Shimshal Pamir Lakes: a prospective high altitude wetlands site for transboundary collaboration between China and Pakistan

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K E Y W O R D S

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A B S T R A C T

Gilgit-Baltistan mountainous area of Pakistan is home to a number of alpine wetlands including Shimshal Pamir Lakes. Two weeks long expedition focused on studying vegetation, birds, small and large mammals, herps and water quality parameters. Results revealed that Shimshal Pamir Lakes area fall into extreme alpine zone with no woody vegetation. A total of 58 plant species (mostly grasses); 48 birds; five large mammals; eight small mammals and four reptilian species were recorded during the study. Values for water quality parameters i.e., pH, temperature, Electrical Conductivity and Total Dissolved Solids were within permissible limits of National Environmental Quality Standards. However, Dissolved Oxygen values were slightly lower than normal and microbial growth was much higher in the lakes and their outlets. Shimshal Pamir Wetlands, their adjacent peatlands, streams, rivers and lakes contain rare and unique biodiversity common to China and Pakistan. A comprehensive transboundary conservation strategy is needed to conserve fast vanishing resources side by side offering economic opportunities to the pastoral communities of Pamir border region.

Introduction

Wetlands are the "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" as defined by Ramsar Convention (1971). World's lakes and rivers constituting about 2.5% of the earth's water are perhaps the planet's most important freshwater resources that form the habitat of the large number of species, representing a substantial sector of the Earth's biological diversity (UNEP, 1994). Approximately 50% of the world's wetlands have been lost in the past one century due to rapid urbanisation, drainage for agriculture, and inefficient water system regulation (Shine & de Klemm, 1999).

Despite the generally arid nature of Pakistan's climate, the region supports an estimated 78,000km^2 of wetlands representing 225 significant wetlands inclusive of the nineteen sites being recognised internationally (Ali, 2005). These areas are crucial for maintaining healthy bird populations. A number of migratory birds use these sites for staging and breeding (summer breeders) during their migration, particularly waterfowl densities and their propagation is related with the number of wetlands (Bellrose, 1977). Almost 20 threatened species of mammals, 25 birds, six reptiles, one amphibian and 198 freshwater fishes of substantial economic importance are either wetlands dependent or associated with wetlands in Pakistan (Khurshid, 2000; BirdLife, 2004). Of the 75 endangered or threatened animals, 43 are totally wetland dependent including nine bird species (Ali, 2005). About one-third of bird species use wetlands for food, shelter, and (or) breeding (Ali 2005), however, the birds that visit or breed in poorer quality habitats will not contribute to a sustainable population through the years (Pulliam & Danielson, 1991).

There is an influx of winter visitor birds from northern breeding grounds, or summer breeding visitors both from the northern mountain regions and from the Indus Plains, to more warmer southern latitudes (Ali, 2005). Of the total Pakistan's bird species, 30% visit the country for a significant period of the year as long distance migrants, 43% are either Palearctic species visiting Pakistan only for breeding and 28% are regular winter visitors, which breed extra-limitally and mainly in trans-Himalayan northern regions (Ali, 2005; Roberts, 1992). Siberian Crane *Grus leucogeranus,* Sarus Crane *Grus antigone,* Dalmatian Pelican *Pelicanus crispus*, Ferruginous Duck *Aythya nyroca,* White-headed Duck *Oxyura leucocephala,* Marbled Teal *Marmaronetta angustirostris,* Sociable Plover *Vanellus gregarius,* Jerdon's Moupinia or Sindh Babbler *Chrysomma altirostre,* Lesser White-fronted Goose *Anser erythropus,* Long-tailed Grass Warbler *Prinia burnesii, and* Pallas's Fish Eagle *Haliaeetus leucoryphus* need immediate actions for conservation (Khurshid, 2000).

However, it is clear that birds do not follow rigidly defined paths and may travel over very broadly extended areas, in some cases, even to hundreds of miles. Individuals from the breeding population of a species, from the same locality may follow widely different migration routes and winter in quite separate regions, and vice versa (Moreau, 1972; Baker, 1980). Quite a large number of migratory water birds fly over the Indus Flyway and use adjacent high altitude lakes, streams, marshlands, peatlands and bogs as temporary and permanent staging, feeding and breeding grounds. The insect life and vegetation cover becomes abundant after the monsoon in these areas and so offer rich feeding conditions to the wintering birds. The common wetland birds that visit Pakistan include grebes (Podicipedidae), ducks and geese (Anseriformes), storks (Ciconiiformes), pelicans and cormorants (Pelecaniformes), herons (Ardeidae), spoonbills (Threskiornithidae), rails and crakes (Rallidae), cranes and bustards (Gruiformes), gulls (Laridae), waders (Calidridinae) and plovers (Charadridae). Utter, Hundrab, and Shandoor lakes harbour around 230 species of birds - one of the most diverse populations in mountain regions of the world. Rare species like Lammergeyer (*Gypaetus barbatus*) and Golden Eagle (*Aquila chrysaetos*) live and breed here while Demoiselle Crane (*Grus virgo*) use these wetlands for wintering, staging and feeding grounds (WWF, 2011).

