found to be endangered, that of *Tor putitora* (Hamilton-Buchanan), *Neolissocheilus hexagonolepis* (Mc Clelland), *Chagunius chagunio* (Hamilton-Buchanan), and *Brachydanio rerio* (Hamilton-Buchanan) were found to be vulnerable (VU); five species were uncommon (UN) and 24 species were common (C) including common exotic(C*). The lakes were found to be influenced by human activities such as direct disposal of domestic sewage, unscientific agricultural practices, construction of dams without fish ladder or passes, deforestation causing soil erosion etc., which were creating threat to the lentic ecosystem.

Key words : Lentic ecosystem, deforestation, bioresources, alien species, migration.

INTRODUCTION

Pokhara valley has nine lakes with rich fish diversity along with other aquatic bioresources. Wetlands are considered to be one of the world's most productive and important natural ecosystems. They are the cradle of aquatic biodiversity and provide the water and primary productivity upon which countless species of plants and animals depend for survival (Dugan, 1990). Properly managed wetlands can be a critical life supporting habitats for millions of people throughout the world (Russel, 1993). Fish constitute the important group of aquatic biodiversity which has been used as food from the time immemorial. The deforestation or denudation of the watersheds or riparian vegetation was mentioned to be an important factor causing landslide, soil erosion, and siltation resulting in degradation of habitat and alteration in run-off which adversely influence the biodiversity, shrinkage of breeding grounds and multiplication of fish population (Wetzel, 2001; Shrestha 2003; Pokharel, 2010a). The published literature on fish biodiversity of Pokhara Valley includes those of Ferrow and Badgami (1980); Agriculture Research Centre Pokhara (Fisheries) (2001-02); Pokharel (1999a), Pokharel *et al*. (2010), Bista, Dhakal and Gurung (2001/02), which studied on fish diversity and fisheries resources of the water bodies in the valley.

Present study aimed to explore occurrence, distribution and status of fish diversity in major lakes of Pokhara valley. The findings of this study may help for planning in management of lakes.

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MATERIALS AND METHODS

Study Area

Pokhara, a beautiful valley in the western part of Nepal extends between 25°07' N to 28° 10' latitude, and 83°50' E to 84°50'E longitude and lies 800 m above sea level (Tripathi, 1984-85). The valley has many fascinating water bodies such as lakes, rivers, streams, ponds, creeks, falls etc with rich bioresources. The lakes included in the present study were Phewa, Begnas, Rupa, Maidi and Dipang (Figure 1). Phewa is the biggest lake situated at an altitude of 742 m asl, covering an area of 5.23 sq.m, extended north to south 6.4 km, east-west width ranging from 50 m to 2 km and up to 19 m in depth. The lake has two perennial creeks i.e., Harpan Khola and Andheri Khola as the main feeding sources. Pardi Khola is the only outlet of the lake which flows downwards to join Phusre Khola. Begnas is the second biggest lake situated at 650 m asl in the eastern part of the valley. It covers 3.28 sq km in area and upto 7.5 m in depth. The main feeding source of the lake is Syankhudi Khola at the upper part of the lake, while Khudi Khola is the natural outlet which meets the Kotre Khola downwards, which finally joins the Seti Gandaki River. Rupa Lake is the third major lake of the Valley, situated at 600 m asl in the eastern part. It covers 1.15 sqkm in area, being 2.4 km in length, 0.8 km in width and 5.0 m or more in depth. A small perennial creek, Talbesi Khola is the main feeding source of the lake. Tal Khola is the outlet, joins Kotre Khola downwards, which finally meets the Seti Gandaki River near Kotre. Lake Maidi and Dipang are small lakes also situated in the eastern part of the valley. Maidi is 0.53 sqkm and Dipang is 0.32 sqkm in area and are upto 2.5 m in depth. The lake has its major part covered by thick layer of grass or macrovegetation surrounded by marshy area. Lake Dipang was also having swampy shore with thick aquatic macrophytes most of which has been removed by the lake conservation authorities with participation of local people.

