

## **1.0 INTRODUCTION**

The Water (Prevention and Control of Pollution) Act, 1974 has been aimed to fulfill the water quality requirement of designated-best-uses of all the natural aquatic resources. Loss of bio-diversity on account of degradation of habitat has become the cause of major concern in recent years. Central Pollution Control Board, while executing the nation wide responsibility for water quality monitoring and management has established water quality monitoring network in the country. The Water Quality Monitoring Network constitutes 784 monitoring stations located on various water bodies all over the country. However, wetland areas have not been included as part of regular water quality monitoring network in the country. Keeping in view the importance of water quality of wetland areas, Central Pollution Control Board has initiated studies on Bio-monitoring of selected wetlands in wildlife habitats of the country. Bio monitoring of wetlands in wild life sanctuaries has been considered as most suitable measure to evaluate the health of wildlife ecosystem. Further, the monitoring of environmental variables will be immensely helpful in protecting and restoring the ecological status in these threatened habitats.

## **2.0 CPCB'S INITIATIVES FOR BIO-MONITORING OF WETLANDS**

- Under the Indo-Dutch collaborative project, the development of bio-monitoring methodology for Indian river water quality evaluation was initiated during 1988. The Central Pollution Control Board carried out a pilot study on the River Yamuna for a selected stretch from Delhi upstream to Etawah downstream. The main objective of this study was to formulate strategic methods, which can be accepted in scientific and legislative framework for water quality evaluation. The application of methodology was undertaken for water quality evaluation of River Tungbhadra, River Chaliyar and the Damodar River.
- Subsequently, it was decided in the 42<sup>nd</sup> Chairmen and Member Secretaries conference of Pollution Control Boards that the inclusion of biological parameters in the monitoring network of MINARS will enhance the quality evaluation in a cost effective manner. The State Pollution Control Boards were advised to ensure that all the natural aquatic resources should meet the desired quality criteria in terms of physico-chemical and biological parameters.
- Since then, CPCB has been exploring the possibilities to introduce bio-monitoring methodology for water quality evaluation of surface water bodies.

- The nationwide bio-monitoring programme has been strengthened through following projects undertaken during past few years in collaboration with State Pollution Control Boards, Pollution Control Committees, NGOs, Local authorities and various research organizations.
  - a) Water quality assessment of raw water intake for drinking water supply, utilizing artificial substratum for bio-assessment of water bodies.
  - b) Bio-mapping of Rivers
  - c) Bio-monitoring of surface water bodies existing in problem areas.
  - d) The nationwide project on 'Water quality assessment through bio-monitoring of wetlands in the wild life habitats in India' has been initiated by Central Pollution Control Board and as such the State Boards were requested to identify wetlands/ surface fresh water bodies existing in major wild life habitats.
- To facilitate the nationwide monitoring network training programmes on "Bio-monitoring of Water Quality" had been organized for State Pollution Control Boards personnel from time to time, since past several years.
- To strengthen the State Pollution Control Board official on scientific background of the bio-monitoring methodology, on the job trainings were imparted through various on-going and collaborative projects on bio-monitoring.
- Central Pollution Control Board (CPCB) during development and validation of bio-monitoring methodology under the Indo-Dutch Bilateral Programme on bio-monitoring had established the fact that among all the biological components of the aquatic ecosystem, benthic macro-invertebrates are best suitable for biological evaluation of water quality.
- Most of these macro- invertebrates particularly insect larvae are aquatic and share their biological life in fresh water. Their adults fly over for miles together in search of suitable fresh water environment for reproduction, breeding and laying eggs for establishment of biological communities in suitable habitats.
- The biological water quality evaluation of water bodies has been undertaken using Biological Water Quality Criteria (BWQC) by Central Pollution Control Board (Table-1). The abnormal combination of range of saprobic score with diversity score indicates sudden change in environmental conditions. The water quality classes obtained from the biological water quality evaluation, may be interpreted in terms of designated best uses.

**Table 1: Biological Water Quality Criteria (BWQC)**

Taxonomic groups	Range of Saprobic score	Range of Diversity Score	Water Quality Characteristics	Water Quality Class	Indicative Colour
Ephemeroptera, Plecoptera, Trichoptera Hemiptera, Diptera	7 and more	0.2-1	Clean	A	Blue
Ephemeroptera, Plecoptera, Trichoptera, Hemiptera Odonata, Diptera	6-7	0.5-1	Slight Pollution	B	Light Blue
Ephemeroptera, Plecoptera, Trichoptera, Hemiptera, Odonata, Crustacea, Mollusca, Diptera, Hirudinea, Oligochaeta	3-6	0.3-0.9	Moderate Pollution	C	Green
Mollusca, Hemiptera, Coleoptera, Diptera, Oligochaeta	2-5	0.4 and less	Heavy Pollution	D	Orange
Diptera, Oligochaeta or No Macro-invertebrates	0-2	0-0.2	Severe Pollution	E	Red

### **3.0 BIO-MONITORING OF WETLANDS IN WILD LIFE HABITATS OF BIRDS SANCTUARIES IN INDIA – CASE STUDIES**

#### **KEOLADEO GHANA NATIONAL PARK, BHARATPUR, RAJASTHAN**

Wetlands of Keoladeo Ghana National Park at Bharatpur in Rajasthan State is famous for endangered cranes, the Siberian crane (*Crus lucogenanus*). The Western population of the Siberian Crane, breeds in the environments of the River Ob (Siberia) and visit to India every year during winter. Keoladeo is named after Keoladeo Shiva temple located inside the bird sanctuary and Ghana means dense forest. Thus, Keoladeo Ghana was the only place in the country where the exotic population of migratory birds regularly used to visit.

However, over the last three decades, the cranes visiting Bharatpur have reduced in number from around 200 Nos. in 1964-65 to just four in 1991-92. The duration of these endangered variety of birds to stay in the park has also decreased due to change in habitat conditions.

Keoladeo Ghana was developed in a total area of 29 km<sup>2</sup> (2900 ha wetland area) and was considered for bird sanctuary in the year 1956 and officially notified as Bird Sanctuary in year 1973. The status of National Park was awarded to Keoladeo Ghana later in the year 1981. National Park was also designated as Ramsar Site - a wetland of international

Photographs 1-3



Photographs 4-6

importance under the Ramsar Conventions. This important wetland has also been declared as a World Heritage Site and got distinction of being included under World Heritage Convention. Approximately 375 species of birds could be observed in three different seasons at Keoladeo Ghana National Park. Air quality monitoring station of Mathura Refinery is located in the sanctuary premises.

**Table 2: Environmental Problems related to various activities in vicinity of Keoladeo Ghana National Park at Bharatpur (Rajasthan)**

S. No.	Location	Wetlands/ Bird Sanctuary	Activities	Environmental Problems
1.	Keoladeo Bird Sanctuary Bharatpur	Ghana Canal	Raw water source of wetlands for Birds Sanctuary	<ul style="list-style-type: none"> <li>Lack of fresh water flow in Ghana Canal during summers</li> <li>Excessive growth of weed such as Duckweed and Azola and other macrophytic vegetation</li> <li>Destruction of feeding habitats.</li> </ul>
2.	K-Block L-Block Keoladeo Bird Sanctuary Bharatpur	Wetlands of Ghana lake	<p>Most of the catchment of wetland is dry during summer leaving habitats for few resident birds. Brick kilns in the vicinity, Tourist activity, grazing animals, Evaporation of water during summers. Drying of wetland plants and Trees, Deforestation, Mathura Refinery in the vicinity of Bharatpur and Mathura.</p> <p>Drying tree and grasses during summer</p> <p>Habitat development for animals such as Python.</p>	<ul style="list-style-type: none"> <li>Loss of Habitat due to lack of fresh water. Profuse growth of weed.</li> <li>Drying of tree leads to habitat destruction.</li> <li>Profuse growth of water hyacinth, duckweed and algal growth</li> <li>Air quality and noise levels in the surrounding.</li> <li>Fish mortality lead to attraction for scavengers</li> <li>Refinery &amp; kilns may affect migration of Birds, Danger of fire catch in the wetland area.</li> <li>Many of birds become victim of the python coming out during winter season.</li> </ul>

**Table 3: Bio-Monitoring of Wetlands of Keoladeo Ghana National Park, Bharatpur**

S. No.	Wetlands	Wetland Location	Temperature °C		Saprobic score	Diversity Score	BWQC	Biological Water Quality
			Air	Water				
1	Ghana Canal)	Keoladeo Bird Sanctuary Bharatpur	28.0	20.5	5.0	0.65	C	Moderate Pollution

2	Wetland Ghana Lake	K- Block L-Block Keoladeo Bird Sanctuary Bharatpur	31.0	19.0	5.0	0.79	C	Moderate Pollution
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## **SAMASPUR BIRD SANCTUARY, SAMASPUR LAKE, RAEBARELY, UTTAR PRADESH**

Samaspur Bird Sanctuary is located in Salon block of Raebarely district at a distance of 122 km from Lucknow in Uttar Pradesh. The bird sanctuary is situated on Lucknow-Varanasi Road about 30 km from Raebarely. Bird sanctuary is connected with Samaspur village by Road at 3 km. distance. Samaspur village to salon is 7 km on Salon-Unchahar Road. Bird Sanctuary is spread over an area of 799.371 ha. During winters, bird sanctuary become of special attraction for local resident and groups of migratory birds. In the year 1987, Samaspur lake and other six lakes were declared combinedly as Samaspur Bird sanctuary in order to provide proper conservation to resident and migratory birds. Almost 250 species of resident and migratory birds find shelter at Samaspur Bird sanctuary. The important aquatic birds are, Egrets, Painted stork, Purple Moorhen, Purple Heron, White breasted water hen, Whistling teal, Phaesant Teal, Jacana, Little grebs, Cormorants, Kingfisher, Bronzed winged Jacana, Darter, Cotton Teal, Brahmany kite, Black Drago, Green Bee Eater, Indian Sarus Crane, Pintail etc. The raw water source in the lake is mainly obtained through rainwater harvesting and run off collected through drains from adjoining villages. The outlet of the Samaspur lake joins River Sai. The water depth of Samaspur lake area varies from 0.30 cm to 1 metre. In the deeper region, half of the depth of water body is occupied by the sediments.