Shimshal Pamir Lakes are naturally formed by the accumulation of glacial melt water, flowing into the lakes through seasonal and perennial streams and springs harbour a variety of endangered

wildlife species including Snow Leopard (*Uncia uncia*), Blue sheep (*Pseudois nayaur*), Brown Bear (*Ursus arctos*), Tibetan Wild Ass (*Equus kiang*) and Marco Polo Sheep (*Ovis ammon polii*), some of which are endemic to Karakoram mountain region. It, being a part of the famous Indus Flyway, provides nesting and staging grounds to a number of migratory birds and waterfowls. Grey Heron (*Ardea cinerea*), Northern Shoveler (*Anas clypeata*), Common Teal (*Anas crecca*), Northern Pintail (*Anas acuta*), Mallard (*Anas platyrhynchos*), Marbled Teal (*Marmaronetta angustirostris*) and Coot (*Fulica atra*) are amongst the key avifauna species of the area. Unfortunately, people living in the Pamir and adjacent areas are poor, and so depend mostly on available natural resources for food, fodder, fuel, water, shelter and thus degrade the peculiar mountain ecosystems and their associated biodiversity. Shimshal Pamir Lakes, despite having immense potential for trans-border cooperation between China and Pakistan, which have never been studied before to explore their biotic resources.

This study was, therefore, conducted as part of the Sino-Pak transboundary cooperation for conservation and sustainable development in Pamir border region to document wetland related biota of the Shimshal Pamir Lakes and explore their potential and opportunities for future collaborative conservation of key species, habitats and high altitude ecosystems in the border region between China and Pakistan.

Methods

Study area

The Gilgit-Baltistan region of Pakistan comprises an intricate system of mountain ranges, i.e. Himalayas, Hindukush and Karakoram, conjoining heads at Pamir Knot and giving birth to several valleys on their way both up and downstream the Indus River (Baig, 2001). Shimshal-Pamir is a part of Khunjerab National Park spreading over an area of 4,455.06 km^2 in the extreme north of Pakistan, along Pakistan-China border. It was designated as National Park by the Government of Gilgit-Baltistan in 1975 to protect Marco Polo Sheep (*Ovis ammon polii*) in its natural habitat (Khan, 1996). Starting right from Shimshal village, the study area extends approximately 50 km into the mountainous valley, covering different habitat types ranging from 3,078 m to 4,731 m asl at Shimshal-Pamir Lake, and then borders with China (Fig. 1).

The Shimshal-Pamir Lake, locally called *Shuvorth*, covers an area of 32 km^2 at an elevation of 4,755 m asl in the extreme north of Pakistan, along the southern border of Xinjiang, China and situated about 40 km to the northwest of Shimshal village. Sherlik is the last valley from Pakistan side, whereas Tagdumbash, Bazaar and Raskam are the three villages bordering Chinese side (Ali & Khan, 2007). Three major streams originate from Sherlik valley watersheds, flowing down the Furzeen, Mustag and Obrang Nullahs on Pakistani territory, and merge into one stream near Sherblock post before entering China. Furzin Nullah originates from Varow Shimshal pass glacier, which feeds the Shimshal Pamir Lakes and also provides water to a number of seasonal and perennial streams, peatlands, lakes and agricultural fields on the other side of the border. Lakes, peatlands and streams on both sides of the Pakistan-China border provide important habitats, staging and breeding places to a number of migratory birds and waterfowls (Ali & Khan, 2007).

Figure 1: Map of the study area (Shimshal Pamir Lakes and adjacent wetlands in Karakoram Pamir border region)

Shimshal comprises of four main villages, i.e. Farmanabad, Aminabad, Khizerabad and proper Shimshal village, having a total population of 2,500 living in 300 households. People have an agro-pastoral life pattern, subsistence farming and livestock herding being their primary sources of livelihood. A small proportion of youth are engaged in seasonal tourism activities (Ali & Khan, 2007).

On average, the area receives 11 mm of rainfall monthly and western monsoon seldom crosses the high mountains of Karakoram Range, usually staying afar. Harsh climate prevails with severe cold winters below freezing temperature from October onward, but pleasant sunny days appear with temperature ascending up to 25°C after April till the peak summer season (IUCN, 2003).

Data Collection

i). Vegetation

Stratified random quadrate method was used for vegetation assessment (Kent & Coker, 1992). Five quadrates (1 m^2) were laid at 10m interval in each stratum wherein number of individuals of each species was counted and their basal area measured. Habit, habitat, life form, distribution patterns and altitudinal range were determined for each species and different attributes like Relative Frequency (RF), Relative Density (RD), Relative Cover (RC) and Importance Value (IV) were calculated thereof. Plant samples for each species were photographed, collected, labelled and stored in Karachi University herbarium. Collected specimen were more precisely identified with the help of keys from the Flora of Pakistan (Nasir & Ali, 1970-1989; Ali & Nasir, 1989-1991; Ali & Qaiser, 1993-2007). Fresh and air dried weights of the clipped material from each quadrate was used to calculate biomass productivity and grazing pressure on the peripheral grasslands.

