

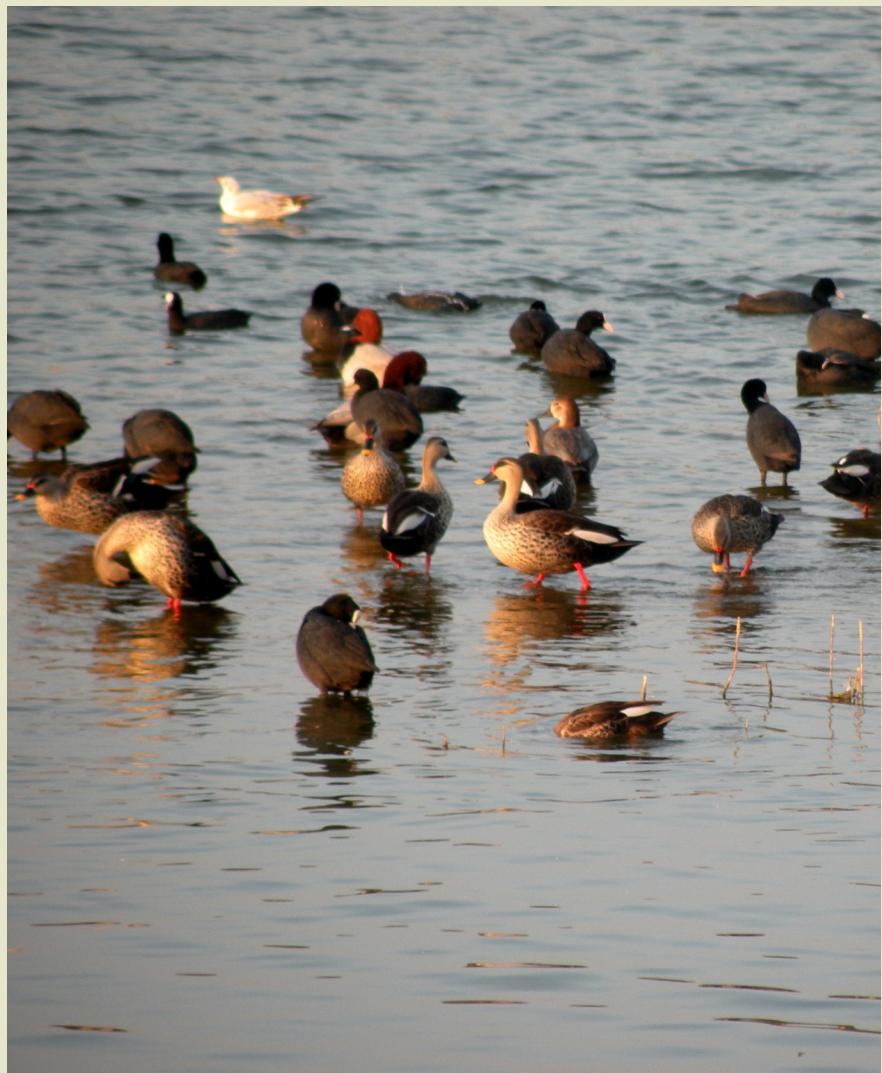
# **Ecological studies on the selected Wetlands in Patan district**

***to prepare management plan for long term  
conservation***

A short term  
Project Report

*Submitted to*

Patan Forest  
Division



**WCB Research Foundation  
Patan**  
[www.wcbresearch.in](http://www.wcbresearch.in)

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- Wetland Project Team

## **Research Team**

***Project  
Coordinator***

: *Dr. Nishith Dharaiya, PhD  
Director of Research  
WCB Research Foundation, Patan.*

***Assistant  
Coordinator***

: *Dr. Nikunj B Gajera,  
Scientist, Gujarat Institute of  
Desert Ecology, Bhuj (Kuchchh)*

***Project Fellows***

: *Ms. Rinku Bhati  
Ms. Jahnvi Patel*

***Volunteer***

: *Mr. Aditya Dharaiya*

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## Summary

Wetlands are viewed as probably the most fertile and beneficial biological systems on the planet on account of the creating food and materials for some individuals in Asia and everywhere on the world and offer significant types of assistance free of charge or cost which assume a significant part in keeping up the amount and security of life on earth for people. Wetlands structure a one-of-a-kind environment, giving irreplaceable natural surroundings and significant nourishment for overwintering birds. Wetlands are the associations between water and land. They can be wet all year, however regularly are just soggy occasionally and some of the time dry. They are typically scene highlights like bogs, swamps, marshes, fens, playas, grassland potholes, vernal pools, shallow lakes, discontinuous and fleeting streams, and straits of bigger lakes. Wetlands cover 6% of the world's land surface and wetlands structure a unique ecosystem, giving basic territories and Valuable food for overwintering birds, which move every year from northern latitude for feeding and reproducing.

A major goal of this study is to evaluate the ecological status of the wetlands of Patan district by a rapid assessment technique for monitoring and conservation purpose. The study area constitutes nine taluka and all the taluka were surveyed to observed bird assemblage and diversity.

During the study period **138** wetlands were surveyed and among these total of **41** wetlands from six taluka were selected based on diversity and abundance for further analysis. A total of **206** bird species belonging to 20 orders, 62 families, and 138 genera were reported at the entire study area. Among these, 47% of birds were recorded as migratory, and 12% of birds were observed as IUCN red-listed. The bird assemblage was further analyzed by feeding guild, WPA status, calculating bird diversity indices, and richness through remote sensing.

The significant statistics of the bird species diversity were analyzed using different indices such as the Shannon-wiener index, Simpson Index, and Evenness to evaluate the current ecological status of the wetland. In the end, a total of **23** wetlands that having high species diversity of birds were listed as an **Important Wetlands of Patan**. Among these Khokhala, Garamdi, Chhanasra-Rajusara highway wetland, Vadilal dam, and Bolera-Sankheshwar road wetlands are the most important. The entire list of these 23 important wetlands is given as annexure III. These wetlands need more attention and regular monitoring to prevent anthropogenic activities.

Western Part of Gujarat (i.e., Kachchh, Patan and Part of Banaskantha district) falls in between the main migratory route of most of the migrants coming from Europe and Africa, and Arabia. It is a staging ground for all these migrants. So, the study provides a strong base and support for conserving these wetlands as a feeding and breeding ground of wetland obligatory birds.

This comprehensive report of short term survey of wetlands of Patan district during the migratory season (November 2020 – February 2021) provide the baseline data on birds of Patan as an annotated checklist, a map of Wetlands of Patan, a list of all the wetlands in the district and a list of important wetlands of Patan with respect to migratory birds. A GIS map of bird congregation areas in Patan district based on species richness and diversity is also prepared during the study and provided in this report. In conclusion, this report will be very useful as a baseline data on birds, especially the wetland birds and help in developing and formulating future conservation and wetland management strategies for the district.

## **Introduction**

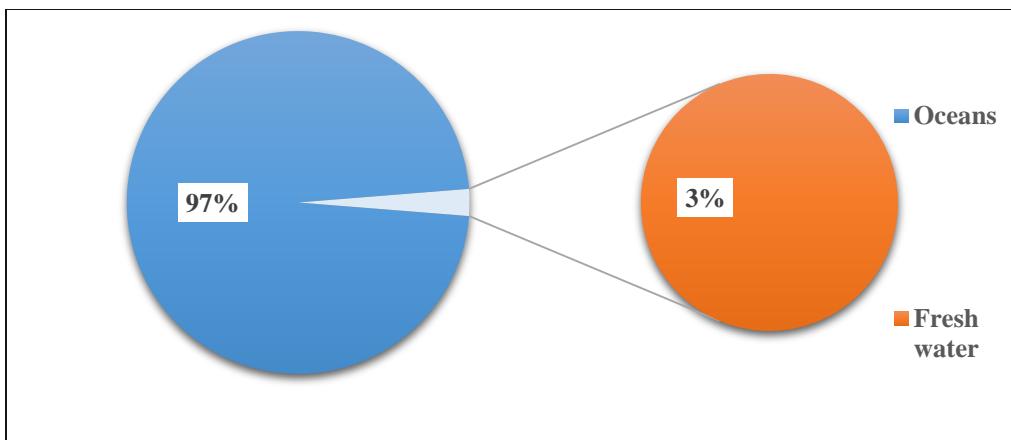
Wetlands comprise areas that transition between terrestrial (land) areas and aquatic (water) areas. It represents a richly diverse web of plants and animals interacting together along with the abiotic factors influencing the ecosystem; hence the health of such ecosystems is determined by the quality of abiotic and biotic factors. These ecosystems also exhibit great sensitivity to disturbance from outside influence, particularly by human development and environmental damage. Wetlands ecosystems are known to provide the world with natural storm barriers, environmental cleansers, and food and water resources for many forms of life. Most of the freshwater resources are under the stress of urbanisation, and misuse, mismanagement of natural resources also responsible for introducing many undesirable modifications to aquatic environments. Information and understanding of environmental change is necessary to allow the protection and remediation of ecosystems (Ramachandra, 2007). Scientists estimate at least 40 percent of the entire world's species resides in wetlands; without healthy wetlands ecosystems, many species on earth would suffer. Apart from the resources, wetlands provide beauty and a place for recreational activities for people to enjoy. Finding sustainable methods to conserve wetlands in an ever-changing world remains of prime importance.