### ***River Sai Upstream***

River Sai Upstream location was selected to compare the water quality of receiving water body after the outlet discharge of Samaspur lake to downstream of River Sai, which originates from Pilibhit district of Uttar Pradesh. After passing through various towns such as Shahjahanpur, Hardoi, Unnao, Rae Bareli and Pratapgarh, River Sai confluences with River Gomti at Jaunpur district of Uttar Pradesh. River Gomti is a major tributary of River Ganga, joining at downstream of Jaunpur. The sampling location for bio-monitoring of River Sai was selected at upstream of Raebarely on Lucknow-Kanpur Road Bridge of NH-25. River Sai is a flowing water body with water depth of approximately 1.5 meter on a clay and muddy substratum.

### ***River Sai Downstream***

The sampling location on River Sai downstream was selected near Saipul on the opposite bank of Baba Aghar Ram Ashram at Munshiganj. The sampling location is 8 km away from Raebarely on the way to Samaspur on Lucknow-Varanasi Road. River Sai at downstream receives outlet discharge of Samaspur Bird Sanctuary through a drain at Mannad and another drain passing through Unchahar and Salon Road. The surrounding



Photograph 10-12

land is a grazing area. The depth of water body ranges from 0.6 to 2 m and the width of river is approximately 35 m.

### **NAWABGANJ BIRD SANCTUARY, UNNAO, UTTAR PRADESH**

Nawabganj Bird sanctuary is situated in Unnao district at 45 km. from Lucknow and Kanpur on Lucknow-Kanpur National Highway-25. In order to promote proper protection and conservation to the resident and migratory birds, Nawabganj lake and its surrounding area was declared as Nawabganj Bird Sanctuary in the year 1984. Approximately 250 species of resident and migratory birds are found here. The arrival of migratory birds starts from the month of November. The lake is in its behest during the month of December and January. By the end of February, these migratory guests gradually start leaving to their respective destinations. Some resident birds stay here round the year, do nesting and lay eggs. The common aquatic birds inhabiting Nawabganj lake are Open Bill Stork, Painted Stork, White Necked Stork, Black Necked Stork, White Ibis, Glossy Ibis, Black Ibis, Darter, Cormorants, White breasted water hen, Kingfisher, Spot Bill, Spoon Bill, Saras Cranes, Whistling Teal, Phaesant Teal, Jacana, Bronzed winged Jacana, Purple Moorhen, Indian Moorhen, Grebs, Lapwing, Egret, Purple Heron and Pond Heron. Nawabganj Bird sanctuary is spread in an area of 2246 sq. km. The nearest railway station is Kusumbi at a distance of 2 km from Nawabganj. Wetlands of Nawabganj Bird sanctuary was left with a small patches of pools of water in the entire area during summer month at the time of monitoring in July. The raw water for the lake is obtained through rainwater harvesting during monsoon. During summer, the requirement of water for resident birds inhabiting the lake is met through tube well source. The Kaushambi canal located 3 km upstream from the lake is the raw water source for bird sanctuary.

### **SANDI BIRD SANCTUARY (SANDI LAKE), HARDOI, UTTAR PRADESH**

Sandi Bird Sanctuary is located at a distance of 19 km on Hardoi-Sandi Road in Hardoi district of Uttar Pradesh. Hardoi is 250 km on the way from Delhi and Lucknow. Hardoi can be approached from Kanpur, Farukhabad and Kannauj. Sandi Bird Sanctuary is 1 km. from Sandi village on Main Road, Nawabganj, near Sandi Police Station Hardoi. Sandi Bird sanctuary was developed in the year 1990 in view to protect the natural habitats and aquatic vegetation for the local residents and migratory birds. The Sandi Bird sanctuary is also known by its ancient name as Dahar Jheel. The lake is spread over 3.0854 square km area. River Garra earlier named as Garun Ganga also located near the sanctuary. Migratory birds rest for sometime in the river front before reaching to Sandi Bird sanctuary. The migratory birds start coming at the beginning of winter in the month of November.

Photograph 13-16

Photograph 17-19

The bird sanctuary acquires its peak habitat during January-February. Some of the birds residing in Sandi Lake are Egrets, Black Drago, Saras Crane, Cattle Egrets etc. At the onset of summer season till March, the migratory birds gradually return back to their native places. At the time of Bio-monitoring during present study in July, the lake was suffering from water scarcity and the entire lake area was reduced to a small pool of 1.0 to 1.25 m depth, with marshy area around. The surrounding land was used for grazing cattle and cultivation.

### **SUR SAROVAR NATIONAL BIRD SANCTUARY (KEETHAM LAKE), KEETHAM, AGRA, UTTAR PRADESH**

Keetham Lake is situated at a distance of 20 km from Agra city in Uttar Pradesh and at a distance of 180 km. from Delhi. The entire lake is formed in a catchment area of 7.13 km<sup>2</sup>. Keetham Lake is linked by Railway track at Keetham Railway Station and it has recently been declared as National Bird Sanctuary in 1991 by U.P. Forest Department and named as Sur Sarovar. Keetham Lake is pentagonal in shape with artificially created islands for shelter and breeding grounds to the migratory birds. More than 106 species of migratory and resident birds are known to have their resting habitats at Sur Sarovar. The important aquatic birds inhabiting Keetham lake are Little Gerbs, Cormorants, Darter, Grey Heron, Purple Heron, Paddy Bird, Cattle Egrets, Large Egrets, Smaller Egrets, Little Egrets, Night Heron, Indian Reef Heron, Black necked Stork, white Ibis, Spon Bill, Greying Goose, Bar headed Goose, Lesser Whistling Teal, Ruddy Shelduck, Pintail, Common Teal, Spot Billed Duck, Gadwall, Wigeon, Shovler and Comb Duck. The riverine belt of River Yamuna surrounds the area of Sur-Sarovar. The raw water for Keetham Lake is obtained from Agra Canal originating from Okhla barrage on River Yamuna in Delhi. At Delhi Agra road, the Agra Canal water is diverted through Jodhpur branch near BMAS Engineering Collage located about 2 km from Keetham.

The climatic conditions of the lake area is typical of Uttar Pradesh plains with hot windy summers and extremely cold winters. The average temperature ranges between 1.5 °C to 49 °C. The monsoon season occurs during July to September. Recently, U.P. Forest Department has created woodlands and developed shallow areas near lake, making it a natural habitat for birds nesting sites. The lake water of Keetham is also used as raw water intake for Mathura Refinery Water Treatment Plant located in vicinity of Keetham Lake. At present the water is chlorinated before use. The entire lake area gets covered by profuse growth of macrophytic vegetation of water hyacinth (*Eichornia sp.*) and *Potamogeton sp.* during summers. The water quality of Keetham lake supports wide range of avifauna during winter season.

**Table 4: Bio-monitoring of Wetlands in selected Bird Sanctuaries in Uttar Pradesh**

S. No.	Bird Sanctuaries	Wetlands	Location	Temperature °C		Saprobic Score	Diversity Score	BWQC	Biological water Quality
				Air	Water				
1.	Samaspur Bird Sanctuary	Samaspur Lake	Salon block of Raebarely	35.0	31.5	5.3	0.68	C	Moderate Pollution
		River Sai Upstream	Upstream of Raebarely at Lucknow-Kanpur Road Bridge on NH25	34.0	31.0	5.55	0.9	C	Moderate Pollution
		River Sai Downstream	Saipul on Lucknow-Varanasi Road Raebarely	35.0	32.0	5.5	0.69	C	Moderate Pollution
July, 2002									
2.	Nawabganj Bird Sanctuary	Nawabganj Lake	Unnao on Lucknow-Kanpur NH-25	36.0	39.0	5.0	0.06	D	Heavy Pollution
July, 2002									
3.	Sandi Bird Sanctuary	Sandi Lake (Dahar Jheel)	Hardoi, 19 km on Hardoi-Sandi Road	38.0	37.0	2.0	0.25	D	Heavy Pollution
		River Garrah	Channel goes to Sandi Lake at Sandi, Hardoi	31.0	32.5	5.6	0.75	C	Moderate Pollution
July, 2002									
4.	Sur Sarovar Bird sanctuary	Keetham lake	Keetham, 25 km from Agra on Delhi – Agra Road	30.5	38.0	5.2	0.86	C	Moderate Pollution
June, 2001									

Sur Sarovar	Keetham lake	Keetham, 25 km from Agra on Delhi- Agra Road	23.0	20.0	5.1	0.84	C	Moderate Pollution
January, 2002								

**Table 5: Environmental Problems related to various Activities in Vicinity of Bird Sanctuaries of Uttar Pradesh**

S. No.	Bird Sanctuaries	Wetland	Activities	Environmental Problems
1.	Samaspur Bird Sanctuary	Samaspur Lake	Tourist Resort, Cattle wading, farming, Cultivation, Fishing, Brick industries, water used for drinking purpose by local inhabitant, Drainage discharge. Open defecation on village side of lake	<ul style="list-style-type: none"> <li>Deforestation</li> <li>Silting in water and sediment deposition.</li> <li>Profuse growth of water Hyacinth infesting the sensitive macrophytic vegetation.</li> <li>Weed infestation</li> <li>Air quality of surrounding</li> <li>Burning fuel in the vicinity of Bird sanctuary,</li> <li>Surface run offs and human influences.</li> </ul>
		River Sai U/s	Construction of Road NH-25, cattle wading, dredging soil, Melon farming, cultivation, open defecation on surrounding land. Brick kilns. Deforestation	<ul style="list-style-type: none"> <li>Silting in water body</li> <li>Faecal contamination through surface run offs.</li> <li>Run offs from cultivated lands of surroundings</li> </ul>
		River Sai D/S	Baba Aughar Ram Ashram for Leprosy patient on the bank of River, Outlet discharge of Samaspur lake through drains, sewage and waste water discharge of Raebareilly city, open defecation in surrounding lands	<ul style="list-style-type: none"> <li>Bio-medical waste discharge from Ashram</li> <li>Profuse growth of Duck weed and water hyacinth due to waste water discharges</li> <li>Growth of Filamentous algae in River, surface run offs, silting etc.</li> </ul>
2.	Nawabganj Bird Sanctuary	Nawabganj lake	Heavy vehicular Traffic on NH-25, Grazing animals in the lake area, Use of Ground water in lake catchment area, Tourism, Children Park, Power grid in the vicinity, Brick kilns, Pigs and cattles wading in lake. Social forestry, leather Tanning and vegetable Tanning Industries	<ul style="list-style-type: none"> <li>Noise and Vehicular emissions</li> <li>Water quality</li> <li>Human influences and disturbance to bird habitats. High tension of Power Grid may affect migratory birds, fire forest</li> <li>Industrial wastewater surface run offs.</li> <li>Water scarcity</li> <li>Deforestation, Lack of proper habitat for resident birds during</li> </ul>