ii). Birds

Birds were carefully observed in all the potential habitats at dawn and dusk. Majority of the birds were identified without using binoculars but a few were identified after keenly observing with binoculars (10 x 40) and consulting reference materials (Roberts, 1992). However, basic information concerning colour, size, habits and habitat were recorded for those which could not be identified in the field, and their photographs were taken from different angles to facilitate their identification later. Conservation status of the recorded birds was determined using IUCN Red List 2001 and the relative abundance was calculated using number of individuals in each species and the total number encountered during the study (R.A = n / N).

iii). Large Mammals

Large mammals were surveyed using direct and indirect counting methods i.e., fixed point surveys, track counts, pellet counts and interviews with local residents. Surveys were held mostly early in the morning and late in the afternoon, when wild herbivores were active for grazing or drinking whereas the signs of presence i.e., animal pellets were also gathered during the day time. When observed, location, number, sex and age classes were determined

and recorded. An index of density (ID) of the number of pellet groups per unit area was then determined following ID = n / A, where n is the sum of pellet groups counted over all plots and A is the total area sampled during the study, not to estimate populations rather to locate different ungulates (Brower *et al.,* 1990).

iv). Small mammals

Small mammals like marmots and pikas were directly observed during the day time whereas nocturnal small mammals were observed either using Spot Lighting Method or Folding Sherman Traps. Traps were often set in the evening and observed early in the morning. Different trapped animals were released after their identification and recording necessary morphological data (Wilson and Reeder, 1992, 2005).

v). Reptiles

Reptiles were observed during the day time (10:00–15:00 hrs) when it was hot enough and lizards were active, basking or feeding (Heyer *et al*., 1994). Lizards were located mostly by turning stones, looking at and through bushes, and walking along dry stream beds. Fast moving agamas were manually captured by striking stones and beating sage bushes with a stick. Some were also pulled out of crevices, holes and from beneath the rocks and bushes using long metal forceps. Collected specimens were killed and preserved by injecting 10% formalin solution into belly, neck, legs and tail and tagged with field information. After necessary morphological recording, collected specimens were preserved in the Zoological Survey Department, Karachi for future study, reference and record (Khan, 2006; Baig, 2008).

vi). Water Quality

Water quality was investigated using on-spot as well as lab analysis. Samples were collected using manual sampling procedures following standard methods for examination of water by American Public Health Association (APHA). Extreme care was taken during the sampling and collected samples were on-site tested for some of the parameters i.e., surface water temperature, pH, DO and electrical conductivity while for other parameters, water samples were collected in sterilised water bottles and preserved by adding nitric acid for lab analysis.

Data Analysis

The state of the art equipment Hydrolab MS-5 was also used for on-site water quality assessment for a number of parameters including surface temperature, pH, conductivity, salinity, Total Dissolved Solids (TDS) and Dissolved Oxygen (DO). Results of the surface water quality were compared with the National Environmental Quality Standards (NEQS), US Environmental Protection Agency (US EPA) and WHO standards where applicable and/or available. Moreover, results concerning animals, plants and birds were analysed using MS Excel 2007 for simple calculations, graphs and tabulation (McCullough & Heiser, 2008).

Results

i). Vegetation

Shimshal Pamir Lakes ecologically represent a typical extreme Alpine Zone with no woody vegetation except sparsely scattered growth of few prostrate shrubs i.e., *Potentilla dryadenthoides* and *Sibbaldia tetrandra*. The week long field study ended with a record of 58 plant species belonging to 36 genera and 21 families. Asteraceae with nine species was the largest family (15.79%) followed by Brassicaceae having seven species (12.28%) of the total. Rest of the families seldom exceeded five species each. Haemicrytophytes representing 54 species (93.1%) was dominant among the floral life-forms followed by Chaemiphytes with 3 species (5.26 %) and Geophytes (1.76%). Almost 92% of the plants were perennial herbs (54 species) while only one prostrate shrub was recorded from the study area (Fig. 2).

Three plant communities were recognised in the project area, including Feldmark, small herb field and the fen community. The Feldmark community was found just below the permanent snowline, where snow melts for a short period and on the dry stony slopes. Vegetation of this community is sparse and most