### **Background**

Water is the bountiful substance, covering more than 70% of the earth's surface and existing in many forms: mostly in the oceans and polar ice caps, but also as clouds, rain water, rivers, freshwater aquifers, and sea ice. Water makes  $\frac{2}{3}$  of our body. Water is used for domestic purposes for cleaning, cooking bathing, and carrying away wastes, and in agriculture for irrigation, power generation, industries, navigation, recreation and in many other ways (Ramchandra, 2007). The world's oceans and other freshwater resources have been increasingly contaminated with sewage, agricultural chemicals, oils, heavy metals, radioactive materials, detergents and many other products of the human settlements. The hydrological cycle of the water maintaining the surface water on the earth. During the monsoon, many empty lands are filled with water (Mao *et al.*, 2010).

Although covering a huge area, water is not distributed evenly on the Earth; 97.47% water deposited in the oceans and only 2.53% is remains as fresh water (Figure 1) (Jones, 1997).





**Figure 1:** Distribution of water on the earth

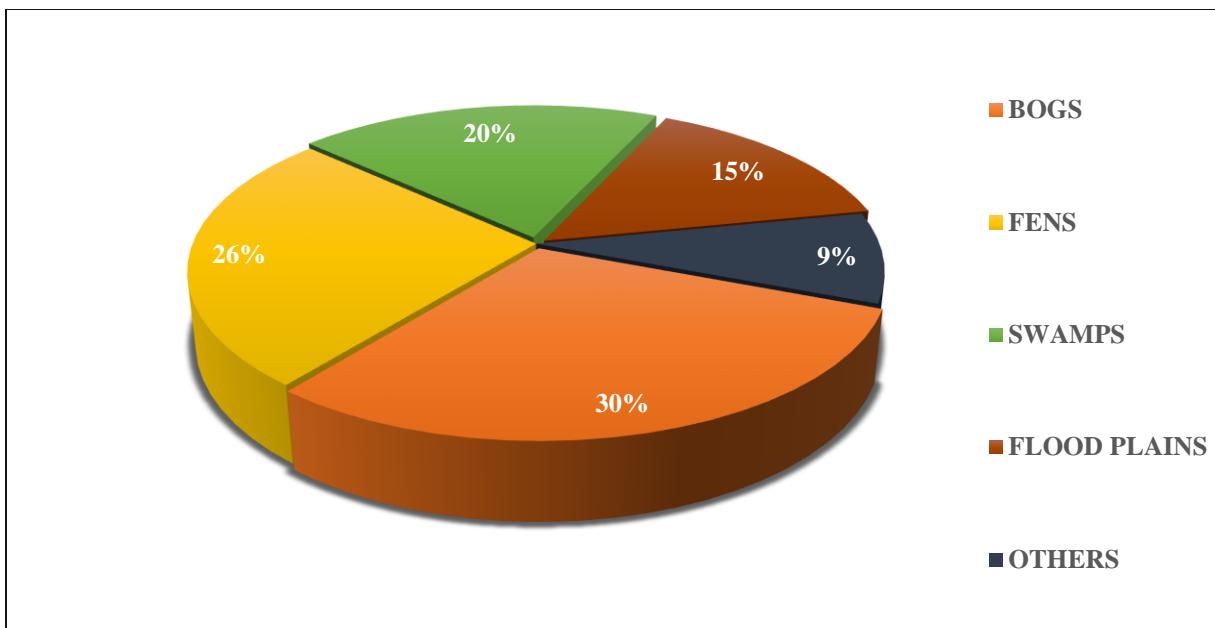
### Types of water bodies

Surface water is any water body above ground, including streams, rivers, lakes, reservoirs, and creeks. The ocean, despite being saltwater, is also considered surface water. Among these Wetlands are very fragile and constitute treasure of biodiversity (Padmavathy *et al.*, 1970). Wetlands are considered as transitional land between terrestrial and aquatic eco-systems where the water table is usually at or near the surface or the land is covered by shallow water (Mitsch and Gosselink, 1986).

### Wetlands

Wetlands are defined and explained differently by different scientists. The combination of aquatic and terrestrial conditions that produce what we describe as 'wet-lands' makes these ecosystems among the most complex in the world (Halls, 1997). Wetlands are the area of land that are either permanently or temporarily covered by water exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry. A wetland is a land area that is saturated with water, either seasonally or permanently. It has a distinct characteristic of a marked ecosystem of the earth. Primarily, the factor that distinguishes wetlands from other land forms or other waterbodies is their special biodiversity. (Abraham, 2015). Globally, wetlands are estimated to occupy nearly 6.4% of the earth surface, out of which man-made wetlands are shown in figure 2 (Acharya and Adak, 2009).





**Figure 2:** Different wetlands occupying the earth surface

Tropical wetlands are cover about 2.64 million km<sup>2</sup> worldwide whereas wetlands in temperate and boreal regions occupy about 5.72 million km<sup>2</sup>. Indian wetlands are mostly associated with river systems distributed from the cold, arid zone of Ladakh, and the wet-humid zone of the Southern Peninsula. Of an estimated 4.1 million ha of wetlands (excluding irrigated agriculture lands, rivers, and streams) 1.5 million ha are natural and 2.6 are man-made, while the coastal wetlands occupy an estimated 6750 km<sup>3</sup>, largely dominated by mangroves (Acharya and Adak, 2009).

### Classification of wetlands

Categorization of wetlands are mainly in two parts that is Natural and Man-made, among them 17 are Natural and 7 are man-made wetlands includes Inland and coastal wetlands (Table 1). It is possible to identify five broad wetland systems that include estuaries, marine wetlands, riverine wetlands, palustrine and lacustrine wetlands (Wondrefash M., 2003).



## *Study on wetlands of Patan*

**Table 1: Classification of wetlands**

	<b>Inland Wetlands</b>	<b>Coastal wetlands</b>
<b>Natural</b>	<ul style="list-style-type: none"> <li><input type="radio"/> Lakes/ponds</li> <li><input type="radio"/> Oxbow lakes/ cutoff meanders</li> <li><input type="radio"/> Waterlogged (seasonal)</li> <li><input type="radio"/> Playas</li> <li><input type="radio"/> Swamps/marsh</li> </ul>	<ul style="list-style-type: none"> <li><input type="radio"/> Estuary</li> <li><input type="radio"/> Lagoon</li> <li><input type="radio"/> Creek</li> <li><input type="radio"/> Backwater (Kayal)</li> <li><input type="radio"/> Bay</li> <li><input type="radio"/> Tidal flat/split/bar</li> <li><input type="radio"/> Coral reef</li> <li><input type="radio"/> Rocky coast</li> <li><input type="radio"/> Mangrove forest</li> <li><input type="radio"/> Salt marsh / marsh vegetation</li> <li><input type="radio"/> Other vegetation</li> </ul>
<b>Man-made</b>	<ul style="list-style-type: none"> <li><input type="radio"/> Reservoirs</li> <li><input type="radio"/> Tanks</li> <li><input type="radio"/> Waterlogged</li> <li><input type="radio"/> Abandonned quarries</li> <li><input type="radio"/> Ash pond/ cooling pond</li> </ul>	<ul style="list-style-type: none"> <li><input type="radio"/> Salt pans</li> <li><input type="radio"/> Aquaculture</li> </ul>