S. No.	Bird Sanctuaries	Wetland	Activities	Environmental Problems
				summers.
3.	Sandi Bird Sanctuary	Sandi Lake	Railway Track 20 km at Hardoi cultivation, Grazing animals, Residential, Municipal solid waste dumping on roadside along the sanctuary. Surface drainage overflow during monsoon, wood cutting for shops, cattle wading in the lake	<ul style="list-style-type: none"> <li>• Lack of water in lake during summer</li> <li>• Habitat destruction for resident birds, water quality deterioration due to grazing cattles, buffalos etc.</li> <li>• Surface run offs from cultivated lands in lake area, city sewage and municipal waste from Sandi village</li> </ul>



Photograph 20-23

S. No.	Bird Sanctuaries	Wetland	Activities	Environmental Problems
			deforestation, Open defecation, cattle cow dung etc. Brick kiln Industries	<ul style="list-style-type: none"> <li>Noise levels etc.</li> </ul>
4.	Keetham- Sur Sarovar Bird Sanctuary	Keetham lake	Water Intake for Mathura Refinery Treatment Plant, Chlorination of Intake water, Mathura Refinery on the way to Keetham lake. Railway track, Heavy vehicles on Delhi-Agra Road	<ul style="list-style-type: none"> <li>Air quality &amp; Noise levels</li> <li>Excessive growth of water hyacinth and other Macrophytic vegetation</li> <li>Water loss during summer and effect on water quality</li> <li>Silting due to deforestation in the area.</li> </ul>

## **WETLANDS OF MANJIRA BARRAGE, SANGAREDDY, ANDHRA PRADESH**

The State of Andhra Pradesh constitute one of the major river systems in India, comprising three major river valleys viz. Godavari, Krishna and Pennar and about 37 medium and minor river systems. The drainage area of Rivers Krishna and Godavari within the State is 1,47,722 km<sup>2</sup>, which is nearly 64% of total geographical area of the State. The average rainfall in the State is 946 mm derived from both South-West and North-East monsoon. Indian rivers are mainly classified into four groups, Himalayan rivers, the rivers of Deccan plateau, the Coastal rivers, and the drainage originated rivers. All rivers in Andhra Pradesh are basically rain dependent. Some rivers are even dry in summer. Thus rainwater harvesting in barrages across rivers are sole source of fresh waters. Some of these rivers are major wetland site for wild life habitats.

Manjira Barrage is located at Sangareddy near Hyderabad in Andhra Pradesh. The water body has been identified as one of the major wetland site in the country by Ministry of Environment and Forests. Manjira wild life sanctuary inhabits all kinds of animals including Birds, Reptiles and Mammals. The raw water of Manjira Barrage is used as drinking water source for Hyderabad Metropolitan Water Supply and Sewerage Board Phase II water and Treatment Plant at Kalabgoor. Besides wild life, the water quality supports variety of aquatic fauna and flora. The surrounding land use is agriculture and forest.

River Manjira is one of the tributary of largest River Godavari of the Peninsular India. The Godavari basin extends over an area of 3,12,812 km<sup>2</sup>, which is nearly 10 percent of the total geographical area of the country. The basin lies between East longitudes 73°26' and 83°7' and North latitudes 16°16' and 22° 36' at Decan plateau, and covers large areas in the states of Andhra Pradesh, Madhya

Pradesh and Maharashtra in addition to smaller areas in Karnataka and Orissa.  
River Manjira is an  
Photograph 24-29

important tributary at upstream of Godavari. Among other tributaries, such as the Pranhita, the Indravati and the Sabari joins the River Godavari in its downstream reaches. River Manjira originates from Balaghat Hills near Ahemednagar. After travelling through Latur and Bidar districts, it reaches Medak district in the vicinity of Bolaram and Patancheru near Hyderabad, Andhra Pradesh. Ultimately it drains into River Godavari at Basara, Nizamabad.

## **WETLANDS OF KOLLERU LAKE, KRISHNA AND WEST GODAVARI DISTRICTS, ANDHRA PRADESH**

The Kolleru lake has been identified as one of the major fresh water wetland site in the districts of Krishna and West Godavari in the State of Andhra Pradesh India. The Kolleru lake and its ecological stretch spreads over about 2,00,000 acres (from 0 to 10 ft. contour M.S.L.) between longitude 81-05' and 81-20' East and latitudes 16-32' and 16-51' North in the districts of Krishna and West Godavari. Kolleru Lake is fed directly by two seasonal rivers, the Buameru and Tammileru (East and West branches). Beside almost 30 inflowing drains and channels feed Kolleru Lake with the run off waters. In between Godavari and Krishna deltas, the Kolleru Lake functions as a natural flood balancing reservoir. The deltaic region serves as highly productive, agriculture, fishing and related cottage occupations for the livelihood of local inhabitants. The catchment area of Kolleru Lake stretches over 4763 km<sup>2</sup> of upland area. Out of it 1358 km<sup>2</sup> of agricultural delta area are mostly cultivated with paddy. Kolleru Lake joins Bay of Bengal on the south-eastern end of the lake through an outlet channel of 62 km of original length known as Upputeru channel. Kolleru lake inhabit wide range of migratory and resident birds. The common aquatic birds observed were Grey Heron, Coot, Purple Heron, Lepwing, Egrets, Common Teal, Pochard, Cormorants, Pond Heron, Purple Moor Hen, Grey Heron, Teal. Aquaculture and fishing is practiced in the fishponds being fed by direct pumping through Kolleru lake water. During monsoon, the backwaters of sea create serious drainage problems, which cause floods in the towns and cities around the lake.

**Table 6: Bio-monitoring of Wetlands of Kolleru Lake in West Godavari Districts**

S. No.	Wetlands	Location on water body/ Wetland	Temperature °C		Saprobic score	Diversity Score	BWQC	Biological Water Quality
			Air	Water				
1.	Circar Channel	Alapadu run off at Wooden Bridge	32.5	31.9	5.1	0.64	C	Moderate Pollution
2.	Sringavara-pupadu	Confluence of Upputreru drain and Sringavara pupadu drain	29.0	31.5	5.2	0.5	C	Moderate Pollution

Photograph 30-31

S. No.	Wetlands	Location on water body/ Wetland	Temperature °C		Saprobic score	Diversity Score	BWQC	Biological Water Quality
			Air	Water				
3.	Circar Channel	½ km from wooden Bridge at Alapadu	32.5	31.9	5.3	0.55	C	Moderate Pollution
4.	Kolleru Lake	Kolletikota	34.5	34.0	5.2	0.52	C	Moderate Pollution
5.	Kolleru lake	Pedaedlagadi on Eluru-Kaikaluru Road	32.0	38.0	5.0	0.75	C	Moderate Pollution
6.	Upputeru outlet Drain	Akiveedu Road Bridge, Vijaywada	31.5	32.0	5.5	0.71	C	Moderate Pollution
7.	Polaraju Drain	Lokumudy Near Road Bridge	34.5	33.8	5.0	0.50	C	Moderate Pollution
8.	Chinaedlaga di Drain	Eluru-Kaikaluru Road Kowadalanka Area	34.5	32.0	4.9	0.54	C	Moderate Pollution
9.	Kolleru lake	Pedaedlagadi on Eluru-Kaikaluru Road	32.0	38.0	5.0	0.75	C	Moderate Pollution

## **WETLANDS IN CORINGA WILD LIFE SANCTUARY, EAST GODAVARI DISTRICT, ANDHRA PRADESH**

Coringa wild life sanctuary is part of the Godavari mangroves, declared as a sanctuary in July 1978 to conserve the mangrove vegetation of the estuary extending in an area of about 235 km<sup>2</sup>. Coringa sanctuary is located between 16°-30' to 17°00' N latitudes and 82°-14' to 82°-23' E longitudes in East Godavari district of Andhra Pradesh. The sanctuary can be visited from Chollangi, Matlapalem or Ramannapalem on Kakinada to Yanam road at about 10-15 km distance from Kakinada.

In Coringa region, the Godavari River divides into two major distributaries at Dowaliswaram near Rajahmundry. These distributaries are Gautami-Godavari and Vasista-Godavari. The Gautami joins the sea at Kapileswarapuram (Coringa) about 53 km upstream from 'Vrudha'. The vast deltaic regions of Krishna and Godavari in Andhra Pradesh support the luxuriant growth of mangroves due to their alluvial rich deposits. Mangroves occur at about 200 km<sup>2</sup> area in Krishna and Godavari delta. Two major wild life sanctuaries such as Krishna wild life

sanctuary in Krishna delta and Coringa wild life sanctuary in Corangi estuary are located in this region.

**Table 7: Environmental Problems related to various activities in vicinity of Bird sanctuary of Andhra Pradesh**

S. No.	Wild Life Habitats	Wetland/ water bodies	Activities	Environmental Problems
1.	Coringa Wild life Sanctuary, East Godavari District	River Godavari upstream at Aryapuram Rajahmundry	Drinking water Intake at upstream of this location. Leaf litter, solid waste dumping site on the bank of river, washing ghat, domestic wastewater seepage from residential area. Temple, Domestic & Industrial waste discharge, Nallah channel join at downstream of location	<ul style="list-style-type: none"> <li>Unhygienic conditions at the site</li> <li>Water quality deterioration on downstream reaches.</li> </ul>
		River Godavari downstream at Dowaleswaram	Washing, bathing and religious activities, fishing, Irrigation canal off take, boating etc.	<ul style="list-style-type: none"> <li>Water quality is subjected to human influences.</li> </ul>
2.	Coringa wild life Sanctuary	River Corangi	Aquaculture, Prawns and fish ponds, Transportation through motor Boats, Nursery of Mangrove forest, Medicinal Plants, Mangrove have been exploited for highly valued products like timber for boat building, Bark for tanning, seeding for wood etc. Mangrove and wetland plants have been used as fodder and fuel by local villagers. Digging channels at 12.5 m. Taking up of large scale afforestation of banks	<ul style="list-style-type: none"> <li>Silting and sludge deposition in water body,</li> <li>Profuse growth of water hyacinth &amp; other aquatic weeds due to surface run offs and drainage from surroundings</li> <li>Surface drainage from Aquaculture and fish ponds using fish food and fertilizers</li> <li>Noise generated through Motor Boats affect wild life, Birds habitats</li> <li>Habitat destruction due to deforestation activities</li> <li>Digging channels near water body enhances silting through run off during high tides.</li> </ul>
		River Gaderu	Fish landing Jetty, commercial fishing, crabs, prawns, shells of molluscs used as raw material for calcium carbide industry etc. Fishermen habitation on the bank, fish ponds, aquaculture, confluence to River Godavari and Bay of Bengal at downstream.	<ul style="list-style-type: none"> <li>Silting in water body</li> <li>Salinity intrusion</li> <li>Solid waste dumping from commercial fishing,</li> <li>Automobile waste from Motor Boats.</li> <li>Surface run off and domestic waste</li> <li>Discharge from Savitri Nagar Village</li> </ul>
3.	Kolleru wild life Sanctuary, West Godavari	Godavari Canal at Downstream of Hydel project Chettipeta, West Godavari District	Hydel power generation, fishing, irrigation for cultivation all along the canal. The canal water ultimately joins Kolleru	<ul style="list-style-type: none"> <li>Heavy flow and deep water body</li> <li>Canal banks are unprotected and open for surface run offs from</li> </ul>