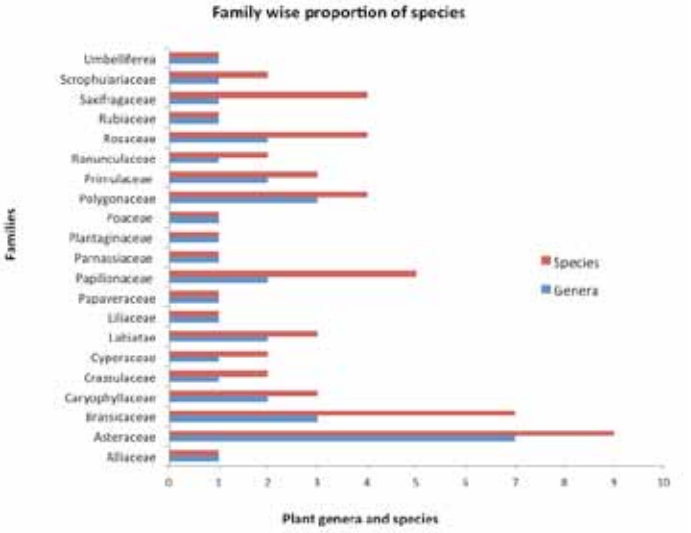

Figure 2: Family-wise proportion of plant species in the study area

of the species adapt to ecological changes withstanding intensive solar radiation and prevailing chilling temperatures. Characteristic species of the community are *Saussurea simpsoniana*, *Allardia glabra*, *Christolea crassifolia*, *Primula macrophylla moorcroftiana*, *Oxytropis macrophylla*, *Oxytropis chiliophylla*, *Potentilla pamirica pamiroalorica*. The small herb field community occurred below the late-lying snow patches perhaps due to higher availability of moisture in the form of ice melting. Vegetation in this region is dense compared to the late-lying snow patches. Characteristic species were *Aster flaccidus*, *Saxifraga hirculis alpine*, *Saxifraga oppositifolia asiatica*, *Allium carolinianum, Silene kunawarensis* and *Lioydia serotina*. Fen community was observed in the lower reaches where depressions were common with water standing for almost half of the year. *Carex stenocarpa* and *Carex psychrophilla* were the dominant whereas *Pedicularis alba* and *Pedicularis oedorei* were infrequent species of this community.

Phyto-sociologically, *Carex stenophylla* was the most dominant species with the highest IVI value (101.007) followed by *Carex psychrophilla* and *Astragalus saratagius* having 39.6254 and 8.7635 values, respectively. Value of IVI ranged between 23.6982 and 8.2423 in the remaining taxa (Table 1).

Average forage productivity of the pastures was calculated to be 66.75 kg ha^{-1} and the total forage productivity was estimated around 694,200 kg, which could hardly support a total of 715 yaks for a maximum of six months. Contrary to available total forage productivity, there were more than 5,000 yaks being grazed in addition to 2000 goats, 2000 sheep and about 500 cows at the time of survey, which all together exert tremendous grazing pressure on the peripheral grazing lands, and consequently, the catchment area of the lakes has been alarmingly degraded.

ii). Avifauna

Eight prominent locations viz., Shimshal village, Garee Sar, Pust Furzeen, Ooch Furzeen, Arbab Pureen, Shujerab Pass, Gulchin Wash Top and Shimshal Lake, representing characteristic bird

Table 1: Phyto-sociological values (IVI) for species abundance

Name of Species	D3	F3	C3	IVI
Carex stenophylla	29.46	17.02	54.528401	101.007
Carex psychrophilla	19.38	12.77	7.4795986	39.6254
Potentilla pamirica	7.752	10.64	0.7975875	19.1878
Astragalus saratagius	15.5	14.89	8.3659637	38.7635
Ranunculus pulchellus	3.101	4.255	0.8862084	8.2423
Oxytropis chiliophylla	9.302	10.64	3.7575783	23.6982
Sibbaldia tetrandra	3.101	6.383	11.077605	20.5614
Pedicularis oederi	4.651	8.511	4.3070044	17.4688
Pleurospermum stellatum	3.876	6.383	1.1077654	11.3667
Leontopodium leontopodinum	2.326	4.255	2.1534863	8.73439
Primula schlagintweitiana	1.55	4.255	5.5388023	11.3445

habitats were surveyed during the study. A total of 1,069 birds belonging to 48 species, nine orders and 24 families were recorded from the project sites. Out of the total, 20 were resident, 2 were winter visitors, 21 were summer breeders and 2 were passage migrants or year-round visitors to the study area. Description of three birds is unknown as these were recorded for the first time from the study area whereas according to the IUCN Red Data List 2010, most of the species fall in the Least Concern category. The relative abundance results showed House sparrow (*Passer domesticus*) as the most common bird and Lammergeyer (*Gypaetus barbatus*) as the least common bird species in the area. RA values for the rest of bird species remained between 0.0018 and 0.1281 (Table 2).

Almost nine bird species were recorded for the first time from the study area that include Desert Wheatear, Plain Mountain Finch, Masked Wagtail, Brown Dipper, Eurasian Chiffchaff, Tibetan Lark, White-cheeked Bulbul, Common Moorhen and Indian Tree Pipit (Table 3).

Occurrence of the above mentioned birds particularly that of Tibetan Lark (*Melanocorypha maxima*) in Shimshal valley constitute a fresh avian record, extending its distribution range further into the northern Karakoram mountain range.

iii). Large mammals

Spending about two weeks in the field (July 12 to 27, 2010) and applying all the possible direct and indirect observation methods, five mammalian species (Snow Leopard, Indian Wolf, Common Red Fox, Himalayan Ibex and Blue Sheep), belonging to two orders, three families and five genera were recorded from the study area (Table 4).