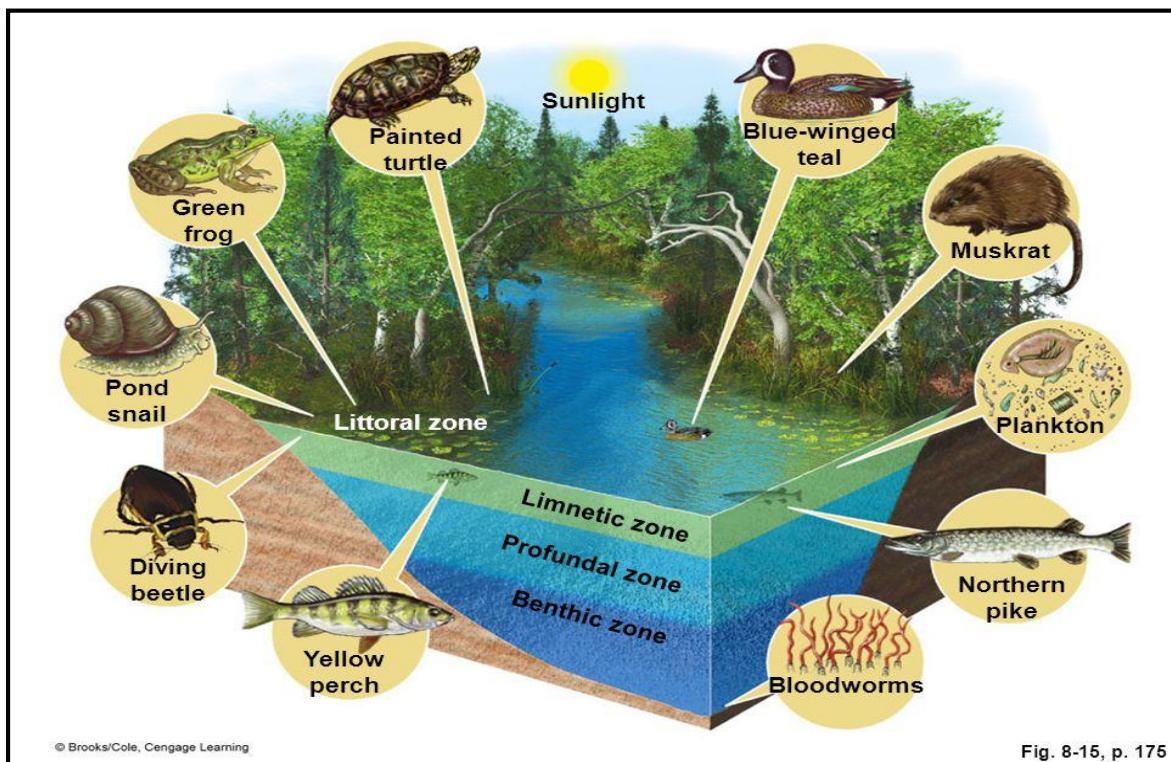
## **Wetland Ecology (Limnology)**

According to Cherry, (2011) wetlands ecosystems are actually biologically diverse and productive and home to a variety of plant life, including floating pond lilies, cattails, cypress, tamarack, and blue spruce, wetlands support diverse communities of invertebrates, which in turn support a wide variety of birds and other vertebrates. Primary consumers from crustaceans, mollusks, and aquatic insect larvae to muskrats, geese, and deer rely on the abundance of algae, plants, and detritus for food. It is also support a variety of carnivores, including dragonflies, otters, alligators, and osprey. These all are present in different life zones of wetlands.



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Life zones in a lake are distributed as shown in the figure are;



**Figure 3:** Life zones of the wetland

(Chapter 8 Aquatic Biodiversity Summary Key Questions and Concepts, n.d.)

**Littoral zone** – also called riparian zone, near the shore region, nutrient rich zone, where sunlight penetrates all the way to the sediment and allows aquatic plants (macrophytes) to grow, such as cattail, pond-lilies, rooted in the mud under water and their upper leaves and stem emerge above the water. The gradation of plants from land into water represents a transition from one environment to another and is known as the zone of succession (hydrosere). The zone provides habitat for insects like dragonflies (*Odonata*), mayflies (*Ephemeroptera*), Stonefly (*Plecoptera*), caddis flies (*Trichoptera*) and midges (*Diptera*) and other creatures such as pond snail, crustaceans (crabs and shrimps).

**Limnetic zone** – also called the pelagic zone or photic zone. Is the open water area where light does not penetrate to the bottom, it is the home of plankton and Nekton. Zooplankton depends on phytoplankton for food and they are linked between the algae and the much larger creatures such as birds and fish. Pelagic fishes are important for human and for birds too, as a food, most birds



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like ducks and geese are eating the fish by diving or catching the prey, they are commonly fed in this zone.

**Profundal zone** – called aphotic zone, which is deeper, colder and darker zone, open waters away from the shore. Located below the range of light penetration hence very trace amount of light, rich to the zone or no light.

**Benthic zone** – the term benthic applies to the flora and fauna living at the bottom, some shallow lakes, benthic algae may be an important source of food but most benthic animals beyond the littoral zone derive their food from detritus raining down from the open water. The larger inhabitants of this zone are worms, larvae of Chironomid flies, mollusks, and the smaller creatures such as nematode worms and ostracods. Many of the worms found in fresh waters have hemoglobin in the blood, which help trap oxygen. Carps are typical benthic fish which feed on whatever available. Some benthic fish has whiskers as a sense organ because they cannot find their prey by sight. (Keddy, 2000).

### **Benefits and values of wetlands**

The Ramsar 'Guidelines on wise use' provide a succinct account, for both decision-makers and the general public, of the benefits and values of wetlands which may be felt within the wetland itself or some way away from it (for example in the case of wetlands which absorb floods).

Wetlands performs numerous valuable functions such as;

- Sediment and erosion control;
- Flood control;
- Maintenance of water quality and abatement of pollution;
- Maintenance of surface and underground water supply;
- Support for fisheries, grazing and agriculture;
- Outdoor recreation and education for human society;
- Provision of habitat for wildlife, especially waterfowl;
- Contribution to climatic stability(Prasad *et al.*, 2002)

If the natural functions of wetlands are maintained, these benefits will accrue to human populations free of charge. Destruction of wetlands means either that these functions have to be provided



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artificially at considerable cost, or that the wetland has to be restored, which costs even more.(Jones, 1997).

### **Threats to wetlands: In Study area perspective**

Wetlands are one of the most threatened habitats of the world. Wetlands in India, as elsewhere are increasingly facing several anthropogenic pressures (Prasad *et al.*, 2002)

- **Invasion of *Prosopis juliflora*:** In order to check the advancing Rann, *Prosopis juliflora* was introduced by Gujarat government (in c. 31,550 ha.), this exotic species has spread rapidly along the fringes of the wetlands and grasslands and changed the vegetation composition. The analysis of the remote sensing data during the period in between 1980 to 1988 (Jadhav *et al.* 1992) and 1980 to 1992 (Kadikar, 1994) clearly stated that the *Prosopis juliflora* is expanding at a faster rate, nearly 25 sq.km / year.
- **Overgrazing:** During good rainfall years, in summer season most of the grazers, graze their cattle adjacent to the wetlands. Over grazing in these areas has led to denudation of the habitat due to trampling. During the dry spell of the year topsoil in the area gets eroded and blown off by high wind. This windblown soil gets deposited in the wetland and depressions thus reducing the depth and affecting the water holding capacity and the quality.
- **Salinity:** The core problem of Patan wetlands is salinity. Though the inherent salinity was existing during the early days in most of wetlands.
- **Over-fishing:** Local people use few wetlands for fishing, but now some fishermen have also started commercial over-fishing. The using of gill nets of smaller mesh size affects the fish production due to catching of potential breeding size and juveniles. This sometimes causes entangling of diving birds like Coot, Grebes and Pochards leading to their death.

### **Ramsar Convention, 1971**

Ramsar is a city in Iran where the first World Convention on Wetland was held on 2<sup>nd</sup> February 1971. Each year 2<sup>nd</sup> February celebrates as, “World Wetland Day”. Ramsar Convention on wetlands, which is an international treaty signed in 1971 for national action and international cooperation for the conservation and wise use of wetlands and their resources (Kar and Kar 2013). The Ramsar Convention defines - “Wetlands are areas of marsh, fen, peat-land or water, whether



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natural or artificial, fresh, brackish or salty, including area of marine water, the depth of which at low tides does not exceed six meters”.

### **Ramsar sites or wetlands of International Importance**

United States Environmental Protection Agency (EPA) or wetland Reserve Program describes wetlands as “those areas that are saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions” (Abraham, 2015). Overall, 1052 sites in Europe, 289 sites in Asia, 359 sites in Africa, 175 sites in South America, 211 sited in North America and 79 sites in Oceania regions identified in the world as Ramsar sites (Ramsar Secretariat, 2013).

### **Ramsar Sites in India**

There are 42 Ramsar sites in India with a surface area of 1,081,438 hectares (as of December 2020). The largest Ramsar site of India is a Chilika Lake (Orissa) with a surface area of 1,16,500 hectares. This lake and Keoladeo National Park (Rajasthan) were recognized as the first Ramsar sites of India. Uttar Pradesh has the largest number of Ramsar Sites in India with 8 Indian Wetlands. Also, rensuka wetland in Himachal Pradesh is the smallest wetland of India a surface area of 20 hectares ([ramsar-sites-in-india-1605708327-1](#)) (ENVIS Centre on wildlife and Protected Areas).