S. No.	Wild Life Habitats	Wetland/ water bodies	Activities	Environmental Problems
	District	Nanidadavole	lake. Bathing, washing activities, Industrial cooling	adjacent cultivated lands. <ul style="list-style-type: none"> <li>• Artificial substratum of water body.</li> </ul>

S. No.	Wild Life Habitats	Wetland/ water bodies	Activities	Environmental Problems
4.	Kolleru Lake	½ km after Circar channel at Alapadu	Boating, fish pond, Aquaculture, cultivation, Transportation through Motor Boats, Storage of fish food, prawns fertilizer bags etc. habitats for Birds, on wetland plant saccharam, tourism, deforestation	<ul style="list-style-type: none"> <li>Pumping water from Kolleru lake and Tube well for fish pond and aquaculture</li> <li>Surface run offs contributing to water quality.</li> <li>Motor Boats producing noise</li> <li>Habitats destruction for Birds, water Hyacinth &amp; weed growth</li> <li>Silting is water body</li> </ul>
		Sringavarapupadu	Culture of white lotus, macrophytes, vegetables, Birds habitat, Wetland plant saccharam, fish pond, prawns aquaculture, finishing, Boating, Drainage from villages.	<ul style="list-style-type: none"> <li>Profuse growth of water hyacinth and other macrophytic weeds etc.</li> <li>Surface run offs from villages and fishing,</li> <li>Aquaculture activities</li> <li>Silting in water body</li> </ul>
		Circar channel at Alapadu run off wooden Bridge	Transportation through motor Boats, commercial fishing, fish ponds, aquaculture, Palm tree cultivation, Habitats for Birds, Burning of wetland plants saccharam deforestation	<ul style="list-style-type: none"> <li>Bore well water and Kolleru lake water is used for fish ponds and Aquaculture</li> <li>Surface run offs joins Kolleru lake water.</li> <li>Habitat destruction for birds due to burning activities</li> <li>Silting in water body</li> </ul>
		Kolletikota	Burning wetland plant, deforestation, Transport through motor Boats, pumping water for fish pond, cultivation, aquaculture etc. Drainage of surface run off from villages. Habitats for Birds	<ul style="list-style-type: none"> <li>Silting in water bodies</li> <li>Lowering of water level</li> <li>Habitat (Bird nests) destruction due to transport by motor boats</li> <li>Noise and air quality affects bird's normal behaviour</li> <li>Dry wetland plants catch fire</li> <li>Profuse growth of water hyacinth and other macrophytic vegetations.</li> </ul>
		Upputeru outlet Drain	Washing, cultivation, fish pond kolleru lake outlet discharge. Fishing, Boating, Habitat for Birds	<ul style="list-style-type: none"> <li>Profuse growth of water hyacinth, silting in water body.</li> </ul>
		Polaraju Drain	Road traffic, Electrical High tension wires, Domestic wastewater. Surface run off join Kolleru lake. Fish ponds, fish trop in the water body, Birds habitat, water body used as raw water for fish pond and	<ul style="list-style-type: none"> <li>Domestic waste water and surface run off join Kolleru lake</li> <li>Silting in water body</li> <li>Excessive water Hyacinth and duckweed, azola etc.</li> <li>Infestation on lotus plantation</li> <li>Habitat destruction</li> </ul>

S. No.	Wild Life Habitats	Wetland/ water bodies	Activities	Environmental Problems
			cultivation, Deforestation.	<ul style="list-style-type: none"> <li>• Noise levels due to traffic High tension wires prevent proper movement of birds</li> </ul>

S. No.	Wild Life Habitats	Wetland/ water bodies	Activities	Environmental Problems
			Compounding of Industrial waste with sewage and agricultural run offs directly joining Kolleru lake.	<ul style="list-style-type: none"> <li>• Abstraction of water for fish pond affects the water level.</li> <li>• Eutrophication</li> </ul>
		Chinaedlagadi Drain	Drain carrying surface run off and domestic wastewater join Kolleru lake. Road traffic, water abstraction for fish pond, cultivation. Birds habitat, Deforestation, fish trap used in water body	<ul style="list-style-type: none"> <li>• Excessive growth of water hyacinth, Duckweed and other wetland plants</li> <li>• Noise levels affect birds</li> <li>• Silting in water body of Kolleru lake</li> <li>• Water quality deterioration due to abstraction for fish pond</li> <li>• Eutrophication.</li> </ul>
		Pedaedlagadi	Domestic wastewater discharge surface run offs, Boating for transport of construction material, feed and fertilizer for fish and aquaculture. Bird's habitats, deforestation traffic, High tension wire (Electrical) on road side.	<ul style="list-style-type: none"> <li>• Silting in water body</li> <li>• Habitat destruction due to noise of traffic</li> <li>• Deforestation</li> <li>• Electrical wires across the roads, water quality deterioration due to surface run offs and excessive growth of water hyacinth, duckweed etc.</li> <li>• Water abstraction for fish ponds affect the water level in wetlands.</li> </ul>
5	Manjira Barrage	River Manjira	Wild life sanctuary, Raw water intake for Hyderabad Metro water supply and sewerage Board. Phase II water and treatment plant at Kalabgoor. Forestry, Rain water Harvesting, Agriculture, Irrigation, fishing and tourism. Habitat for aquatic fauna and flora.	<ul style="list-style-type: none"> <li>• Lack of water during non-monsoon period,</li> <li>• Deforestation</li> <li>• Silting in water body</li> <li>• Aquatic weed growth</li> <li>• Habitat destruction due to various human influences.</li> </ul>

The rich mangroves of Coringa wild life are fed by two important tributaries of Gautami Godavari i.e. River Gaderu and River Corangi, which ultimately drain into Kakinada Bay. The mangrove provides different niches for variety of animal populations such as smooth Indian otters. The sanctuary has an unique distinction of having 18 km. long sand spit in the North Eastern side, where the species of Olive Ridley sea turtle (Endangered species) nests during January-March every year. Apart from these animals, mangroves invariably attract large population of birds, which feed on various organisms inhabiting in the mangrove forest and in the backwaters. During low tide, some of the areas are exposed (elevated mud flats having small fishes, shrimps, molluscs) attracting avifauna for

its feed. Over 120 species of birds have been reported so far. The most common variety of avifauna are - Little Egret, Cattle Egret, Pied Kingfisher,  
Photograph 32-33

Small blue kingfisher, Black capped kingfisher, Pond Heron, Reef Heron, Grey Heron, Night Heron, Little stine, Sand piper, Red shrank, Red wattle Lapwing, Pheasant, Flamingos, Seagulls, Purple Heron and Little Cormorants.

**Table 8: Bio-Monitoring of Wetland of Coringa Wild Life in East Godavari District of Andhra Pradesh**

S. No.	Wetland	Location on water body/ Wetland	Temperature °C		Saprobic score	Diversity Score	BWQC	Biological Water Quality
			Air	Water				
1.	River Godavari upstream	Arya puram at Raja mundry	29.5	31.0	4.5	0.35	D	Highly Polluted
2.	River Godavari Downstream	Dowailleswaram	28.5	31.0	4.71	0.47	C	Moderate Pollution
3.	Godavari Canal	Downstream Hydal Power Plant at Chettipeta	35.5	31.5	6.0	0.44	C	Moderate Pollution
4.	River Corangi at Lowtide	Ramanapalam East Godavari District	27.5	26.5	5.6	0.31	C	Moderate Pollution
5.	River Gaderu	Savitri Nagar Yanam	29.0	31.0	6.0	0.48	C	Moderate Pollution

### **WETLANDS OF RIVER YAMUNA, PAKSHI VIHAR AT OKHLA BARRAGE, DELHI**

Delhi is situated on the bank of river Yamuna between latitude 28°23'17" North - 28° 53'00" North and 76°50'24" East-77°20'37" East. Delhi is the part of Indo-Gangetic Alluvial plains at an elevation ranging from 198 m to 220 m above the mean sea level. The area in Delhi sprawls to an extent of 1488 km<sup>2</sup> (148, 300 ha) of terrain. Delhi is surrounded by Uttar Pradesh State on the eastern side and Haryana to the North, South and West. Two major landform systems converge here - the Ganga plain and Ridge. The later is an extension of Rajasthan's Aravalli ranges. The major wild life habitats in Delhi are mainly Pakshi Vihar at Okhla Barrage on River Yamuna, Najafgarh Drain. The resident and migratory birds such as Gees, Teal, Coot, Pintail, Spot Bill, Pochard, Surkhab, Wigeon, Pelican, Alwar, Godwall, Malard, Open wild Stork, Cormorant, Sarus crane, Painted Stork, White breasted kingfisher, Bee Eater, Egret, Heron, Purple Moorhen have been observed at these wild life habitats.