According to the IUCN Red List of Threatened Species, Snow Leopard is Endangered (E) whereas rests of the four species are categorised as Least Concern (IUCN, 2012). However, in Pakistan, Snow Leopard is Critically Endangered, Wolf and Blue Sheep are Endangered, Red Fox is Near Threatened and Himalayan Ibex is Least Concern (Sheikh and Molur, 2005). According to local respondents, population of Snow Leopard and Wolf had increased during the past two decades apparently due to increasing number of its wild prey in the area but livestock predation, particularly yaks killing, by Snow Leopard and Wolf is an emerging livelihood concern of the local people.

iv). Small mammals

Survey results revealed eight small mammal species including Cape Hare, Royle's or Indian Pika, Long-tailed Marmot, Chinese Birch Mouse, House Mouse, High Mountain Vole, Pamir Vole and Migratory or Gray Hamster belonging to two orders, five families and eight genera in the study area. All the recorded small mammals were observed directly either in the field during day time or after being trapped. However, tracks and droppings of Cape Hare, burrows of Chinese Birch Mouse and House Mouse and droppings of Royle's Pika were also observed in the study area (Table 5).

The Royle's Mountain Vole is categorised as Near Threatened (NT) species in the IUCN Red List of Threatened Species (IUCN, 2012) with a decreasing population trend while rests of the seven

Table 2: Migratory and resident birds of Shimshal Pamir and their relative abundance

#	Common Name	Zoological Name	Family	Order	Description (Grimmett, 2008)	Status (IUCN Red List 2008)	Number Observed	Relative Abundance
1	Black Redstart	*Phoenicurus ochruros*	Muscicapidae	Passeriformes	Summer breeder	Least Concern	6	0.0056
2	White Capped Redstart	*Chaimorrornis leucocephalus*	Muscicapidae	Passeriformes	Summer Breeder	Least Concern	8	0.0074
3	Blue Whistling Thrush	*Myophonus caeruleus*	Muscicapidae	Passeriformes	Summer Breeder	Least Concern	7	0.0065
4	Blue Rock Thrush	*Monticola solitarius*	Muscicapidae	Passeriformes	Summer Breeder	Least Concern	5	0.0046
5	Desert Wheatear	*Oenanthe deserti*	Muscicapidae	Passeriformes	Wintering	Least Concern	22	0.0205
6	White Winged Redstart	*Phoenicurus erythrogaster*	Muscicapidae	Passeriformes	Summer Breeder	Least Concern	7	0.0065
7	Common Rose Finch	*Carpodacus erythrinus*	Fringillidae	Passeriformes	Summer Breeder	Least Concern	63	0.0589
8	Fire Fronted Serin	*Serinus pusillus*	Fringillidae	Passeriformes	Resident	Least Concern	112	0.1047

#	Common Name	Zoological Name	Family	Order	Description (Grimmett, 2008)	Status (IUCN Red List 2008)	Number Observed	Relative Abundance
9	Great Rose Finch	*Carpodacus rubicilla*	Fringillidae	Passeriformes	Resident	Least Concern	17	0.0159
10	Plain Mountain Finch	*Leucosticte nemoricola*	Fringillidae	Passeriformes	Resident	Least Concern	14	0.013
11	Grey Wagtail	*Motacilla cinerea*	Motacillidae	Passeriformes	Summer Breeder	Least Concern	37	0.0346
12	Masked Wagtail	*Motacilla alba personata*	Motacillidae	Passeriformes	Summer Breeder	Least Concern	15	0.014
13	Citrine Wagtail	*Motacilla citreola*	Motacillidae	Passeriformes	Summer Breeder	Least Concern	32	0.0299
14	White Wagtail	*Motcilla alba*	Motacillidae	Passeriformes	Summer Breeder	Least Concern	52	0.0486
15	Red Billed Chough	*Pyrrhocorax pyrrhocorax*	Corvidae	Passeriformes	Resident	Least Concern	17	0.0159
16	Yellow Billed Chough	*Pyrrhocorax graculus*	Corvidae	Passeriformes	Resident	Least Concern	34	0.0318
17	Raven	*Corvus corax*	Corvidae	Passeriformes	Resident	Least Concern	6	0.0056
18	Golden Oriole	*Oriolus oriolus*	Oriolidae	Passeriformes	Summer Breeder	Least Concern	7	0.0065
19	Lesser Whitethroat	*Sylvia curruca*	Sylviidae	Passeriformes	Summer Breeder	Least Concern	46	0.043
20	Brown Dipper	*Cinclus pallasii*	Cinclidae	Passeriformes	Resident	Least Concern	5	0.0046
21	Eurasian Chiffchaff	*Phylloscopus collybita*	Phylloscopidae	Passeriformes	Wintering	Least Concern	17	0.0159
22	Greenish Warbler	*Phylloscopus trochiloides*	Phylloscopidae	Passeriformes	Summer Breeder	Least Concern	11	0.0102
23	Horned Lark	*Eremophila alpestris*	Alaudidae	Passeriformes	Resident	Least Concern	24	0.0224
24	Tibetan Lark	*Melanocorypha maxima*	Alaudidae	Passeriformes	Summer Breeder	Least Concern	5	0.0046
25	House Sparrow	*Passer domesticus*	Passeridae	Passeriformes	Summer Breeder	Least Concern	137	0.1281
26	Rock Bunting	*Emberiza cia*	Emberizidae	Passeriformes	Summer Breeder	Least Concern	37	0.0346
27	Wall Creeper	*Tichodroma muraria*	Sittidae	Passeriformes	Resident	Least Concern	2	0.0018
28	Brown Accentor	*Prunella fulvescens*	Prunellidae	Passeriformes	Resident	Least Concern	16	0.0149
29	Long-tailed Shrike	*Lanius schach*	Laniidae	Passeriformes	Summer Breeder	Least Concern	8	0.0074
30	Himalayan Bulbul	*Pycnonotus leucogenys*	Pycnonotidae	Passeriformes	Resident	Least Concern	16	0.0149
31	Lammergeier	*Gypaetus barbatus*	Accipitridae	Falconiformes	Resident	Least Concern	2	0.0018
32	Himalayan Griffon Vulture	*Gyps himalayensis*	Accipitridae	Falconiformes	Resident	Least Concern	3	0.0028
33	Eurasian Sparrow Hawk	*Accipter nisus*	Accipitridae	Falconiformes	Summer Breeder	Least Concern	5	0.0046
34	Common Kestrel	*Falco tinnunculus*	Falconidae	Falconiformes	Resident	Least Concern	7	0.0065
35	Chukar Partridge	*Alectoris chukar*	Phasianidae	Galliformes	Resident	Least Concern	16	0.0149
36	Himalayan Snow cock	*Tetraogallus himalayensis*	Phasianidae	Galliformes	Resident	Least Concern	21	0.0196
37	Snow Pigeon	*Columba leuconota*	Columbidae	Columbiformes	Resident	Least Concern	41	0.0383
38	European Turtle Dove	*Streptopelia turtur*	Columbidae	Columbiformes	Passage migrant	Least Concern	7	0.0065
39	Golden Eagle	*Aquila chrysaetos*	Accipitridae	Accipitriformes	Resident	Least Concern	3	0.0028
40	Common Sandpiper	*Actitis hypoleucos*	Scolopacidae	Charadriiformes	Summer Breeder	Least Concern	15	0.014
41	Little Stint	*Calidris minuta*	Scolopacidae	Charadriiformes	Passage migrant	Least Concern	47	0.0439
42	Eurasian Cuckoo	*Cuculus canorus*	Cuculidae	Cucliformes	Summer Breeder	Least Concern	33	0.0308
43	Hoopoe	*Upupa epops*	Upupidae	Coraciiformes	Summer Breeder	Least Concern	14	0.013
44	Common Moorhen	*Gallinula chloropus*	Rallidae	Gruiformes	Resident	Least Concern	5	0.0046
45	Black Billed Magpie	*Pica pica*	Corvidae	Passeriformes	Resident	Least Concern	8	0.0074
46	Bluethroat	*Luscinia svecica*	Muscicapidae	Passeriformes	Summer Breeder	Least Concern	6	0.0056
47	Brandt's Mountain Finch	*Leucosticte brendti*	Fringillidae	Passeriformes	Resident	Least Concern	44	0.0411
48	Indian Tree Pipit or Olive-backed Pipit	*Anthus hodgsoni*	Motacillidae	Passeriformes	Unknown	Least Concern	12	0.0112