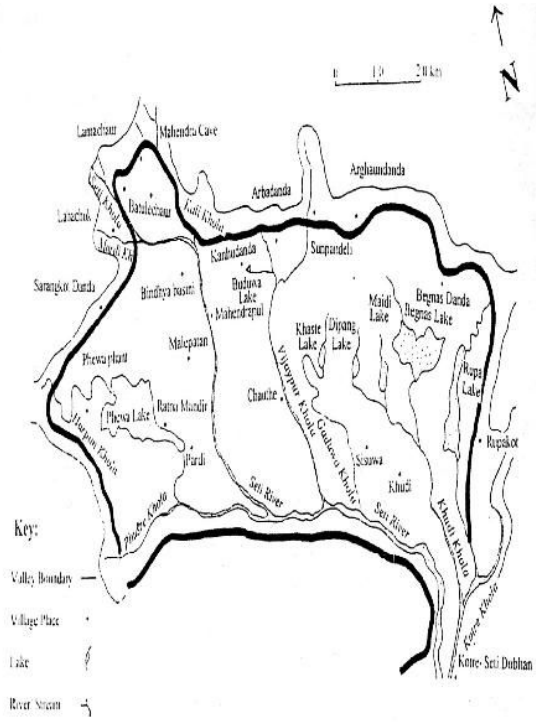

Figure 1. Location map of study area.

Sampling

The present work was performed during September 2009 to February 2010. Experienced local fishermen were employed and gill nets having different mesh sizes (2.5 to 27.5 cm) were used for monthly sampling. Fishes were caught, examined and identified on the site and released into water unharmed. The fish samples which required taxonomic verification were collected and preserved in 10% formalin solution, brought to the laboratory of Department of Zoology, Prithvi Narayan (PN) Campus, TU, Pokhara. The fishes were identified upto species level following Berg (1940), Shrestha (1981, 2001) and Jayaram (1999), and deposited in the museum of the department.

Information on fish diversity, their habitat condition, conservation issues and aspects related to fisheries were acquired through questionnaire from local people, fisher community, fisheries co-operative committee and field observation. The criteria laid out by IUCN (1994, 2001) were followed for assessment of the status of fishes.

RESULTS

Species diversity and distribution

The fishes recorded from the lakes viz., Phewa, Begnas, Rupa, Dipang and Maidi are presented in the Table 1. List of fishes shows that 34 species were recorded from these lakes. Lake Rupa was found to have highest number of species (30), followed by Lake Begnas and Lake Phewa (29), Lake Dipang (24) and Lake Maidi (8 species of fishes).

Fish species recorded from all five lakes were *Puntius sophore*, *P. conchonius, Barilius bendelisis, Xenentodon cancila, Channa orientalis, C. punctatus* and *Mastacembelus armatus*. The species recorded from four lakes viz., Phewa, Begnas, Rupa and Dipang were, *Neolissocheilus hexagonolepis, Chagunius chagunio, Puntius chola, Tor putitora, Labeo rohita, L. angra, Cirrhinus mrigala, Catla catla, Ctenopharyngodon idella, Cyprinus carpio* var *communis, C. carpio*. var *specularis, Hypophthalmichthyes molitrix, Aristichthyes nobilis* and *Oreochromis niloticus*. Likewise, fish species recorded from lakes Begnas, Rupa, Dipang and Maidi was *Mystus bleekeri*. Those recorded only from three lakes viz., Phewa, Begnas and Rupa were *Puntius sarana*, *Barilius vagra, B.barna* and *Danio devario*. Similarly, the species recorded from lakes Rupa and Dipang was *Heteropneustes fossilis*.

Some species of exotic fishes viz., *Cyprinus carpio* var. *communis* (Common Carp), *C. carpio* var. *specularis* (Common Carp), *Hypophthalmichthyes molitrix* (Silver Carp), *Aristichthyes nobilis* (Bighead Carp), *Ctenopharyngodon idella* (Grass Carp), *Oreochromis niloticus* (Nile Tilapia) and *Clarias gariepinus* (African Catfish) were also recorded during the study period.

The status of popular game fish Sahar/ Mahaseer, *Tor tor,* was found to be endangered (EN); Sahar/Mahaseer- *Tor putitora*, Katle/Copper Mahseer- *Neolissocheilus hexagonolepis*, Rewa- *Chagunius chagunio*, and the Zebrafish- *Brachydanio rerio* vulnerable (VU), five species were uncommon (UN) and 24 species common (C) and common exotic(C*).