River Yamuna near Delhi has been identified as internationally important wetland, declared as Ramsar Site. Okhla barrage is located near village Madanpur Khadar and Jaitpur, 20 km downstream from Wazirabad Barrage at upstream. At Okhla Barrage the water of River Yamuna is completely blocked and diverted to Agra canal. The Barrage has been constructed in a catchment

area of 17930 km<sup>2</sup>. This portion of the barrage is under control of U.P. Irrigation Department. At this location, River Yamuna receive discharges from various drains such as Maharani Bagh Drain, Tugalakabad Drain and Kalkaji Drain. A portion of River Hindon water from Ghaziabad (U.P) joins upstream Okhla Barrage through Hindon cut. Okhla Pakshi Vihar is situated in Ghaziabad District of Uttar Pradesh on River Yamuna in between Okhla Barrage and Okhla weir. Pakshi Vihar is 3 km from NOIDA in U.P. and 1.5 km from famous Jamia Milia Islamia University. The entire area of Pakshi Vihar was developed in year 1990 and spread to area of 400 hectare. The area is a tourist resort during November to February. Minimum temperature of 5°C and maximum of 47°C has been reported at this place.

**Table 9: Bio-Monitoring of Wetlands of River Yamuna, Pakshi Vihar at Okhla Barrage, Delhi**

S. No	Wetland	Month/ Year	Temperature °C		Saprobic Score	Diversity Score	BWQC	Biological Water Quality
			Air	Water				
1.	Okhla Barrage	November 2001	22.5	24.5	5.2	0.78	C	Moderate Pollution
2.	Okhla Barrage	December 2001	-	-	4.67	0.80	C	Moderate Pollution
3.	Okhla Barrage	January 2002	23.0	17.0	4.5	0.5	C	Moderate Pollution

### **WETLANDS OF NAJAFGARH DRAIN, CHHAWLA, DELHI**

Delhi Tourism Department, Govt. of India, had identified this site for Chhawla Water World and Ecopark development. However, recently the site has been protected for development of Bird Sanctuary. A number of birds have been observed at the upstream location of Najafgarh drain from Chhawla upto Dhansa regulator. The water level is maintained by the Irrigation and Flood Control, Dept. of Delhi Government. Chhawla is located on Bijwasan-Najafgarh Road at about 10 kilometer from Gurgaon NH-8 on Rajokri crossing. Najafgarh drain receives wastewater from Mundella Drain joining upstream of Chhawla at Kanganheri. Najafgarh drain originates as Dhansa outfall channel from Dhansa regulator located in Dhansa village in South-West of NCT-Delhi near Gurgaon border. Due to storage of water at Dhansa, the water body is stagnant at off take point. The catchment area of Dhansa Regulator/Bund obtains fresh water from drain coming from Jahazgarh Jheel, Sahibi Nadi and Catchment area lying in Lohat and Mundakhera in Gurgaon. Dhansa outfall channel terminates into Najafgarh Jheel. The catchment area of Najafgarh Jheel spreads in Delhi-Gurgaon border located 1-2 km distance from Jhatikra. Najafgarh Jheel is the largest surface water body in Delhi, spread over in an area of 6 km. This natural depression obtains fresh water from west of ridge, north of Karnal and from the catchment area lying in Gurgaon. Najafgarh channel was dug out from the Najafgarh Jheel during the

year 1938 joining to the River Yamuna at downstream of Wazirabad barrage. The water quality of Najafgarh drain upto Chhawla supports wide range of aquatic fauna and flora including birds, fishes etc. The water is used for irrigation by direct pumping into adjacent cultivated lands of wheat, vegetables etc. MCD tube well adjacent to Najafgarh drain is used for drinking purpose by BSF colonies. Up to Kakraula regulator, Najafgarh drain receives several outfalls from sewage treatment plant.

**Table 10: Bio monitoring of Wetlands of Najafgarh drain in Delhi at Chhawla Eco-Park**

S. No.	Wetlands	Location	Temperature °C		Saprobic Score	Diversity Score	BWQC	Biological water Quality
			Air	Water				
1.	Najafgarh Drain	Dhansa Regulator at Dhansa village	20.0	15.0	5.26	0.55	C	Moderate Pollution
2.	Najafgarh Jheel	1 ½ km U/s of Jhatikra on Gurgaon Border	23.0	16.0	5.0	0.22	D	High Pollution
3.	Najafgarh Drain	Jhatikra on Delhi-Gurgaon Border Near Bridge	23.0	17.0	5.0	0.9	C	Moderate Pollution
4.	Chhawla Eco-park on Najafgarh Drain	Chhawla, Guest House of Irrigation and Flood Control Department	17.0	23.0	5.3	0.82	C	Moderate Pollution
5.	Najafgarh Drain	Goela Dairy Police check Post	19.5	14.5	5.1	0.6	C	Moderate Pollution
		Kakraula Regulator	22.0	16.0	4.3	0.24	D	High Pollution
		D/s Uttam Nagar Police Check post	23.0	18.0	4.5	0.25	D	High Pollution



S. No.	Wetlands	Location	Temperature °C		Saprobic Score	Diversity Score	BWQC	Biological water Quality
			Air	Water				
		U/s Keshopuram STP outfall	-	-	2.0	0.32	D	High Pollution

S. No.	Wetlands	Location	Temperature °C		Saprobic Score	Diversity Score	BWQC	Biological water Quality
			Air	Water				
		D/s Keshopuram STP outfall	24.0	18.0	0.0	0.0	E	Severe Pollution
		Basaidarapur, Ashok Vihar, Bharat Nagar	-	-	0.0	0.0	E	Severe Pollution

Najafgarh Drain is canalized after Bharat Nagar upto confluence to River Yamuna at Downstream Wazirabad Barrage .

**Table 11: Environmental Problems related to various activities in vicinity of wild life Habitats in Delhi**

S. No.	Wild life Habitat	Wetland/ Location	Activities	Environmental Problems
1.	Pakshi Vihar	River Yamuna at Okhla Barrage.	Tourist Resort, Bird watching, fishing, Habitat for migratory birds. Supply of Irrigation water to Agra Canal. Cattle wading, cultivation	<ul style="list-style-type: none"> <li>• Profuse growth of water Hyacinth</li> <li>• Waste water discharge from U.P. and Drains of Delhi</li> <li>• Silting and sludge deposition</li> <li>• Water quality deterioration</li> </ul>
2.	Chhawla Eco park	Najafgarh Drain at Dhansa Regulator	Run off from Jahazgarh Jheel, Sahibi Nadi and catchment area lying in Gurgaon., grazing, fishing, Origin of Drain No.6 cultivation etc. Cattle wading. Habitat for migratory Birds	<ul style="list-style-type: none"> <li>• Silting, stagnation of water body due to lack of water in the catchment of Dhansa Regulator</li> <li>• Water Hyacinth</li> <li>• Deforestation</li> <li>• Lack of fresh water source during non-monsoon period salinity intrusion</li> </ul>
		Najafgarh Jheel	Cultivation in the adjacent-fields in Gurgaon. Habitat for birds, STP outfall from Haryana, Solid waste dumping, Eichornia and other weed growth. Open defecation, grazing etc. Road Transport	<ul style="list-style-type: none"> <li>• Water quality deterioration</li> <li>• Surface run offs</li> <li>• Noise due to vehicles passing Haryana border</li> <li>• Silting and sludge deposition in water body</li> <li>• Obstruction in flow of water</li> <li>• Absence of desludging &amp; dewatering activity</li> </ul>

				<ul style="list-style-type: none"><li>• Salinity problem</li><li>• Water Hyacinth growth</li></ul>
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Photograph 34-37

S. No.	Wild life Habitat	Wetland/ Location	Activities	Environmental Problems
		Najafgarh Drain at Jhatikra	Vehicular activities on Delhi Gurgaon Border, Habitats for birds, grazing, cultivation, Irrigation. Solid waste dumping	<ul style="list-style-type: none"> <li>• Increasing noise levels</li> <li>• Water quality affected due to surface run off</li> <li>• Silting and sludge deposition</li> <li>• Solid waste dumping</li> <li>• Habitat destruction</li> <li>• Salinity problem clogging of drain</li> <li>• Water hyacinth growth</li> </ul>
		Chhawla Eco park in Najafgarh drain	Eco park development of bird sanctuary by Irrigation and flood Dept. Forestry, vehicle passing through the Road Bridge. Open defecation, solid waste Habitat for Birds scavengers	<ul style="list-style-type: none"> <li>• Silting and sludge deposition</li> <li>• Low flow in water body</li> <li>• Profuse growth of duckweed water hyacinth &amp; macrophytic vegetation.</li> <li>• Clogging of drain obstruct in flow of water</li> <li>• Salinity problem</li> </ul>

## **WETLANDS OF KASHMIR VALLEY (JAMMU & KASHMIR)**

The wetlands in Kashmir Valley are of significant importance for sustenance of wide array of bio-diversity inhabiting them. The vast network of fresh water, marshy wetlands and depressions in the valley of Kashmir still possess pre-historic importance. Most of them are of post-glacial age. The high attitude fresh water lakes are fed by snow and rainfed streams, rivulets and rivers originate from mountain system of the great Himalayas on the eastern edge of the Valley and the Pir Panjal range extending along the western and south western parts and mostly located in the centre of valley. The River Jehlum is the source of major wetland of Wullar Lake designated as Ramsar site by Government of India as "Wetland of International Importance". River Jehlum flowing from south east to north west, is drained during floods into several inland depression. The major wetlands in the valley are Narkara, Hokera, Mirgund, Shallabugh, Hygam, Dal Lake, Manasbal, Wular etc., which provide an extensive over-wintering resorts, excellent cover and safe roosting and feeding grounds to wide and rich variety of geese, ducks and rails which arrive just at the onset of autumn migrating from Palaearctic breeding grounds. The temporary wetlands buffer the permanent bird refuges for a large number of other birds both migratory and residents during summer. They also serve sites for shelter during night feeding on the left over paddy after harvesting. There are several high land lakes fall on to and fro fly-

way route of these wintering visitors both at the time of in and outward migration, but their use by these birds is still unknown.

The Willow (*Salix alba*) groves and Poplar trees (*Populus sp.*) extending along the peripheries of wetlands are valuable resources of fuel, fodder, timber and material to the wicker work, besides provide roosting and nesting cover to both land and water birds. The residue of the dead aquatic flora and hydrophytic plants (humus) of the littoral zone provides 'Demb', which is extensively used for fuel purposes. Intensive harvesting of *Typha angustata* and *Sparganium ramosum* for making mats and *Pharagmites communis* and *Nymphoides pellatum* for fodder affect the holding capacity of the wetlands, as they provide food and cover niches to the water birds. Floating gardens present in them provide manure rich substratum for vegetation of crops. The geese, ducks and rails are found feeding, dabbling, resting or preening on floating gardens during late winter and early spring. The socio-economic importance of wetland to the people living in the close vicinity are exploitation of water chestnuts (*Trapa natans*); seeds of several plant species form an important food for the geese, ducks and rails.