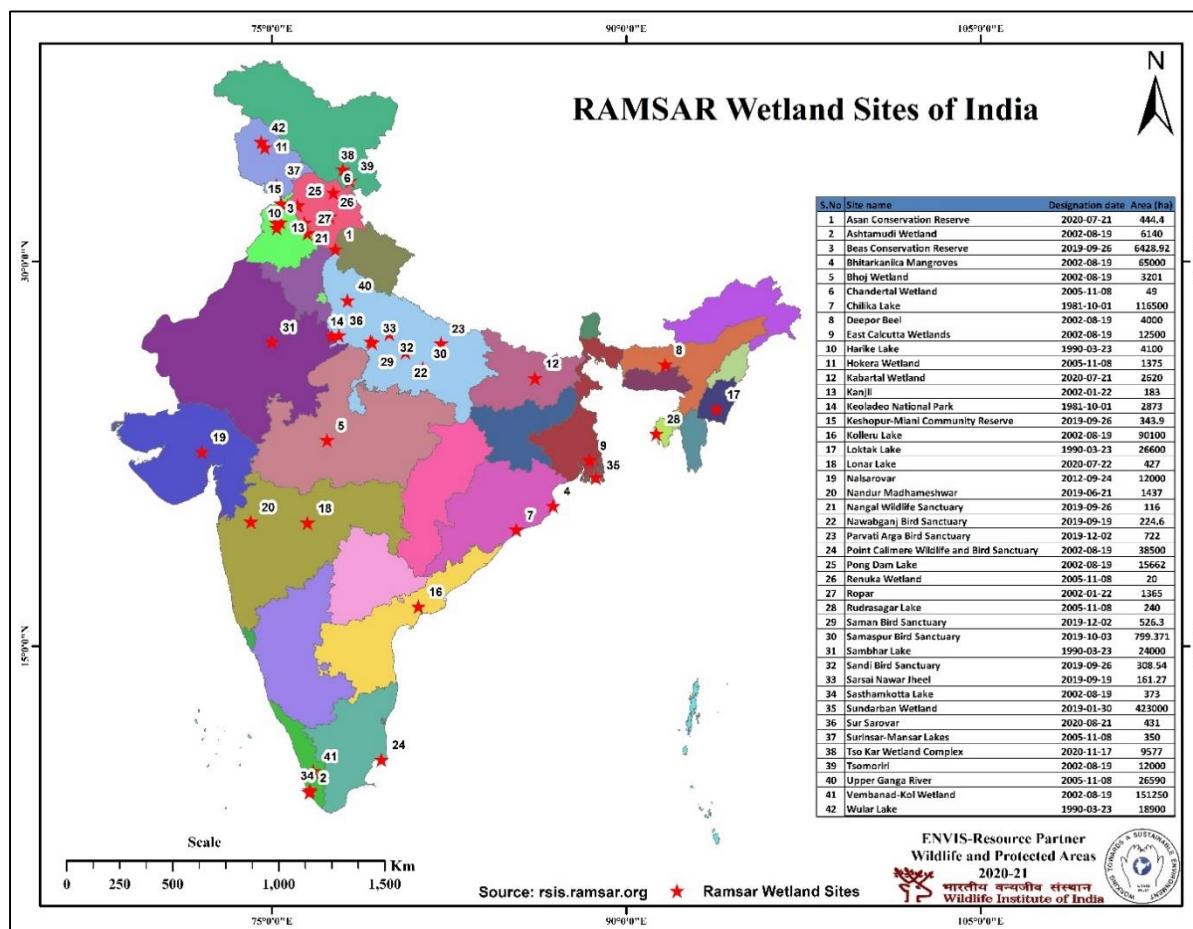
**Table 2: Number of Ramsar sites in different states of India** (ENVIS Centre on wildlife and Protected Areas)

Name of State	Number of Ramsar sites
Andhra Pradesh	1
Assam	1
Bihar	1
Gujarat	1
Himachal Pradesh	3
Jammu and Kashmir	4
Kerala	3
Ladakh	1
Madhya Pradesh	1
Maharashtra	2
Manipur	1
Odisha	2
Punjab	6
Rajasthan	2



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Tamil Nadu	1
Tripura	1
Uttar Pradesh	8
Uttarakhand	1
West Bengal	2



**Figure 4:** State wise distribution of Ramsar sites in India (ENVIS)

### Ramsar site in Gujarat

Nal sarovar Bird Sanctuary is the only Ramsar site in Gujarat, which is natural shallow lake, muddy lagoons and having 300 small islets. The lake is situated at the junction of the Saurashtra Plateau with the Gujarat mainland. It is the largest bird sanctuary in the Gujarat state, and harbours one of the highest populations of waterfowl anywhere in India. It supports different resident bird species as well as attracts several migrant varieties (C. Gujarat and Kumar, 2012).



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### **Wetlands of India**

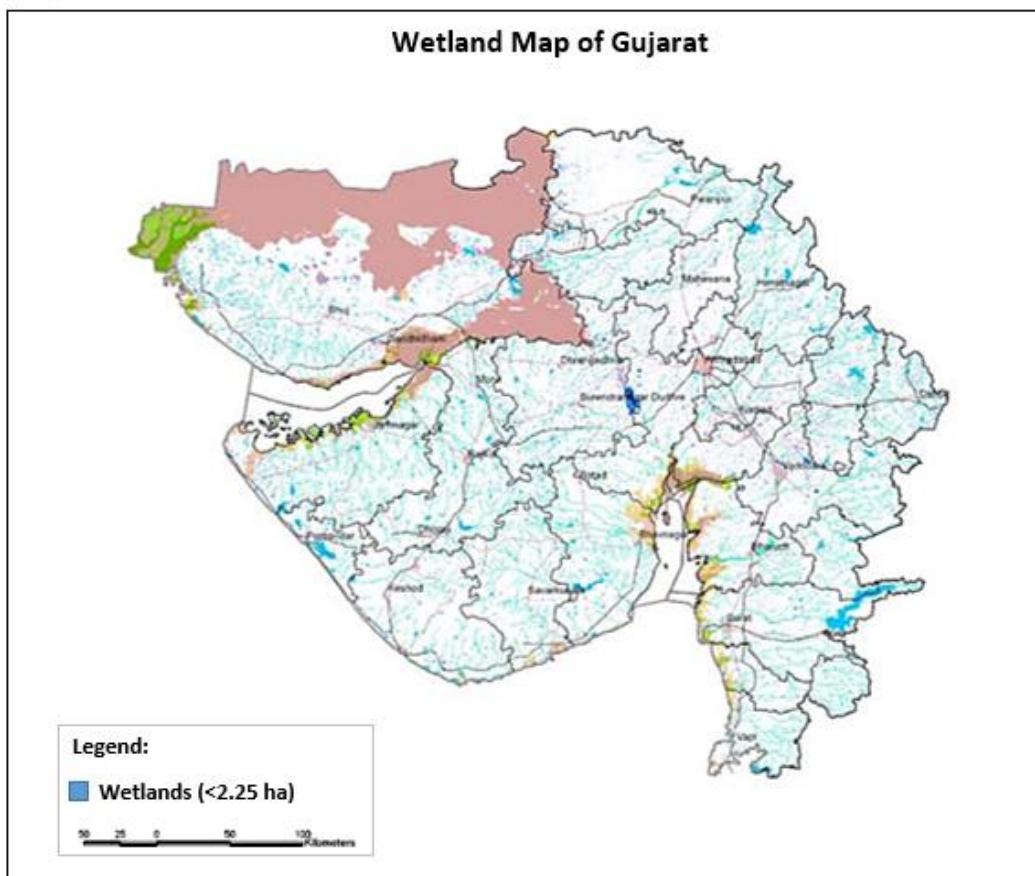
India is very rich in wetland resources and exhibit significant ecological diversity, primarily because of variability in climatic condition and changing topography. Wetlands in India are distributed in different geographical regions from cold arid zone of Trans Central Himalaya to evergreen north- east; Western arid zones of Gujarat and Rajasthan to tropical monsoonal central India; and wet and humid zone of southern peninsula. Wetlands, occupy about 4.1 million ha area, excluding mangroves, in the country (Ministry of Environment and Forest, 1992). Out of this 1.5 million ha are natural and 2.6 million ha are man-made. In addition, Mangroves vegetation along the coastal region of the country occupies 0.6 million ha area (Garg *et al.*, 1998). Majority of the inland wetlands are directly or indirectly dependent on the major rivers like, Ganga, Bhramaputra, Narmada, Godavari, Krishna, Kaveri, Tapti. They occur in the hot arid regions of Gujarat and Rajasthan, the deltaic regions of the east and west coasts, highlands of central India, wet humid zones of south peninsular India and the Andaman and Nicobar & Lakshwadeep islands (Prasad *et al.*, 2002). Lopez and Mundkur, 1997 states that out of 1,421 sites surveyed during the Asian Waterfowl Count (2012-13) 34 sites qualify as sites of international importance on application of the Ramsar criteria. However, these protected wetlands are also under threat.