Table 3: Birds recorded for the first time from Shimshal Pamir area

#	Common Name	Zoological Name	Location
1	Desert Wheatear	*Oenanthe deserti*	Garee Sar
2	Plain Mountain Finch	*Leucosticte nemoricola*	Ooch Furzeen
3	Masked Wagtail	*Motacilla alba personata*	Near Shujerab Pass
4	Brown Dipper	*Cinclus pallasii*	Near Shimshal village
5	Eurasian Chiffchaff	*Phylloscopus collybita*	Near Shimshal village
6	Tibetan Lark	*Melanocorypha maxima*	Gulchin Wash Top, Shujerab Pass
7	Himalayan Bulbul	*Pycnonotus leucogenys*	Near Shimshal village
8	Common Moorhen	*Gallinula chloropus*	Near Shimshal village
9	Indian Tree Pipit or Olive backed Pipit	*Anthus hodgsoni*	Near Shimshal village

Table 4: Large mammals of Shimshal Pamir area

Species observed	Direct	Indirect				
		Pug marks	Body parts	Scent	Scats	Respondents
Uncia uncia	-	+	-	+	+	+
Canis lupus chanco	-	-	-	-	+	+
Vulpes vulpes montana	+	-	-	-	+	+
Capra ibex	+	-	+	-	-	+
Pseudois nayaur	+	-	+	-	-	+

species have been categorised as Least Concern (LC). Among these, Royle's or Indian Pika and House Mouse have a stable population; Cape Hare is decreasing whereas the population trend of Long-tailed or Kashmir Marmot, Chinese Birch Mouse, Pamir Vole and Gray or Migratory Hamster is unknown. According to the IUCN Red List of Pakistan Mammals (Sheikh and Molur, 2005), High Mountain Vole is Near Threatened (NT) whereas, rest of the seven species have been categorised as Least Concern (LC). None of the recorded species are protected in Gilgit-Baltistan under Northern Areas Wildlife Preservation Act 1975 except Cape Hare, which is included in First Schedule. Long-tailed or Kashmir Marmot has been listed in the Appendix III of CITES.