The wetlands are presently under increasing pressure from over exploitation of resources, conversion to other land uses through drainage/river engineering schemes, fertile farmland or buried under refuse tips, pollution and degradation of catchments. It has greatly affected the population size of several water fowl species and discontinued stopover of many more including Common Cranes (*Grus grus*) in the valley over the years.

The overall water fowl status assessed from valley revealed the Common Teal (*Anas crecca*) as the most commonest species; Pintail (*A. acuta*), Mallard (*A. platyrhynchos*), Gadwall (*A. catripera*), Wigeon (*A. Penelope*) and Coot (*Fulica atra*) as common, Garganey (*Anas querquedula*), Greylag Goose (*Anseranser*), Shoveller (*Anas clypeata*), Red Crested Pochard (*Netta rufine*) and Common Pochard (*Tadoma ferruginea*), White-eyed Pochard (*Aythya nyroca*) and Tuffed Duck (*A. fuligula*) with a vulnerable status. The water fowl census conducted in sixteen wetlands during 1992 was repeated during winter session (September to April) with addition of new areas from time to time, to monitor population fluctuation over the season and population trend over the years, besides to evaluate their status in the valley.

These wetlands are weedy and extensive morass, bounded by thick willow (*Salix sp.*) groves with scattered stands of poplar (*Populus sp.*). Whereas, some water bodies support Apple (*Prunus sp.*) Orchards as well. A definite type of vegetation ranging from sub-merged, attached, free floating and emergent aquatic vegetation of grasses, herbs, reeds and sedges are found in wetlands. Some of the important species are:

<i>Typha angustata</i>	<i>Typha laximani</i>
<i>Phragmites communis</i>	<i>Elecharis palustris</i>
<i>Sagittaria Sagitifolia</i>	<i>Saccharum spontaneum</i>
<i>Butomus umbellatus</i>	<i>Trapa natans</i>
<i>Myriophyllum verticillatum</i>	<i>Myriophyllum spicatum</i>
<i>Sparganium ramosum</i>	<i>Polygonum sp.</i>
<i>Nymphoides peltatum</i>	<i>Potamogeton sp.</i>
<i>Scripus sp.</i>	<i>Frimbistylis squarosa</i>
<i>Lemna gibba</i>	<i>Lemna minor</i>
<i>Lemna trisulea</i>	<i>Spirodella polyrhiza</i>
<i>Alisma plantagoaquatica</i>	<i>Menta longifolia etc.</i>

The diverse land use by way of willow/popular plantations, orchards and paddy cultivation fringing the wetlands add food and spatial niches to fragile and productive ecosystem, paving way for rich and varied aquatic as well as terrestrial avifauna species both native and migratory (summer & winter). But the study sites of Hokera, Mirgund, Narkara, Chatlum and Manibugh still continue to be managed for organized shooting from November/December to April, every year, which has now been temporarily stopped for the past few years.

Protection to the wetland ecosystem and inhabiting avi-fauna is proposed through identification of adequate protected areas network by upgradation of Hokera as a sanctuary together with declaration of Manibugh – Kranchu, Lasjan, Narkara, Baba Shuku-r-din (Bathi/Raw Kach) as Sanctuaries.

**Table 12: Geographical Details of Wetlands in Kashmir Valley**

S. No.	Name of wetland	District	Altitude MSL	North Latitude	East Longitude
1.	Panzipora	Pulwama	1,607	33 <sup>0</sup> .52'	75 <sup>0</sup> .03'
2.	Manibugh	Pulwama	1,607	33 <sup>0</sup> .59'	74 <sup>0</sup> .56'
3.	Chatlum	Pulwama	1,593	34 <sup>0</sup> .01'	74 <sup>0</sup> .56'
4.	Dal Lake	Srinagar	1,585	34 <sup>0</sup> .05'	74 <sup>0</sup> .50'
5.	Narkara	Budgam	1,588	34 <sup>0</sup> .02'	74 <sup>0</sup> .45'
6.	Hokera	Budgam/Srinagar	1,584	34 <sup>0</sup> .05'	74 <sup>0</sup> .40'
7.	Mirgund	Badgam	1,583	34 <sup>0</sup> .07'	74 <sup>0</sup> .38'
8.	Mirgund Numbal	Baramulla	1,632	34 <sup>0</sup> .08'	74 <sup>0</sup> .39'

Photograph 38-41



The water bodies of Manibugh-Kranchu, Lasjan, Narkara, Hokera and Mirgund sprawl over an area of 0.40 km<sup>2</sup>, 0.30 km<sup>2</sup>, 3.25 km<sup>2</sup>, 13.75 km<sup>2</sup> and 4.00 km<sup>2</sup> respectively.

All these wetlands are characterized by low water level that fluctuates greatly during the year in response to the natural discharge from their sources. Most of the wetlands except Chatlum and Manibugh are surrounded on all sides by paddy fields and excess water from these washes down alongwith various organic and inorganic constituents.

**Table 13: Bio-monitoring of wetlands in Bird Sanctuaries of Kashmir Valley**

S. No.	Wetlands	Location	Temperature °C		Saprobic score	Diversity score	BWQC	Biological Water Quality
			Air	Water				
1.	Hokersar	Zaina Kote Sector 1, NH-1A	29.5	24.5	5.0	0.55	C	Moderate Pollution
2.	Mirgund	Mirgund, Noorabad	26.5	26.5	4.25	0.40	D	Heavy Pollution
3.	Narkara Nadru	Nadru, Army Air Port Road	23.5	25.5	5.33	0.45	C	Moderate Pollution
4.	Hygam	Hygam at Srinagar-Baramulla NH-1A	24.0	25.5	5.5	0.43	C	Moderate Pollution
5.	Ajas	Ajas, Srinagar-Bandipora Road	28.0	30.0	5.66	0.55	C	Moderate Pollution
6.	Manasbal	Manasbal near Kondabal	26.0	25.5	8.0	0.71	A	Clean
7.	Wullar	Haretare	31.0	-	5.6	0.78	C	Moderate Pollution
8.	Shallabugh	Shallabugh, Ganderbal	20.0	12.15	5.3	0.49	C	Moderate Pollution
9.	Panzipora	Kapore, Marhama, Srinagar-Jammu NH-1A	25.0	20.5	5.0	0.33	C-D	Moderate to Heavy Pollution
10.	Padgampora	Pulwama at Pulwama-Avantipora Road	31.0	25.0	3.4	0.84	C	Moderate Pollution

S. No.	Wetlands	Location	Temperature °C		Saprobic score	Diversity score	BWQC	Biological Water Quality
			Air	Water				
11.	Manibugh	Pampore, Galender, NH-1A	28.0	20.0	5.28	0.59	C	Moderate Pollution

Photograph 42-45

S. No.	Wetlands	Location	Temperature °C		Saprobic score	Diversity score	BWQC	Biological Water Quality
12.	Chatlum Lalpore	Chatlum, NH-1A	25.0	25.0	5.3	0.42	C	Moderate Pollution
13.	Inner Dal Lake	Srinagar	24.0	24.5	4.75	0.46	D	Heavy Pollution
14.	Nagin Lake	Srinagar	24.5	26.0	5.4	0.61	C	Moderate Pollution
15.	River Sind	Mamer, Sonamarg-Srinagar Road	20.0	10.0	0.0	0.0	E	
16.	River Sind Inner Nullah	Mamer Sonamarg-Srinagar Road	20.0	8.0	5.33	0.19	D	Heavy Pollution
17.	Thajiwas Glacier	Border of Sonamarg-Leh	10.0	2.0	7.4	0.30	A	Clean
18.	Dachigam Nullah	Srinagar	27.5	16.0	7.4	0.64	A	Clean

**Table 14: Environmental Problems related to various activities in vicinity of wildlife of Kashmir Valley**

S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
1.	Hokersar's (Hokera) wetland	Zaina Kote Sector 1, NH-1A	Fish farm, paddy cultivation, willow, poplar tree plantation, grazing cattle, forest, Dweeding in wetland, domestic wastewater discharge, cattle farming, open defaecation, captive breeding of Bar headed goose. Over wintering resort for migratory birds.	Hard substraction due to Siltation, profuse weed growth, wild grass, habitat destruction for bird nesting, encroachment of paddy cultivation, water quality due to surface runoffs.
2.	Mirgund	Srinagar-Gulmarg Road Mirgund, Noorabad	Paddy cultivation, abstraction of water, cattle wading, grazing, forest of poplar tree & willow plantation for cottage industry, human settlement, cultivation of vegetables.	Encroachment of wetland catchment area, low level of water, Siltation, lack of nesting habitats profuse weed growth water quality due to decomposition of macrophytic vegetation.
3.	Narkara Nadru	Nadru, Army Air Port Road	Paddy cultivations, human settlement, solid waste dumping poaching, reclamation of land for paddy cultivation and vegetable cultivation in catchment, cattle, farming,	Uprooting of tree due to heavy snowfall and rains, Siltation due to flood channel of excessive growth of wild grass, habitat destruction for birds, water quality due to

S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
			domestic wastewater discharge. Traffic of air and roadways.	surface runoffs. Shrinking of wetland area. Bird hit to aero planes.

Photograph 46-48

S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
4.	Hygam	Hygam at Srinagar-Baramulla NH-1A	Residential colonies, Deweeding for cattle feed, illegal occupation by villagers, willow plantation, burning of dried grass, construction of bunds. Abstraction of water. Habitat for migratory birds, over growth of Wapaygrass, drain discharge from Ningli & Balkul nullah.	Shallow water body, Siltation, encroachment by paddy cultivation, lack of nesting habitat, over growth of wapay grass, replacing the fodder grass, tree felling due to heavy snow fall. Fish kills due to eutrophic condition in water body.
5.	Ajas	Ajas, Srinagar-Bandipora Road	Paddy fields, stone quarry grazing land, traffic adjacent to wetland, deforestation, surface drainage from surrounding and Waniyar nullah, Walnut plantation, Honey Bee cultivation, Brick formation	Low level of water, encroachment by paddy fields, Siltation, water scarcity during summer, lack of habitat for birds, water quality.
6.	Manasbal Lake	Manasbal near Kondabal	Tourism, boating, fish harvesting, private lotus cultivation, residential activities, stone quarry, lime klin, paddy cultivation, solid waste disposal at amusement park. Surface drainage to lake. Cultivation of Nadru and Euryale ferox salisb (rare aquatic plant).	Water quality, Siltation on the boundaries, decomposition of aquatic weeds near residential settlement. Deep-water body profuse macrophytic submerged vegetation. Few benthic macro invertebrate populations.
7.	Lake Wullar	Haretare	Paddy cultivation, willow plantation, fishing, Deweeding encroachment of residential settlement, Kanihome drain discharge, illegal settlement on the bank, cattle forming, temporary bunds, drying of weeds in water body. Silviculture, captive fisheries, water chestnut, lotus rhizome, fish and fodder, egg hatchery of ducks and mass deweeding.	Shrinking of catchment area, Siltation, lowering of depth of water body, water quality due to drain water, development of floating lands, animal mortality due to floods, decomposition of profuse growth of macrophytic vegetation, lack of nesting habitats.
8.	Shallabugh	Shallabugh, Ganderbal	Cattle wading, Deweeding, fishing, flood water of river Sind joins wetland, drain water discharge from villages willow plantation for cottage sports industry,	Water quality, Siltation, profuse filamentous algal growth, due to willow tree, shrinking in catchment area and development of floating lands, low level of

S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
			grazing lands, surface runoff.	water, sedimentation.