### **Wetlands of Gujarat**

The State of Gujarat has a landmass of 1,96,02,400 ha, which is about 6 per cent of the area of the country. Out of the 10 Bio-geographic Zones in the country (Rodgers and Panwar 1988), the State has part of four Zones - the Indian Desert, the Semi-arid Zone, the Western Ghats and the Coast of India. The total wetland (831) area of the state is 27.17 lakh ha. Of that, the inland wetlands (393), cover 2,09,206 ha (7.7%) and coastal wetlands (438) cover 25,08,262 ha (93.3%), with Great and Little Rann of Kachchh (1,930,581 ha), contributing the major part.

Due to marked variation in the physiography and climatic condition, the state is rich in wetland resources and exhibit significant diversity. Types of wetlands found in the state are riverine, salt marsh, creeks, mudflats, estuarine, swamps, mangrove swamps and many manmade wetlands like reservoirs and lakes.





**Figure 5: distribution of wetlands in Gujarat state(NWA,2010)**

#### **IBA (Important Bird Areas) Sites in India**

Birds are magnificent indicators of ecosystem health. The IBA programme of Birdlife International aims to identify, monitor and protect a global network of IBAs for conservation of the world's birds and associated biodiversity. The IBAs serve as conservation areas for protection of birds at the global, regional or sub-regional level. According to Birdlife International, designation of IBAs is based on standardized criteria, namely (i) hold significant numbers of one or more globally threatened bird species, (ii) be one of a set of sites that together hold a suite of restricted-range species or biome-restricted species and (iii) have exceptionally large numbers of migratory or congregatory birds. The IBAs contain a range of habitats, such as wetlands, mudflats, microhabitats in biodiversity hotspots, grasslands and scrublands, making them excellent indicators of biodiversity richness (India's 5<sup>th</sup> National Report to the Convention on Biological Diversity, 2014). The Bombay Natural History Society (BNHS; [www.bnhs.org](http://www.bnhs.org)) and Birdlife International have identified 467 IBAs in India (Islam and Rahmani, 2004). Also, BNHS has



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prepared a list of 96 new/potential sites which can be designated as IBAs in the future ([www.bnhs.org](http://www.bnhs.org)).

### **Wetland and Human**

The interaction of man with wetlands during the last few decades has been of concern largely due to the rapid population growth - accompanied by intensified industrial, commercial and residential development further leading to pollution of wetlands by domestic, industrial sewage, and agricultural run-offs as fertilizers, insecticides and feedlot wastes. The fact that wetland values are overlooked has resulted in threat to the source of these benefits (Prasad *et al.*, 2002).

### **Need for the Study**

Patan, extending to a total area of 3332 sq. km, experiences tropical monsoon climate with average annual rainfall of less than 600 mm. In spite of being arid, Patan district covers maximum area under wetlands. Based on the distribution, the wetlands of Patan can be divided in to two major types; the central inland wetlands (manmade), and wetlands in the southern and western region i.e. saline wetlands (Ranns) in the Southern limit. The studies on wetlands and waterfowl in the Patan region are mostly naturalistic observations on new records or rare sighting for the region (Ali, 1945, 1992; Akhtar *et al.*, 1992, Himmatsinghji and Barat, 1990; Vijayraiji, 1912) and breeding records (Ali, 1960, Ali, 1974, Akhtar and Himmatsinghji *et al.*, 1991, Mundkur and Parvez 1984, Mundkur *et al.*, 1989,).

Patan and Part of Banaskantha district) falls on the migratory route of many migratory birds coming from Europe, Africa and Arabia. It is a staging ground for all these migrants. They land here first and depending on the availability of water in the wetlands, get dispersed within district's wetlands and to other wetlands in the Sub-Continent. The endangered bird species like Dalmatian Pelican (*Pelicanus crispus*), Oriental Darter (*Anhingia rufa*), Black necked Stork (*Ephippiorhynchus asiaticus*), Sarus Crane (*Grus antigone*) and Indian Skimmer (*Rynchops albicollis*) visit every year and their numbers depend on the availability of water in the wetlands, their quality and food availability (Singh, 2012)

Salinity, overgrazing by cattle, invasion of exotic species and anthropogenic activities by humans are major threats to the wetlands. However, these threats are said to exist, there has not been any detailed quantitative study to visualize these, in terms of its magnitude and effect. Therefore, this



### ***Study on wetlands of Patan***

study would highlight, how significant are these threats for the management and conservation of the Patan wetlands and the waterfowls.

In many parts of the developed world, efforts have been made to mitigate wetland losses through restoration and rehabilitation (Swanson, 1979; Cole, 1979; Klotzli, 1981; Race and Christie, 1982). However, in tropics most of the wetlands have not yet been adequately investigated, even though they are fast disappearing or being degraded (Gopal, 1992). The poor state of our knowledge is indicated by the fact that even some of the best-known wetlands have not been fully surveyed for their biota (Gopal, 1992).

Keeping these facts in mind, this project envisages studying the overall status, biological functions and values (socio-economic, biodiversity, cultural etc.) of wetlands in Patan district. The information base would be used to find how these factors affect the wetland ecosystem, the waterfowl and their use. This study is the first of its kind in the district and hence this study will provide the scientifically collected and analysed facts about wetlands in the district. In addition, it would provide a strong base and support for classifying some of the wetlands as candidates for the Ramsar sites. The entire study has been carried out focusing on the following objectives.

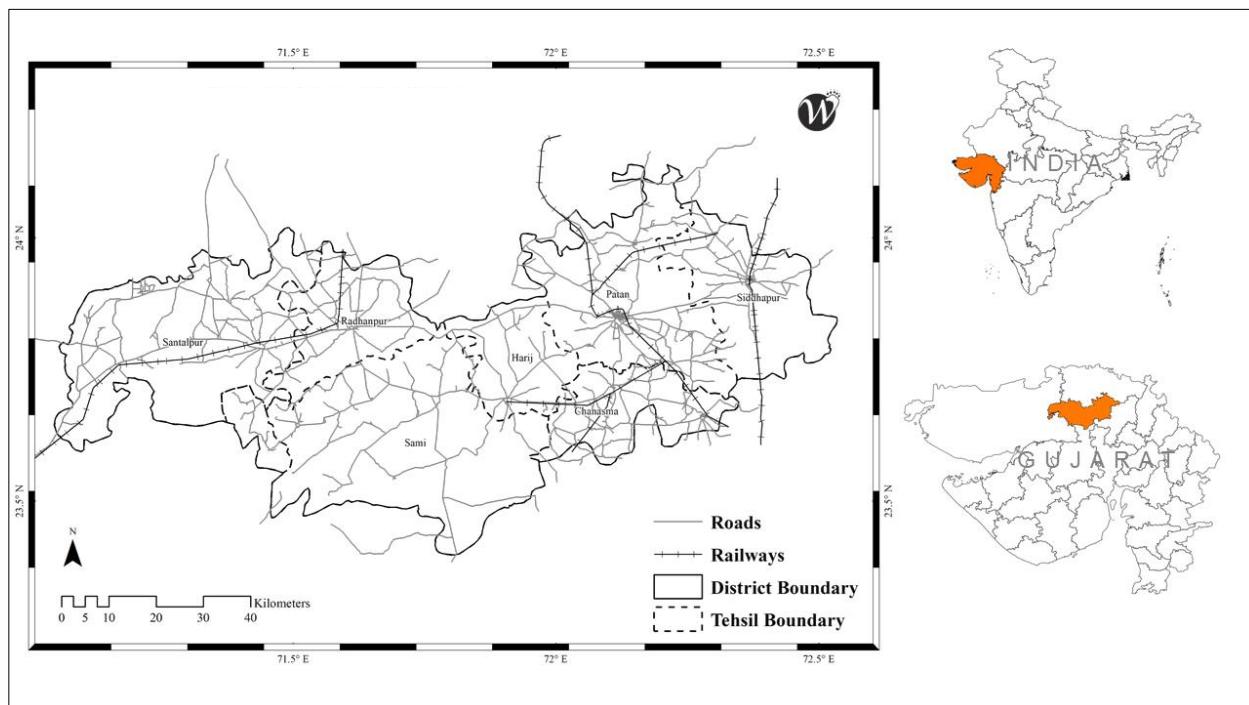
### **Objectives**

- Preparation of GIS based wetland map of Patan
- Rapid survey of wetlands and identification of threats to the wetlands
- Status and diversity of wetland birds and other associated fauna



## Study Area

Patan ( $23^{\circ} 23' 00''$  and  $24^{\circ} 09' 00''$  N latitude,  $71^{\circ} 02' 00''$  and  $72^{\circ} 29' 00''$  E longitudes) district is bordering Banaskantha district in the north and northeast, Mehsana in its south and southeast, Kutch and little Rann of Kutch in the east (Figure 2). The district is located on the bank of river Saraswati and known as the ancient capital of Gujarat state covering a total area of  $5740 \text{ km}^2$  and it is situated at the elevation of 82.30 MSL. The city of Patan is the head quarter of the district and is known as the heritage city, established by Vanaraj Sinh Chavada in 745 AD. The study area have many tourist attractions including the UNESCO world heritage site; Rani ki Vav (The Queen's step well), Sahastraling lake and many ancient temples as place of worship. The district is also known for very famous silk fabric called Patola (Parmar, 2016).