Occurrence

Monthly occurrence of different species of fishes recorded during the study period in various lakes are presented in Tables 2-3. The *Tor tor* , an endangered (EN) species was recorded in low to very low occurrence in four months, vulnerable (VU) species viz., *Neolissocheilus hexagonolepis, Chagaunius chagunio, Tor putitora* and *Brachydanio rerio* were recorded having low to very low occurrence. Among the uncommon (UN) species *Puntius sarana* had very low occurrence, *Naziritor chelynoides* had low to very low occurrence, and *Labeo angra* and *Barilus vagra* had moderate to low occurrence. The common (C) species were found to have moderate to high occurrence during all months of the study period. The exotic species *Clarias gariepinus* and *Oreochromis niloticus* exceeded almost all other in occurence in most of the lakes. During the study period the indigenous catfish *Heteropneustes fossilis* was also recorded from Lakes Rupa and Dipang. The fresh water eel (Raj-bam), *Anguilla bengalensis,* which occurred in considerable number in Lakes Begnas and Rupa could not be recorded during the study period.

Table 1. List of fishes and their status in lakes of Pokhara Valley.

S.N.	Fish Species	Local/Common Name	Distribution Sites	Status
	Family: Cyprinidae			
1.	*Neolissocheilus hexagonolepis* (Mc Clelland)	Katle	F,B,R,D	VU
2.	*Chagunius chagunio* (Hamilton - Buchanan)	Rewa	F,B,R,D	VU
3.	*Puntius sophore* (Hamilton - Buchanan)	Bhitta	F,B,R,D,M	C
4.	*P. sarana* (Hamilton - Buchanan)	Kande	F,B,R	UN
5.	*P. chola* (Hamilton - Buchanan)	Bhurluk	F,B,R,D,M	C
6.	*P. conchonius* (Hamilton - Buchanan)	Tike Bhitta	F,B,R,D,M	C
7.	*Tor putitora* (Hamilton - Buchanan)	Sahar	F,B,R,D	VU
8.	*T. tor* (Hamilton - Buchanan)	Sahar	F	EN
9.	*Naziritor chelynoides* (Mc Clelland)	Karange	R	UN
10.	*Labeo rohita* (Hamilton - Buchanan)	Rohu	F,B,R,D	C
11.	*L. angra* (Hamilton - Buchanan)	Gardi	F,B,R,D	UN
12.	*Cirrhinus mrigala* (Hamilton - Buchanan)	Naini	F,B,R,D	C
13.	*C. reba* (Hamilton - Buchanan)	Reba	F	UN
14.	*Catla catla* (Hamilton - Buchanan)	Bhakur	F,B,R,D	C
15.	*Ctenopharyngodon idella* (Valenciennes)	Grass Carp	F,B,R,D	C*
16.	*Cyprinus carpio* var. *communis* (Linnaeus)	Scale/ Common carp	F,B,R,D	C*
17.	*C. carpio* var. *specularis* (Linnaeus)	Mirror/ Common carp	F,B,R,D	C*
18.	*Hypophthalmichthyes molitrix* (Valenciennes)	Silver carp	F,B,R,D	C*
19.	*Aristichthyes nobilis* (Richardson)	Big Head Carp	F,B,R,D	C*
20.	*Barilius bendelisis* (Hamilton - Buchanan)	Faketa	F,B,R,D,M	C
21.	*B. vagra* (Hamilton - Buchanan)	Lam Faketa	F,B,R	UN
22.	*B. barna* (Hamilton - Buchanan)	Bage Faketa	F,B,R	C
23.	*Danio devario* (Hamilton - Buchanan)	Sera/ Silbhitta	F,B,R	C
24.	*Brachydanio rerio* (Hamilton - Buchanan)	Zebra fish	B	VU
25.	*Esomus danricus* (Hamilton - Buchanan)	Sidhra	B,R	C
Family: Bagridae				
26.	*Mystus bleekeri* (Day)	Junge	B,R,D,M	C
Family: Clariidae				
27.	*Clarias batrachus* (Linnaeus)	Magur	F	C
28.	*C. gariepinus* (Burchell)	Bikasi Magur	F,R,D	C*
Family: Heteropneustidae				
29.	*Heteropneustes fossilis* (Bloch)	Balim	R,D	C
Family: Belonidae				
30.	*Xenentodon cancila* (Hamilton-Buchanan)	Chuche Bam	F,B,R,D,M	C
Family: Channidae				
31.	*Channa orientalis* (Bloch and Schneider)	Bhoti (Hile)	F,B,R,D,M	C