Table 5: Small mammals of Shimshal Pamir area

English Name	Zoological Name	Order	Family	Status
Cape Hare	*Lepus capensis*	Lagomorpha	Leporidae	Less Common
Royle's or Indian Pika	*Ochotona roylei*	Lagomorpha	Ochotonidae	Less Common
Long Tailed Marmot	*Marmota caudata*	Rodentia	Pteromydidae	Common
Chinese Birch Mouse	*Sicista concolor*	Rodentia	Zapodidae	Less Common
House Mouse	*Mus musculus*	Rodentia	Muridae	Common
High Mountain Vole	*Alticola roylei*	Rodentia	Muridae	Near Threatened
Pamir Vole	*Microtus juldaschi*	Rodentia	Muridae	Less Common
Migratory/Grey Hamster	*Cricetulus migratorius*	Rodentia	Muridae	Less Common

v). Reptiles & amphibians

Fifteen specimens belonging to four species of Agamidae family viz., *Laudakia himalayana*, *Laudakia pakistanica*, *Laudakia tuberculata* and *Laudakia badakhshana*, were recorded from the study area (Table 6).

A careful review of literature with the collected specimen features showed the occurrence of *Laudakia himalayana*, *L. pakistanica*, *L. tuberculata* and *L. badakhshana* at 4,082 m, 4,172 m, 4,005 m and 4,240 m asl, respectively, never reported from such an altitude before. The terrain offers a variety of ecological barriers, in the form of fast and freezing running waters and massive glaciers with peculiar harsh climatic conditions prevailing for nine months of the year, which restricts species migration and thus increases endemism. Although one of the four species recorded from the study area, i.e. *L. pakistanica* is endemic to Pakistan, *L. tuberculata* and *L. badakhshana* are new records from Shimshal, Pakistan (Khan *et al.*, 2012).

vi). Water Quality

Water samples taken from several different locations of the lakes and their adjacent streams were tested for pH, surface temperature, electrical conductivity, salinity, total dissolved salts, dissolved oxygen and micro-organism. Results revealed that average pH

Table 6: Specimens of reptiles and amphibians collected from Shimshal Pamir area

#	Species Name	Sex	Location	Elevation (m)
1	*Laudakia himalayana*	M	N 36º 26' 27.6 E 75º 20' 01.2	3090
2	*Laudakia himalayana*	M	N 36º 26' 27.6 E 75º 20' 01.2	3090
3	*Laudakia himalayana*	M	N 36º 27' 40.2 E 75º 26' 47.0	3486
4	*Laudakia himalayana*	F	N 36º 27' 51.9 E 75º 28' 06.1	3703
5	*Laudakia himalayana*	F	N 36º 28' 10.4 E 75º 29' 28.2	4082
6	*Laudakia pakistanica*	M	N 36º 26' 27.6 E 75º 20' 01.2	3090
7	*Laudakia pakistanica*	M	N 36º 26' 27.6 E 75º 20' 01.2	3090
8	*Laudakia pakistanica*	M	N 36º 27' 40.2 E 75º 26' 47.0	3486
9	*Laudakia pakistanica*	F	N 36º 27' 51.9 E 75º 28' 06.1	3703
10	*Laudakia pakistanica*	F	N 36º 28' 10.4 E 75º 29' 28.2	4082
11	*Laudakia pakistanica*	M	N 36º 28' 19.7 E 75º 34' 53.2	4172
12	*Laudakia pakistanica*	F	N 36º 28' 19.7 E 75º 34' 53.2	4172
13	*Laudakia tuberculata*	M	N 36º 28' 25.5 E 75º 33' 21.0	4005
14	*Laudakia tuberculata*	M	N 36º 28' 23.2 E 75º 33' 07.1	3942
15	*Laudakia badakhshana*	M	N 36º 28' 04.1 E 75º 35' 44.4	4240

of the samples collected from the lake, its inlet and outlet streams ranged between 6.8 – 6.9, which means water is neither acidic (<7) nor alkaline (> 7), which is almost neutral. Similarly, surface water temperature at the time of survey ranged between 10.2°C to 10.3°C at various sampling locations. Electrical Conductivity values observed were slightly higher ranging between 216 µS cm^{-1} to 217 µS cm^{-1} in lake waters. Salinity recorded was around 0.1 ppt at all three sampling locations. A relatively lower concentration of TDS viz., 55 mgL^{-1}, 50 mgL^{-1} and 47 mgL^{-1} was recorded at south-eastern, centre and western proximities of the lakes. Almost all of the values were within permissible limits of the Pakistan NEQS (3500 mgL^{-1}) and US EPA (500 mgL^{-1}). However, the values of DO ranged between 4.4 mgL^{-1} and 4.6 mgL^{-1} for all the sampling sites, which being slightly lower than normal (4.0 – 4.6 mgL^{-1}) could have been stressful for fish species but there was no fish in Shimshal Pamir Lakes (Table 7).

Lab analysis of collected water samples for microbiological parameters including total colony count, total coliforms, faecal *E. coli* and faecal enterococci/streptococci were negative for the inlet points but it was positive in the lakes and their outlets, meaning lake water and its outflow had faecal contamination. As per WHO guidelines *(A = 0 E.coli; B=1-10 E.coli; C=11-100 E.coli and D=101-1000 E.coli per 100 ml)*, water at the inlet is somehow safe for drinking but water in the lake and its outlet streams has microbial contamination, so is not safe for drinking purposes.