**Figure 6:** The map showing an Image of Patan district and its location in Gujarat state

Patan has population of 1,343,734 with the population growth of 13.53% the decade 2001-2011 (Kumar *et al.*, 2017). According to census 2011, density of Patan district is about 232 people per sq.km. It constitutes 2.22 percent of total Gujarat population (Parmar, 2016).

The district divided into nine sub-districts (taluka), viz. Patan, Sarasvati, Sidhpur, Chanasma, Harij, Sami, Sankheshwar, Santalpur and Radhanpur and a total of 517 villages. The land



### **Study on wetlands of Patan**

configuration is agriculture land, wetland, waste land and some riverine patches in its surroundings (Singh, 2001). The wetlands are important sites for biodiversity and provides economic, social and cultural benefits. It improve the quality of water by trapping sediments and filtering out pollutants. Wetland supports agricultural activities by supporting irrigation, livestock and for domestic consumption and also supports recreational activities such as swimming, boating, fishing, bird watching and tourism.

### **Climate**

Being a semi-arid and arid climatic condition, the district has a hot summer and general dryness in the major part of the year. According to Kumar *et al.* (2017), the climate is warm, sub-humid and sub-tropical. The study area experiences wide variation in temperature (Parmar *et al.*, 2014). Generally, May and June are the hottest months and January and February are coldest. The minimum temperature ranges from 8 °C to 10 °C in winter and a maximum temperature ranges from 40 °C to 48 °C in summer. Monsoon is irregular with 26 rainy days.

### **Rainfall**

Patan is considered as one of the water deficit districts of Gujarat and most of the water bodies and tributaries of river are fed through the rainwater. Majority of the agriculture in the district is also chiefly depends on the rainfall. The monsoon set in the study area by the end of June and continues up to late October with irregular rainfall. The average rainfall of Patan district is 548 mm since 1986-2016. Rainfall percentage against average rain is 73.50% is recorded by State disaster management authority.

### **Topography and Geology**

Total geographical area of the Patan district is about 5.66 lacs ha and its 70% of the geographical area is under cultivation in the district. Forest cover of Patan district is only 8% and the coverage of the forest area is almost nil in Patan, Siddhpur and Chanaasma taluka of the district. The district has 5% of its land as pastureland and wasteland forms 8 percent of geographical area. The soil of the Patan district in general possesses neutral to alkaline reaction with pH of 7.25 to 8.50 and the electrical conductivity of the soil is 1.0 to 3.0 dS/m (medium). Soil of the district show low organic carbon and nitrogen content; high potassium and medium phosphorus content. Some part of the district soil are found deficient in multi-micronutrients such as Iron and Zinc.



## **Study on wetlands of Patan**

### **Flora**

The arid to semi-arid conditions results in highly saline lands adjoining the little Rann of Kachchh reported by Patel and Dharaiya, (2015); Parmar ( 2016) due to which, the study area has a very less diversity in vegetation. The study area lacks the natural forest; however, tree density of this area is adequate in some plains (Singh, 2001) mostly through the plantation under the re-forestation and social forestry programmes of the forest department. Because of the paddy fields and soil quality, the area supports good seasonal wetlands and hence support some grounds of natural vegetation.

Forest area of the Patan district are mostly saline, desert affected and stunted and there are tree with a great preponderous of mature, unsound and inferior species, predominantly *Prosopis juliflora*. According to Champion & Seth (1968), the area can be classified into bio-geographic zone 4 as dry deciduous forest types i, 6/E3 Rann saline thorn forest, ii.6/E4 Salvadora scrub, iii.5/E8 Salin/Alkaline scrub, iv.6/DS1 *Casia auriculata* scrub, *Euphorbia* scrub reported by Parmar.M.J,(2016). Following species are appear in certain localities viz. *Accia Sneagal* (Gorad), *Acacia nilotica* (Desi Baval), *Azadirachta indica* (Neem), *Salavadora oleoides* (Pillu), *Salvadora Percica* (Kharijar), *Euphorbia Spp.* (Thor), *Cappaphyllaris* (Kerada). Tree growth is very poor in many patches. Among the woody species *Prosopis cineraria* (Khijdo), *Zizyphus mauritiana* (Boradi) and *Calotropis procera* (Ankado) are common here. The ground cover is pre dominated by some grasses such as *Themeda cymbalaria* (Ratad), *Achrachne racemosa* (Umardo) and *Alloteropsis cimicina*, (Sumer grass) and herbaceous plants like *Acalypha indica L.* (Dadro), Awal (*Ludwigia octovalvis*), Gokharu (*Indigofera cardifolia*) provide the thick cover of vegetation.

### **Fauna**

Despite of no natural forests the area supports good and unique faunal diversity including variety of resident and migratory birds, freshwater fishes, amphibians, reptiles and mammals. Patan is important breeding grounds for migratory birds. According to Dharaiya (2009), this area has about 175 species of both migratory and resident birds like *Tadorna ferruginea* (Ruddy shelduck), *Anas strepera* (Gadwall), *Anas platyrhynchos* (Mallard), *Antigone antigone* (Sarus crane), *Hydrophasianus chirurgus* (Pheasant tailed jacana), *Anas crecca* (Common teal), *Anas acuta* (Northern Pintail), (Grey lag Geese ). Among the resident birds, *Phoenicopterus minor* (Lesser flamingo) and *Phoenicopterus roseus* (Greater flamingo), *Francolinus pondicerianus* (Grey



## **Study on wetlands of Patan**

Francolin), *Dendrocygna javanica* (Lesser whistling duck), *Anas poecilorhyncha* (Indian spot billed duck), Little grebe (*Tachybaptus ruficollis*) are common (Ganpule, 2016); and around 35 species of reptiles found in this area are *Hemidactylus* spp., *Geochelone elegans* (Indian star turtoise), *Naja Naja* (Indian cobra) and *Ptyas mucosus* (Rat snake). Apart from birds and herpatofauna, 33 species of mammals have been recorded in the area which includes, wildass (*Equus hemionus khur*), Bluebull (*Boselaphus tragocamelus*), Jungle cat (*Felis chaus*), Desert cat (*Felis libyca*), Small Indian mongoose (*Herpestes auropunctatus*) Indian fox (*Vulpes bengalensis*) Desert fox (*Vulpes vulpes*) and Jackal (*Canis aureus*), Striped hyena (*Hyaena hyaena*), Hedgehog (*Para echinus micropus*), and Indian hare (*Lepus nigri collis*) are also common in the study area (Dharaiya, 2007).

### **Local community**

The region is dominated by human by human beings and the main communities of the people are categorized as According to census 2011, Patan has a sex ratio of 935 females for every 1000 males. Patidars, Rabaris, Thakors, Brahmins, Rajputs, Prajapati and Dalit are major cast of this city. Among Muslim Memon and Vohra are business communities reside in the regions. The villagers mainly keeps cow, buffalo, goat, camel, sheep and domestic ass as the livestock and it is important for Rabari community in the study as their main source of livelihood is through the sale of milk and milk products. Approximately 98.36% population of Patan district spoke Gujarati and remaining used to Hindi as their first language.

Although there is no natural forest in the district, the study area is comprising both protected and non-protected areas. The wildass sanctuary encompasses an area of 4953.71 sq. km of the Lill Rann of Kachchh and some part of the sanctuary is falling in the Patan district, which is declared as Ecotourism site by the Patan forest division. In Radhanpur range no village had very dense forest cover Gokhantar and Parsund have some dense forest otherwise rest of the villages had degraded and open forest. Gokahntar also showed water body in area more than 1000 hectares. In Sami range Chandroda, Rasalpura had area of dense cover and other villages had lager area of degraded forest followed by open ones. Dadka, Ved, Eklava, Roda, Anvarpura, Kodadha Rasulpura and Taranagar showed the presence of water bodies and Charanka, Bakutara Eval, Modhutara, Rozu showed degraded forest with presence of water bodies in Santalpur taluka.



### **Study on wetlands of Patan**

Patan is one of the important districts in the state in terms of wetlands; 6% of the total area of district is covered by around 1037 different categories of wetlands. (NWIA, 2010). According Parmar (2016) these wetlands are categorized into Inland wetlands, coastal wetlands, and small man-made tanks (table 3). According to the space application center (SAC) of ISRO the major wetland categories are Mud flats, Rivers/Streams, Reservoirs and Tanks/Ponds in the district (Patel and Dharaiya, 2015; Paramar, 2016) and open water spread of the wetlands is significantly lesser in pre-monsoon (2593 ha) than higher during post monsoon (11595 ha) (Patel and Dharaiya, (2015); Paramar, (2016); Patel.S.P, (2015-unpublished data).