S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
9.	Panzipora	Kapore, Marhama, Srinagar	Paddy farming, cattle wading, willow & popular tree plantation for cottage industry of Bat making, deforestation, drainage of surface run offs from surrounding, quarries, stone crushing, lime kiln, human settlement, open defaecation. Irrigation canal running parallel, saffron cultivation, cement factory.	Encroachment in catchment area of wetland. Siltation, water quality, water scarcity, profuse duckweed growth, land reclamation for human settlement and cultivation.
10.	Padgampora	Pulwama- Avantipora Road, Seed Multiplication farm	Seed multiplication farm for cultivation of corn, paddy, cereals, beans and cattle feed seeds, willow plantation, air port, abstraction of water for paddy cultivation using high capacity pump, grazing, open defaecation. Water scarcity, saffron fields, almond cultivation, and cement industry, stone quarry.	Shrinking of catchment area of wetland, water scarcity, development of marshy land habitat destruction, noise levels, Siltation. Bird hit chances due to close vicinity of airport.
11.	Manibugh	Pampore, Galender, NH-1A	Paddy cultivation, apple, saffron, peas, apricot, maize, cherry, almonds and nuts plantation, willow tree plantation in surrounding, stone quarries, lime kiln, storage of petroleum product, bottling plant in the vicinity, deforestation. Drainage of surface run off.	Encroachment in catchment area, Siltation in wetland, habitat destruction, water quality, and profuse growth of duckweed, high-tension wire across the wetland, soil erosion.
12.	Chatlum Lalpore	Pampore on NH-1A near Chatlum, Dept. of Fisheries Govt. of India	Fish seed farming, cattle wading, human settlement, cultivation of saffron, maize, vegetables, bottle polythene bags, plastic alongwith solid waste dumping site. Heaps of cow dung used as fuel drain discharge, surface run offs, lotus cultivation.	Water quality of wetland, shrinking of catchment area, Siltation, decomposition of macrophytic vegetation, sedimentation
13.	Inner Dal Lake	Srinagar	Tourism, transport, commercial activity, domestic wastewater discharge, house boats, medical centres, de-	Water quality, shrinking of lake area, Siltation, anaerobic and unhygienic conditions in canal, habitat destruction for fauna and

S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
			sludging, Deweeding, floating aerators for cleaning, floating gardens,	flora, clusters of houseboats at one place. Heavy Siltation near sluice

Photographs 49-51

S. No.	Wildlife Habitat	Wetland location	Activities	Environmental Problems
			reclamation of land for building construction, vegetable cultivation, electrical power supply, wastewater discharge through canal from Rainawari area, dumping of abandoned house boats, bathing, washing etc. profuse macrophytic vegetation, duckweed etc. construction of radh, formation of dembs.	gate residential area near polluted water body, Deforestation for shikarra industry near lake.
14.	Nagin Lake	Srinagar, Hazarat Bal, Saderbal, Nagamala and Barhal area	Drinking water source, swimming, tourism, house boats, construction of bridge, waste water discharge of Rainawari area through canal deforestation, cultivation, floating gardens, Amir Khan nullah joining the lake, Transport, cottage industry of mats and ornamental items, construction of radh, dembs.	Development of peat lands, Siltation, profuse weed growth, lack of habitats for birds, water quality.
15.	River Sind Inner nullah	Mamer, Sonamarg-Srinagar Road	Turbulent river, Hydro-electric power generation, tourism, construction of cultivated lands, radh.	Sandy substratum of river, Siltation in Inner nullah, domestic waste discharge through surface run offs.
16.	Thajiwas Glacier	Border of Sonamarg-Leh	Origin of river Sind, Tourism, Transport through horse, pony etc. settlement of army (BSF) forest and Thajwas wildlife.	Horse and cattle dung, open defaecation, solid waste dumping through tourist activities use of polythenes bottles & plastic bags.
17.	Dachigam Nullah	Srinagar	Dachigam National Park, conservation of Hangul Deer endangered sp. Paddy cultivation, water reservoir in the vicinity, fishponds, swimming pool, Dachigam stream is main source of water to Dal lake.	Surface runoffs from Fishpond, swimming pool and cultivated lands.

#### **4.0 BIOLOGICAL WATER QUALITY ASSESSMENT OF WETLANDS IN BIRD SANCTUARIES**

Bio monitoring of water quality was initiated at wetlands/water bodies used for propagation of wildlife and fisheries as one of the important designated best use

of the aquatic resources. The wetlands existing in wildlife habitats of most of the Bird sanctuaries demand water quality suitable for highly productive and rich bio-diversity of fauna and flora. In view of protection of rare and endangered/threatened species of migratory and resident birds, the bio-monitoring of water quality was initiated at 42 nos. of wetlands identified in 26 nos. of bird sanctuaries existing in the state of Rajasthan, Uttar Pradesh, Andhra Pradesh, Delhi and Jammu & Kashmir. Wetlands in Bird Sanctuaries include various surface water bodies such as Rivers, Canals, Lakes, Barrages, Drains, Marshes, Beels, Estuaries and Mangroves.

The taxonomic composition of wetlands varied with respect to hydrological conditions of water bodies such as Rivers, Lakes and Ponds. Most of the wetlands identified in Bird Sanctuaries belonged to the Biological Water Quality Class of 'C' and 'D'. Classes. 'A' water quality of clean stretches existed either in the upstream river stretches of wetlands or in very deep-water bodies (Table 14). These stretches are not suitable for bird sanctuaries due to non-availability of sufficient fauna and flora. A total of 15 nos. of families of benthic macro-invertebrates were collected from 3 wetlands of Class 'A' quality.

None of the wetlands existed in 'B' class of water quality of BWQC as a result of habitat destruction due to various human activities such as bathing etc.

A maximum of 27 nos. of wetlands supported biodiversity suitable for 'C' class of water quality (Table 17). Maximum of 43 nos. of benthic macro-invertebrate families (Table 17) have been collected from wetlands of moderately polluted water quality (Class 'C'). There were only 9 nos. of wetlands having water quality with heavy pollution of water quality class 'D'. A total of 27 nos. of families of benthic macro-invertebrates were collected from these wetlands (Table 18). The water quality of 4 nos. of wetlands belonged to class 'E' of BWQC either due to severe pollution or due to sandy substratum (Table 19).

**Table 15: Clean Water (Class 'A') Stretches of Wetlands existing in Bird Sanctuaries**

S. No.	State	Wetland	District/Town/Village	Location of Stretch/Bird Sanctuary	Taxa/Families of Benthic Macro-invertebrates available from wetlands
1.	Jammu & Kashmir	Manasbal Lake	Manasbal near Kondabal	Manasbal Lake	<u>EPHEMEROPTERA/</u> Heptageniidae, Leptophlebiidae, Empemerellidae, Baetidae
		River Sind	Sonamarg	2-3 km upstream of Sonamarg and Leh	<u>TRICHOPTERA/</u> Leptoceridae, Goeridae,

		upstream		border Thajiwat wildlife sanctuary	Rhyacophilidae, Polycentropodidae
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S. No.	State	Wetland	District/Town/Village	Location of Stretch/Bird Sanctuary	Taxa/Families of Benthic Macro-invertebrates available from wetlands
		Dachigam Nullah	Srinagar	Dachigam National Park	<u>ODONATA/</u> Lestidae, Gomphidae, Libellulidae  <u>PLANARIA/</u> Planariidae  <u>DIPTERA/</u> Simuliidae, Blepharoceridae  <u>HIRUDINEA/</u> Glossiphoniidae

**Table 16: Slightly Polluted (Class `B`) Stretches of Wetlands in Bird Sanctuaries**

None of the wetlands of Bird Sanctuaries existed in Class `B`
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**Table 17: Moderately Polluted (Class C) Stretches of Wetland existing in Bird sanctuaries**

S. No.	State	Wetland	District/ Town Village	Location of Stretch/ Bird sanctuary	Taxa/families of Benthic Macro-invertebrates available from wetlands
1.	Rajasthan	Ghana Canal	Bharatpur	Keoladeo Bird Sanctuary	EPHEMEROPTERA/ Ephemerellidae, Baetidae
		Ghana lake		Keoladeo Bird Sanctuary K&L Block	ODONATA/ Lestidae, Gomphidae, Libellulidae, Aeschnidae
2.	Andhra Pradesh	River Godavari Upstream	Rajahmundry East Godavari District	Dowaileswaram	MOLLUSCA/ Thiaridae, Lymnaeidae, Viviparidae, Physidae, Unionidae, Planorbidae, Bithynidae, Sphaeriidae, Hydrobiidae
3.	Andhra Pradesh	River Corangi at Low tide	Ramanapalam East Godavari District	Corangi Wild Life sanctuary	
4.	Yanam (Pondicherry)	River Gaderu in Coringa Wild life Sanctuary	Savitri Nagar	Wooden Bridge Coringa Wild Life Sanctuary	CRUSTACEA/ Asellidae, Atyidae, Gammaridae, Paleamonidae, Potamobiidae (Hermit Crab)
5.	Andhra Pradesh	Manjira Barrage	Sangareddy, Hyderabad	Manjira Wild Life Sanctuary	