32.	*C. punctatus* (Bloch)	Bhot (Hile)	F,B,R,D,M	C
Family: Cichlidae				
33.	*Oreochromis niloticus* (Linnaeus)	Tilapia	F,B,R,D	C*
Family: Mastacembelidae				
34.	*Mastacembelus armatus* (Lacepede)	Bam	F,B,R,D,M	C

Abbreviation:

a. Sites: P= Phewa, B=Begnas, R=Rupa, D= Dipang, M=Maidi

b. Status: C= Common, UN= Uncommon, EN= Endangered, VU= Vulnerable, C*= Common Exotic.

Table 2. Monthly occurrence of fishes in lakes Phewa and Begnas.

S.N.	Fish Species	Months											
		Sep.		Oct.		Nov.		Dec.		Jan.		Feb.	
		Ph	Be	Ph	Be	Ph	Be	Ph	Be	Ph	Be	Ph	Be
1.	*Neolissocheilus hexagonolepis*	c	b	b	b	b	b	b	b	a	a	a	a
2.	*Chagunius chagunio*	b	c	b	b	b	b	b	b	a	a	a	a
3.	*Puntius sophore*	b	c	d	d	d	d	d	d	d	d	d	d
4.	*P. sarana*	b	a	a	a	a	a	a	-	a	-	a	-
5.	*P. chola*	b	b	b	b	a	a	a	a	a	a	a	a
6.	*P. conchonius*	b	c	d	d	d	d	d	d	d	d	d	d
7.	*Tor putitora*	c	c	b	b	b	b	b	b	a	a	a	a
8.	*Tor tor*	b	-	a	-	a	-	a	-	-	-	-	-
9.	*Labeo rohita*	b	b	b	b	b	b	b	b	b	b	b	b
10.	*L. angra*	b	-	c	-	c	-	d	a	d	a	d	a
11.	*Cirrhinus mrigala*	b	b	b	b	b	b	b	b	b	b	b	b
12.	*C. reba*	c	-	c	-	c	-	b	-	b	-	b	-
13.	*Catla catla*	c	c	d	d	d	d	d	d	d	d	d	d
14.	*Ctenopharyngodon idella**	b	b	a	b	b	b	b	b	b	b	b	b
15.	*Cyprinus carpio* var. *communis**	b	b	b	b	b	b	b	b	b	b	b	b
16.	*C.carpio* var. *specularis**	b	b	b	b	b	b	b	b	b	b	b	b
17.	*Hypophthalmichthyes molitrix**	b	b	d	d	d	d	d	d	d	d	d	d
18.	*Aristichthyes nobilis**	b	c	d	d	d	d	d	d	d	d	d	d
19.	*Barilius bendelisis*	b	b	b	b	b	b	c	c	d	c	d	c
20.	*B. vagra*	b	b	b	b	b	b	b	b	c	b	c	c
21.	*B. barna*	c	b	c	b	c	b	c	b	c	a	b	a
22.	*Danio devario*	b	b	b	b	b	b	b	b	c	c	c	C
23.	*Brachydanio rerio*	-	-	-	-	-	-	-	a	-	a	-	a
24.	*Esomus danricus*	-	-	-	-	-	a	-	a	-	a	-	a

25.	*Mystus bleekeri*	-	b	-	b	-	b	-	a	-	a	-	a
26.	*Clarias batrachus*	c	-	c	-	c	-	b	-	b	-	b	-
27.	*C. gariepinus**	b	-	b	-	b	-	b	-	a	-	a	-
28.	*Xenentodon cancila*	b	b	b	b	b	b	b	b	a	a	a	a
29.	*Channa orientalis*	c	b	c	c	b	c	b	b	b	b	b	b
30.	*C. punctatus*	c	c	c	c	b	c	b	b	b	b	b	b
31.	*Oreochromis niloticus**	b	d	b	d	b	d	b	d	b	d	b	d
32.	*Mastacembelus armatus*	b	c	b	c	b	b	b	b	a	b	a	b

Occurrence rank and sites:

(-) = absent, a = very low occurrence, b = low occurrence, c = moderate occurrence, d = high occurrence, Ph = Phewa, Be = Begnas