**Table: 3      Different categories of wetlands in Patan district with their respective area  
(Parmar, 2016)**

Sr. No	Wetland Category	Number of wetlands	Total wetland areas
<b>Inland wetland Naturals</b>			
<b>1</b>	Lakes/Ponds	9	1725
<b>2</b>	Waterlogged	19	1947
<b>3</b>	River/Stream	31	9430
<b>Inland wetland man-made</b>			
<b>4</b>	Reservoirs/Barrages	25	3922
<b>5</b>	Tanks/Ponds	484	5035
<b>6</b>	Salt pans	2	294
<b>Total-inland</b>		<b>570</b>	<b>22353</b>
<b>Coastal Wetlands- Natural</b>			
<b>7</b>	Intertidal mud flats	34	11004
<b>8</b>	Salt marsh	2	392
<b>Coastal wetlands-Man-made</b>			
<b>9</b>	Salt pans	15	103
<b>Total-Coastal</b>		<b>51</b>	<b>11499</b>
<b>Sub-Total</b>		<b>621</b>	<b>33852</b>
Wetland (<2.25ha>), mainly tanks		416	416
<b>Total</b>		<b>1037</b>	<b>34268</b>



### ***Study on wetlands of Patan***

The present study has been carried out in the wetlands of urban and desert areas of Patan district during November 2020 to February 2021, i.e. the period of migratory bird. The main focus of the study is to identify important wetlands and water bodies of the district with respect to the migratory birds.



## **Methodology**

The study has been carried out in Patan district. The area is mainly covered by saline and semi-arid land. According to Patan forest department, there are more than 50 wetlands identified into nine sub-districts (taluka) viz. Patan, Sarasvati, Siddhpur, Chanasma, Harij, Sami, Sankheswar, Santalpur, and Radhanpur under the important bird area programme. The field survey was carried out during the migratory season starting from November to February and wetlands were identified using the digital elevation model (DEM) image. Each of the identified wetlands were physically visited and their locations were marked with GPS then these GPS data converted to GIS format. Based on this ground survey, a total of 138 wetland were marked and surveyed for the study with reference to the list of wetlands from 9 taluka of Patan district provided by the forest department.

The study site was visited at least once in a month from December to February and the visits covered all the taluka of district, where local and migratory birds were observed. The observations were made between 8:00 to 11:00 hrs in the morning and 15:00 to 18:00 hrs in the evening on each sides of the wetland. The observations involved bird count using the direct visual count method (Bhuva and Soni, 1998; Patel and Dharaiya, 2015) with appropriate light condition (Tere and Parasharya, 2013). Birds were observed using a pair of binoculars 10x 50 Olympus® and a spotting scope Nikon®. The different species of birds were sighted and identified to prepare a checklist of birds using Birds of Indian Subcontinent by Grimmett *et al.*, (1998). The population of each species was estimated by actual count (where the birds were countable) and block count methods (Howes and Bakewell, 1989), along with bird count other associated fauna were listed and information regarding human activities and disturbance were also recorded.

**Table : 4      Taluka wise list of wetlands in Patan district.**

<b>Range No.</b>	<b>Range</b>	<b># of wetlands (forest division)</b>	<b># of Wetlands identified</b>
<b>1</b>	<b>Patan</b>	12	12
<b>2</b>	<b>Sarswati</b>	5	10
<b>3</b>	<b>Siddhpur</b>	8	6
<b>4</b>	<b>Chanasma</b>	7	14
<b>5</b>	<b>Harij</b>	4	8
<b>6</b>	<b>Sankheswar</b>	3	20
<b>7</b>	<b>Radhanpur</b>	4	25
<b>8</b>	<b>Santalpur(varahi)</b>	6	34
<b>9</b>	<b>Sami(koddha)</b>	10	9



## **Study on wetlands of Patan**

### **Data Analysis:**

All the data were analyzed to know the important wetlands of the district with respect to the migratory birds. The wetlands were categorized on the bases of secondary information of last few year's data of Asian Water bird Census and surveys carried out by forest department and other birders. These information along with the primary data were then classified according to their species richness. Analyses of data include the classification of bird species according to their family, residential status, WPA Status (Pravin *et al.*, 2016), as well as conservation status according to IUCN ([www.iucnredlist.org](http://www.iucnredlist.org)). Feeding guilds of the birds were also recorded to know the dependency of avifauna on the wetland and their surroundings and during the whole study period collected data were further analyzed to calculate the density, species diversity, richness and species composition by using PAST Statistical Software (Hammer *et al.* 2001; Gajera *et al.*, 2012).

### **Mapping:**

Mapping of wetland was done using satellite imageries. This helped in detecting the changes in vegetation composition, number of wetland, their size and shape, broad pattern of sedimentation and water depth.

The study area( Figure 6) of surface water bodies and wetlands were analysed and studied using the dataset from the satellite named, Sentinel 2B of the Sentinel mission, acquired from European Space Agency (ESA) and used as a primary data source for generating the wetland map of Patan district. The Patan district and tehsil boundary was acquired from ISRO data repository. The satellite uses a versatile instrument called the Multispectral instrument (MSI) for analysing different features such as wetlands, surface water, barren area, etc., using different bands of Electromagnetic spectrum i.e., band 8 (NIR) and band 3 (VIS - green) of resolution 10 m. Those bands were used as an input rasters in order to process the Modified Normalised Difference Water Index (MNDWI) by using ArcGIS® software. This index generally uses Green and NIR/SWIR bands for enhancement of open water features. The built-up area features which are often correlated with open water in other indices also diminishes and presented water bodies and wetlands more precisely. The formula for MNDWI is as follows:

$$MNDWI = \frac{Green - NIR}{Green + NIR}$$



### ***Study on wetlands of Patan***

Here (Figure 7) the green band represents Band 3 and Near Infrared represents Band 8, hence, the formula for sentinel 2 to be entered in GIS software is:

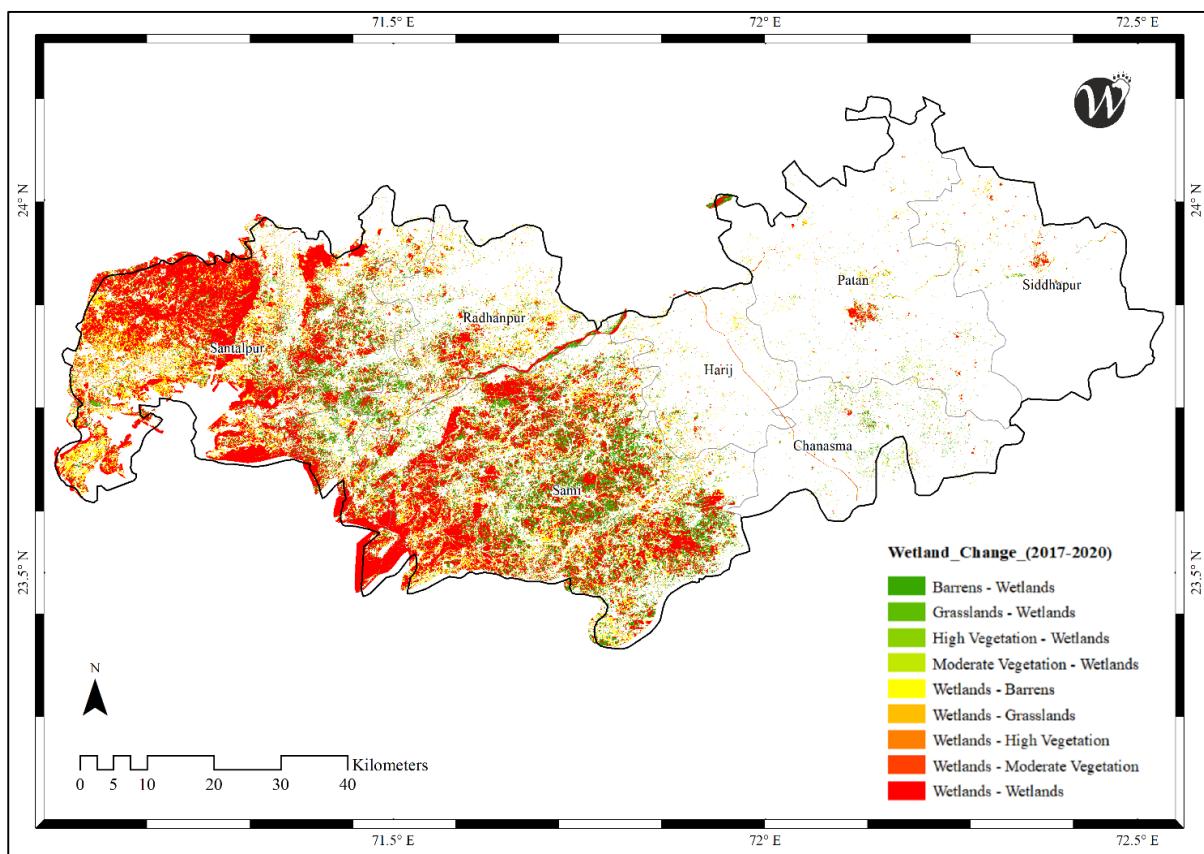
$$MNDWI = \frac{Band\ 3 - Band\ 8}{Band\ 3 + Band\ 8}$$

On processing this formula, this generates one raster image which on classifying, it depicts separate classes for Barren area, Wetlands, surface water, etc. With this the surface water, wetlands and barren lands were preliminarily observed. Further, the temporal datasets of Landsat 8 OLI acquired from USGS Earth explorer were used for detecting the change in wetlands of Patan from 2017 to 2020. Again, MNDWI was processed in the temporal datasets to illustrate the respective features. The change detection map was created on intersecting both the images.