S. No.	State	Wetland	District/ Town Village	Location of Stretch/ Bird sanctuary	Taxa/families of Benthic Macro-invertebrates available from wetlands
6.	Andhra Pradesh	Godavari Canal	Chettipeta West Godavari Dist.	Downstream of Hydrel Power Plant, U/s of Kolleru Bird Sanctuary	HEMIPTERA/ Gerridae, Naucoridae, Nepidae, Belastomatidae, Pleidae, Corixidae, Notonectidae, Aphelocheiridae, Velida



S. No.	State	Wetland	District/ Town Village	Location of Stretch/ Bird sanctuary	Taxa/families of Benthic Macro-invertebrates available from wetlands
8.	Andhra Pradesh	Upputeru outlet Drain of Kolleru lake	Akiveedu at Vijaywada	Near Road Bridge Kolleru Bird Sanctuary	COLEOPTERA/ Gyrinidae, Hydrophilidae, Dytiscidae, Hygrobiidae, Elminthidae
9.	Andhra Pradesh	Polaraju Drain of Kolleru lake	Lokumudy West Godvari District	Near Road Bridge, Kolleru Bird Sanctuary	DIPTERA/ Chironomidae, Tipulidae, Syrphidae, Simuliidae
10.	Andhra Pradesh	Chinaedlagadi Drain	Kowadalanka Area, West Godavari Dist	Eluru-Kaikaluru Road, Kolleru Bird Sanctuary	PLANARIA/ Planaride HIRUDINEA/ Glossiphonidae, Erpobdellidea
11.	NCT Delhi	Najafgarh Drain	Dhansa	Dhansa Regulator, Najafgarh Jheel	MEGALOPTERA/Sialidae
	Delhi-Gurgaon Border		Jhatikra	Near Road Bridge, Najafgarh Jheel	OLIGOCHAETA/ Oligochaetes
	Delhi		Chhawla	Chhawla, Guest House of Irrigation and flood control Department, Najafgarh Drain	
			Goela Khurd	Goela Dairy Police check post, Najafgarh Drain	
12.	Uttar Pradesh	River Yamuna	Delhi	Wazirabad water works	
				Wazirabad Barrage opposite bank at Sonia Vihar	
				Okhla Barrage Pakshi Vihar	
		Keetham Lake	Keetham (Agra)	Delhi-Agra Road, 20 km from Agra City, Sur Sarovar Bird Sanctuary	
		Samaspur Lake	Raebarely	Samaspur Bird sanctuary	
		River Sai Upstream	Raebarely	Lucknow-Kanpur Road Bridge on NH-25 Samaspur Bird sanctuary	
		River Sai Downstream	Raebarely	Saipul on Lucknow-Varanasi Road Samaspur Bird Sanctuary	

S. No.	State	Wetland	District/ Town Village	Location of Stretch/ Bird sanctuary	Taxa/families of Benthic Macro-invertebrates available from wetlands
		River Garrah	Sandi at Hardoi	Channel goes to Sandi lake Bird sanctuary	

S. No.	State	Wetland	District/ Town Village	Location of Stretch/ Bird sanctuary	Taxa/families of Benthic Macro-invertebrates available from wetlands
13.	Jammu & Kashmir	Hokersar's	Zainakote	Hokera wetland Sector 1, on NH-1A	
		Narkara Nadru	Nadru	Army Airport Road By pass on the right side	
		Hygam	Hygam	Right side of Srinagar-Baramulla NH-1A	
		Ajas Jheel	Ajas	Adjacent to Srinagar-Bandipora road	
		Wullar Lake	Haretare	Sumbal-Spore Road	
		Shallabugh	Shallabugh	Ganderbal Headquarter near Jaswant Post F. Co.	
		Padgampora	Pulwama, Padgampora	Avantipora-Pulwama Road on the way to Army Air Port Road near Seed Multiplication farm	
		Manibugh	Pampore, Manibugh	Near Galander Village on NH-1A	
		Chatlum-Lalpore	Pampore, Chatlum	NH-1A, near Dept. of Fisheries J & K Govt. Fish seed farm office of the Fisheries Development Assistant	
Nagin Lake	Hazarat Srinagar	Bal, Saderbal, Nagmala and Barhal area			

**Table 18: Highly Polluted (Class 'D') stretches of Wetland existing in Bird sanctuaries**

S. No.	State	Wetland	District/Town Village	Stretch/ Bird Sanctuary	Taxa/ families of Benthic Macro-invertebrates available from Wetlands
1.	Andhra Pradesh	River Godavari Upstream	Rajahmundry, East Godavari District	Arya Puram u/s Coringa Wild Life Sanctuary	EPHEMEROPTERA/ Baetidae, Leptophlebiidae

2.	Delhi-Gurgaon Border	Najafgarh Jheel	Jhatikra	1½ km upstream of Jhatikra	CRUSTACEA/ Gammaridae
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S. No.	State	Wetland	District/Town Village	Stretch/ Bird Sanctuary	Taxa/ families of Benthic Macro-invertebrates available from Wetlands
3.	Delhi	Najafgarh Drain	Kakrola	Kakrola Regulator Near Bridge	MOLLUSCA/ Viviparidae, Thiaridae, Planorbidae, Sphaeridae, Lymnaeidae  HEMIPTERA/ Belastomatidae, Corixidae, Notonectidae, Nepidae, Pleidae
			Uttam Nagar	Near Uttam Nagar Police check post	
			Vikas Puri	U/s of Pankha Road Drain confluence	
4.	Uttar Pradesh	Nawabganj Lake	Nawabganj in Unnao	Lucknow-Kanpur NH-25 Nawabganj Bird sanctuary	COLEOPTERA/ Hydrophilidae, Dytiscidae,  Hygrobiidae, Psephenidae
5.	Uttar Pradesh	Sandi Lake	Sandi in Hardoi	19 km on Hardoi Sandi Road Near Sandi Police Station, Sandi Bird sanctuary	DIPTERA/Tipulidae, Culicidae, Chironomide, Ephidridae, Blepherozeridae
6.	Jammu & Kashmir	Mirgund, Srinagar	Mirgund, near Noorbad Hyderpura	16 km from Srinagar on Srinagar-Gulmarg Road	ODONATA/ Libellulidae, Lestidae,
		Panzipora	Kapore, Marhama	Srinagar-Jammu NH-1A towards left turn from Sangam Bridge	OLIGOCHAETA/ Oligochaetes  MEGALOPTERA/ Sialidae  HIRUDINEA/ Glossiphonidae
		Inner Dal Lake	Srinagar	Adjoining the city of Srinagar, Dal Kutwal upto Watpore area	

		River Sindh Inner nullah u/s Shallabugh to	Mamer Sonamarg	Sonamarg- Srinagar Road	
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**Table 19: Severely Polluted (Class ‘E’) stretches of Wetland existing in Bird Sanctuary**

S. No.	State	Wetlands	District/Town/ Village	Location stretch/ sanctuary	of Bird	Taxa/families of Benthic Macro- invertebrate available from Wetlands
1.	Delhi	Najafgarh Drain	Delhi	D/s of Keshopuram STP outfall		No macro- invertebrates recorded.
				Basaidarapur behind I & F Control office		
				Ashok Vihar Near Wazirpur Police Check Post		
				Bharat Nagar		
2.	Delhi	Najafgarh Drain		Bharat Nagar to confluence to River Yamuna at D/s of Wazirabad Barrage Najafgarh drain is canalized		
3.	Jammu & Kashmir	Shallabugh, River Sindh d/s	Ganderbal	HQ of Shallabugh near Jaswand post F. Company on the way to Shallabugh wetland by boat		No macro invertebrates due to Sandy substratum
		River Sindh u/s	Mammar	Sonamurg-Srinagar Road		

**Table 20: Taxonomic Composition of Benthic Macro-invertebrate families of Wetlands in Bird Sanctuaries**

S.	Taxa	Biological Water Quality Classes of Wetlands
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No.		A	B	C	D	E
1.	EPHEMEROPTERA	Heptageniidae, Leptophlebiidae, Ephemerellidae, Baetidae	No animals	Ephemerellidae Baetidae	Leptophlebiidae, Baetidae	No Macro invertebrates
2.	TRICHOPTERA	Leptoceridae, Goeridae, Rhyacophillidae, Polycentropodidae	No animals	No animals	No animals	No Macro invertebrates
3.	ODONATA	Lestidae, Gomphidae, Libellulidae	No animals	Lestidae, Gomphidae, Libellulidae, Aeschnidae	Lestidae, Libellulidae	No Macro invertebrates
4.	PLANARIA	Planariidae	No animals	No animals	No animals	No Macro invertebrates
5.	MOLLUSCA	No animals	No animals	Thiaridae, Lymnaeidae, Viviparidae, Physidae, Unionidae, Planorbidae, Bithynidae, Sphaeridae, Hydrobiidae	Viviparidae, Thiaridae, Planorbidae, Sphaeridae, Lymnaeidae	No Macro invertebrates
6.	CRUSTACEA	No animals	No animals	Asellidae, Atyidae, Gammaridae, Paleamonidae, Potamobiidae	Gammaridae	No Macro invertebrates
7.	HEMIPTERA	No animals	No animals	Gerridae, Naucoridae, Nepidae, Belastomatidae, Pleidae, Corixidae, Notonectidae, Aphelocheiridae, Velidae	Belastomatidae, Corixidae, Notonectidae, Nepidae, Pleidae	No Macro invertebrates
8.	COLEOPTERA	No animals	No animals	Gyrinidae, Hydrophilidae, Dytiscidae, Hydrobiidae, Elminithidae	Hydrophilidae, Dytiscidae, Hydrobiidae, Psephenidae	No Macro invertebrates
9.	DIPTERA	Simuliidae Blepharoceridae	No animals	Chironomidae, Tipulidae, Syrphidae, Simuliidae	Tipulidae, Culicidae, Chironomidae, Ephidridae, Blepharoceridae	No Macro invertebrates
10.	HIRUDINEA	Glossiphonidae	No animals	Glossiphonidae, Erpobdellidae	Glossiphonidae	No Macro invertebrates

S. No.	Taxa	Biological Water Quality Classes of Wetlands				
		A	B	C	D	E
11.	MEGALOPTERA	No animals	No animals	Sialidae	Sialidae	No Macro invertebrates
12.	OLIGOCHAETA	No animals	No animals	Oligochaetes	Oligochaetes	No Macro invertebrates
<b>Total families</b>		<b>15</b>	<b>0</b>	<b>42</b>	<b>27</b>	<b>0</b>



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