Table 3. Monthly occurrence of fishes in lakes Rupa, Dipang and Maidi

S.N.	Fish Species	Months																	
		Sep.			Oct.			Nov.			Dec.			Jan.			Feb.		
		Ru	Di	Ma	Ru	Di	Ma	Ru	Di	Ma	Ru	Di	Ma	Ru	Di	Ma	Ru	Di	Ma
1.	***Neolissocheilus hexagonolepis***	b	b	-	b	b	-	b	b	-	a	a	-	a	a	-	a	a	-
2.	*Chagunius chagunio*	b	b	-	b	b	-	a	b	-	a	a	-	-	a	-	-	a	-
3.	*Puntius sophore*	c	c	c	c	c	-	c	c	-	c	c	-	c	c	-	c	c	-
4.	*P. sarana*	a	a	-	a	a	c	a	-	c	-	-	c	-	-	c	-	-	c
5.	*P. chola*	b	a	-	b	a	-	b	a	-	a	a	-	a	-	-	a	-	-
6.	*P. conchonius*	b	c	c	b	c	c	b	c	c	b	b	b	b	b	b	b	b	b
7.	*Tor putitora*	b	b	-	b	a	-	b	a	-	a	-	-	a	-	-	a	-	-
8.	*Naziritor chelynoides*	b	-	-	b	-	-	b	-	-	b	-	-	a	-	-	a	-	-
9.	*Labeo rohita*	-	-	-	-	-	-	-	b	-	-	a	-	a	a	-	a	a	-
10.	*L. angra*	-	-	-	-	-	-	-	b	-	-	a	-	a	a	-	a	a	-
11.	*Cirrhinus mrigala*	b	b	-	b	b	-	b	b	-	a	b	-	b	b	-	b	b	-
12.	*Catla catla*	c	b	-	c	b	-	d	c	-	d	c	-	d	c	-	d	c	-
13.	*Ctenopharyngodon idella**	c	c	-	b	c	-	b	b	-	b	b	-	b	b	-	b	b	-
14.	*Cyprinus carpio* var. *communis**	b	b	-	b	b	-	b	b	-	b	b	-	b	b	-	b	b	-
15.	*C. carpio* var. *specularis**	b	b	-	b	b	-	b	b	-	b	B	-	b	b	-	b	b	-
16.	***Hypophthalmichthyes molitrix****	c	c	-	d	c	-	d	c	-	b	c	-	d	c	-	d	c	-
17.	*Aristichthyes nobilis**	c	c	-	d	d	-	d	d	-	d	d	-	d	d	-	d	d	-
18.	*Barilius bendelisis*	b	b	b	b	b	b	b	b	b	c	c	c	c	c	c	c	c	c
19.	*B. vagra*	b	b	b	b	b	b	b	b	b	b	b	a	c	c	a	c	c	a
20.	*B. barna*	b	-	-	b	-	-	b	-	-	b	-	-	c	-	-	c	-	-
21.	*Danio devario*	b	-	-	b	-	-	b	-	-	c	-	-	c	-	-	c	-	-
22.	*Esomus danricus*	-	-	-	-	-	-	-	-	-	a	-	-	a	-	-	a	-	-
23.	*Mystus bleekeri*	b	b	-	b	b	-	b	b	-	b	b	-	a	a	-	a	a	-

24.	*Clarias gariepinus**	b	b	-	b	b	-	b	b	-	b	a	-	a	a	-	a	a	-
25.	*Heteropneustes fossilis*	b	b	-	b	b	-	b	b	-	a	a	-	a	a	-	a	a	-
26.	*Xenentodon cancila*	c	b	a	b	b	a	b	b	a	b	b	-	a	a	-	a	a	-
27.	*Channa orientalis*	c	c	b	c	c	b	c	b	b	b	b	a	a	b	a	a	b	a
28.	*C. punctatus*	c	c	b	c	c	b	c	b	a	b	b	a	a	b	a	a	b	a
29.	*Oreochromis niloticus**	b	c	-	b	c	-	c	b	-	b	b	-	b	b	-	b	b	-
30.	*Mastacembelus armatus*	c	b	b	c	b	b	c	b	b	d	b	a	b	a	a	b	a	a

Occurrence rank and sites:

(-) = absent, a = very low occurrence, b = low occurrence, c = moderate occurrence, d = high occurrence, Ru = Rupa, Di = Dipang, Ma = Maidi