Discussion

The Karakoram Pamir region has two adjoining Protected Areas located on either sides of the Pakistan - China border; Khunjerab National Park on the Pakistani side and the Taxkorgan Nature Reserve on the Chinese side of the border. The entire area maintains a similarity in its natural physiology, eco-characters and ethnic background of the people dwelling in the areas and their subsequent culture and socio-economic conditions. The endemic

Table 7: Surface water quality and Microbiological profile of Shimshal Pamir Lakes

#	Parameter	Units	Sampling Locations			Quality Standards	
			Inlet	Lake	Outlet	NEQS	USEPAQS
1	pH	mgL^{-1}	6.8	7	6.9	6.0 - 9.0	6.5 - 9.0
2	Temperature	°C	10.2	10.3	10.3	-	-
3	Electrical conductivity	µS cm^{-1}	216.2	214.8	217	-	-
4	Salinity	ppt	0.1	0.1	0.1	-	-
5	TDS	mgL^{-1}	50	52	47	3500	-
6	DO	mgL^{-1}	6.4	6.4	6.5	-	-
Source	**Sample code**	**Units**	**Vol filt 100 ml**	**No of colonies**	**F.C/100 ml**	**E. coli/ 100 ml**	**WHO Category**
Sample1	SP-	Cfu $100ml^{-1}$	100 ml	0.00	0.00	0.00	A
Sample2	SP-	Cfu $100ml^{-1}$	100 ml	1.00	1.00	1.00	B
Sample3	SP-	Cfu $100ml^{-1}$	100 ml	1.00	1.00	1.00	B

animals found in this stretch of land also roam around and across the border frequently. Even the effects of climate change are equal in its intensity on both mountain ecosystems and livelihoods of the people dependent on this area at large but until now none of the two countries have made any concerted efforts to bring the adjoining areas under collective management. The wildlife species and human communities are equally exposed to unprecedented changes crucial for long-term maintenance of globally significant biodiversity.

The Karakoram Pamir border region harbouring globally significant wildlife species i.e., Snow Leopard, Marco Polo Sheep and Blue Sheep represent one of the most important and unique wildlife areas in the mountains of Asia. Shimshal valley, the north-western part of Khunjerab National Park is known to have the western most population of Blue Sheep in its range (Wegge, 1988). Shimshal Pamir Lakes offer luxurious habitat to a number of migratory birds, especially waterfowls (Ali & Khan, 2007) and their reptilian fauna is also of high scientific interest and significance.

Although the two adjacent Protected Areas have flagship wildlife species in common and share wildlife habitats, watersheds and ecological flows across international borders but their growth has never been satisfactory for the last many years, mainly because of unregulated hunting, habitat destruction and restricted migration of wild animals across the border. Traditionally, Ibex, Blue Sheep and Marco Polo Sheep have been hunted to supplement the diet and to earn money for daily life needs. Pastures are over grazed by domestic livestock. Scattered and sparse vegetation is extracted for fuel and firewood. Predators, particularly Wolf and Snow Leopard, kill large numbers of livestock and are killed by farmers in retribution, and waterfowls are ruthlessly hunted for meat, feathers and sale.

The area is otherwise highly rich in endemic flora and fauna, freshwater ecosystems and their associated species, which if judiciously exploited and managed can bring an economic revolution for the resident pastoral communities of the border region. The future of the Shimshal Pamir wetlands in particular and the Karakoram Pamir border area in general depends largely on the current levels of anthropogenic, socio-economic and pastoral influences in the region. Poverty is common among communities on both sides of the border and subsistence agriculture and pastoralism will continue to be the major sources of livelihood for the local people. Thus future of the areas as viable reserves will depend on the willingness of people to coexist with wild animals and to prevent further deterioration of the critical habitats.

We therefore suggest to devise a multi-pronged trans-border joint conservation strategy encompassing science based species management, habitat improvement, and community based conservation programmes, with avenues for economic development and benefit sharing to restore and manage flagship species and birds, their habitats and peculiar mountain ecosystems, inclusive of High Altitude Wetlands in the Sino-Pak border region.

Conclusion

The Shimshal Pamir mountain area bordering China in the extreme north of Pakistan is known for its glaciers, snow capped peaks, high altitude lakes, alpine pastures and wildlife species of global significance. With two adjacent Protected Areas across international border, the region has defined connectivity for species, habitats, ecosystems and their associated ecological flows. However, the real benefits of trans-border conservation are yet to be harnessed. Although the need for transboundary collaboration was realised to protect the species and shared habitats but such a realisation was transformed into actions when WWF - Pakistan signed an agreement with the Xinjiang Institute of Ecology and Geography (XIEG), Chinese Academy of Sciences (CAS) for collaborative research on biodiversity of the Pamir Plateau in 1993. Shimshal Pamir wetlands, their adjacent peatlands, streams, rivers and lakes have rare and unique biodiversity and fragile mountain ecosystems, unattended so far. Further, promoting the bilateral cooperation between the two friendly countries i.e., China and Pakistan, for future conservation and joint management of common and shared resources is imperative to ensure socio-ecological resilience in the Pamir border region.

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