Human activities and conservation of aquatic bioresources

Protection of habitat is the most important aspect to protect the biodiversity in any ecosystem. The natural healthy abiotic condition in the waterbodies is essential for the conservation and protection of the existing fish diversity along with other aquatic bioresources. Various human activities such as direct disposal of domestic sewage, unscientific agricultural practices, construction of roads and buildings, deforestation, soil erosion etc. near and around the lakes were mainly responsible for the degradation of the aquatic habitat of lakes. The encroachment of the shoreline for agricultural practice, waste disposal, animal grazing, construction of dams without fish-ladder or fish-passes, improper fishing practices etc. were creating threats to aquatic ecosystem. The introduction of alien species for higher production is one of the major cause for decrease in productivity of the indigenous species which may lead to remarkable decline in abundance and species richness in the future.

DISCUSSION

Ferrow and Badgami (1980) mentioned 22 species of fishes from lakes in Pokhara Valley including *Tor, Neolissocheilus, Puntius, Chagunius, Barilius* etc. John and Dhewajoo (1989) reported fishes from Begnas lake including *Tor, Neolissocheilus, Chagunius,* etc. Poudel (1998) observed five species of fishes from lake Satrahazar in Chitwan district including *Puntius sophore, Danio devario, Chagunius chagunio, Barilius bendelisis* and noted *Puntius sophore* as dominant species constituting 41.50% of total fish catch. Pokharel (1999a) reported 25 species from different lakes viz., Phewa, Begnas, Rupa, Dipang, Maidi, Khaste, Gunde, Neureni and Kamal Pokhari including one endangered (EN) species Sahar (*Tor tor*), four vulnerable species, Sahar (*Tor putitora*), Katle (*Neolissocheilus hexagonolepis*), Rewa (*Chagunius chagunio*) and Zebra Fish (*Brachydanio rerio*). Bista *et al.* (2003) recorded 23 species including the important game fish Sahar (*Tor putitora*) and Katle (*Neolissocheilus hexagonolepis*), from Lake Rupa. In the present study, 34 species of fishes were recorded from the major five lakes including one endangered (EN) species Sahar (Tor tor), four vulnerable (VU) species viz., Sahar (*Tor putitora*), Katle (*Neolissocheilus hexagonolepis*), Rewa (*Chagunius chagunio*) and Zebra fish (*Brachydanio rerio*) .

Swar and Shrestha (1997) observed that "in the last few decades, inland waters have been subjected to a range of stress caused by direct and indirect human activities such as irrigation, hydroelectric projects, urbanization, industrialization, modernization of agriculture and changes in land use in the river floodplains, thus created adverse effects on aquatic

biodiversity especially the native fish fauna. The direct disposal of sewage, mixing of chemical fertilizer and pesticides from nearby agriculture field and deposition of silt due to landslide, soil erosion etc. deteriorate the water quality due to their lethal effects, which kill organisms, have drastic impact on discharge and morphology, increase organic load having high oxygen demand reducing the oxygen supply also reduces the abundance and species richness due to pressure upon food organisms available (Gratwick *et al.,* 2003). Construction of dams were found to cause habitat degradation with adverse effects on biota, as well as alteration in ecology and preventing the migration of fishes which move upstream and downstream for various purposes including breeding, create habitat damage below the dams with alteration in stream flow regime (Bernacseck, 2000; Menon *et al.,* 2000; Pokharel, 2010a).

During the study period the lentic water bodies in Pokhara Valley were found influenced by similar human activities such as deforestation causing landslide, soil erosion and siltation, direct disposal of domestic sewage, washing of agricultural pesticides and fertilizers etc. which probably altered the aquatic habitat and status of the fish diversity.

CONCLUSION

The increasing anthropogenic activities on the water bodies and their surroundings are mainly responsible for the degraded condition of the aquatic habitat and declining bioresources. Deforestation, landslide, soil erosion, direct disposal of waste, mixing of chemical fertilizer and pesticides from the adjoining agricultural fields, construction of dams obstructing free movement of the fishes etc. were observed as threats for the longevity of the lakes along with diversity and abundance of the fishes. An integrated development plan should be designed for the aquatic habitat management alongwith the watershed area which in turn can play an effective role for management of lakes and of their bioresources.

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