## Results and Discussion

Wetlands represent one of the world's most important types of the ecosystems as it play a critical role in climate change, biodiversity, hydrology, and human health. A major goal of this study is to identify the overall status, biological functions, and values of the wetlands of Patan district with special reference to the migratory birds. Along with the bird survey, an attempt has been made to see the change in wetland areas in district in last three years (2017-2020) using the geo-spatial technology (Figure 7).



**Figure 7: Map illustrating the change in wetlands in the last three years (2017-2020)**

Figure 1 above show the changes in the land use and land cover that occurred during last three years. Over these years, no any drastic change was observed in Patan district. However, figure 1 also shows a slight increase in wetland from barren lands (0.01%), grasslands (0.4%), vegetation covered areas (0.08%) (Table 5). Although the change in land cover is very minute but, it may be helpful to predict the future changes and aid in monitoring and land management. Moreover, this map would help in detecting the changes in vegetation composition, area and number of wetland as well as shape and size of the wetland over a period of time.

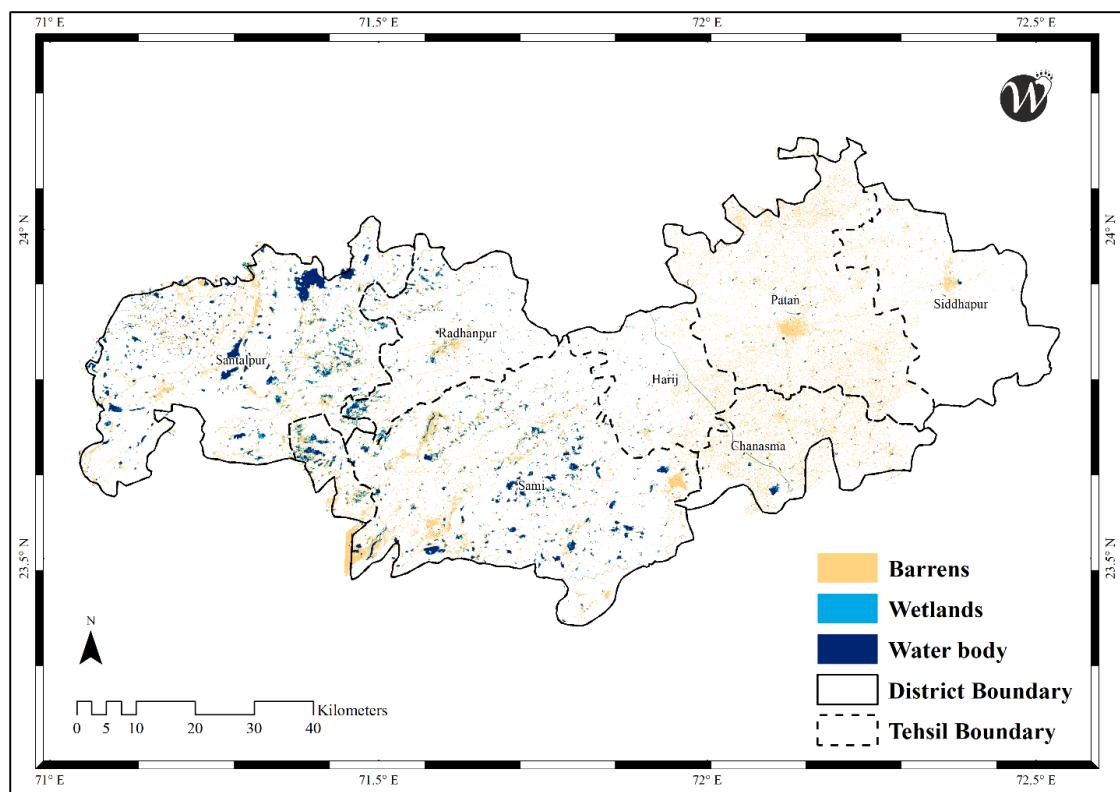
## *Study on wetlands of Patan*

**Table 5:** Change detection of wetlands during 2017-2020

No.	2017-2020	Percentage
1.	Barren-Wetland	0.04%
2.	Grassland-Wetland	0.4%
3.	High vegetation-Wetland	0.01%
4.	Moderate vegetation-Wetland	0.07%
5.	Wetland-Barren	0.03%
6.	Wetland-Grassland	0.005%
7.	Wetland-High vegetation	0.0003%
8.	Wetland-Moderate vegetation	0.001%
9.	Wetland-Wetland	0.1%

### **Wetlands of Patan district:**

The following map of Patan district shows, the total number of water bodies present in nine taluka of the district.



**Figure 8:** The map showing water areas and wetlands in Patan district

## **Study on wetlands of Patan**

Figure 8 depicts the land use and land cover classes representing natural and man-made water bodies such as river wetlands, lakes, and other water streams in the district during the study period. A total of 138 natural and manmade wetlands were identified. During post-monsoon, western part of the district retain water for a longer period of time due to the saline soil structure as well as the area situated close to little Rann of Kachchh where water percolation is very low. The maximum number of water logged areas are recorded in Santalpur taluka (34) followed by Radhanpur (25) and Sankheshwar (20). Whereas, Siddhpur taluka is recorded with the lowest number of wetlands (6) in Patan followed by Harij and Sami taluka (Table 2). These wetlands include both natural and man-made category with various size and shape. This shows that wetlands are more concentrated in the western part of the district which is near to the coastal area as reported by Parmar, (2016). The map also reveals that 196.8 km<sup>2</sup> area of the district is occupied by the wetlands. Which is around 3.5 % of the total area of the district indicating the importance of Patan district in the state with respect to the wetlands and water birds. Among the other land use, 2027.28 km<sup>2</sup> area covered by high vegetation, 2869.30 km<sup>2</sup> is grassland area, 501.17 km<sup>2</sup> is Barren area. Though, very less area is covered by wetlands in the district, it harbors more than 100 species of migratory and resident water birds.

Table 2 shows the number of wetlands reported by forest department and surveyed during the current study from all the nine taluka of Patan district. Table depicts that maximum number of wetlands were surveyed from Santalpur taluka (34) followed by Radhanpur (25), Sankheshwar (20) and the minimum number of wetlands recorded and surveyed from Siddhpur taluka (6).

**Table 6: Wetlands surveyed during the study period**

No.	Taluka	# Wetlands identified by the Forest Department	# Wetland identified and surveyed during the study period
<b>1</b>	Patan	12	12
<b>2</b>	Saraswati	05	10
<b>3</b>	Chanasma	07	14
<b>4</b>	Sidhpur	08	6
<b>5</b>	Harij	04	8
<b>6</b>	Sankheshwar	03	20
<b>7</b>	Radhanpur	04	25
<b>8</b>	Santalpur	06	34
<b>9</b>	Sami	10	9
		<b>59</b>	<b>138</b>



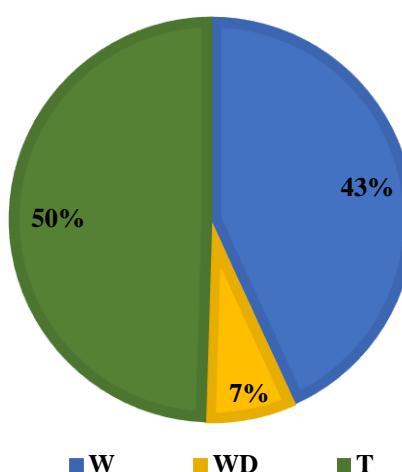
## **Study on wetlands of Patan**

All the identified wetlands (138) were surveyed and evaluated based on the bird abundance and ranked from 1 (less bird abundance) to 5 (high abundance). The wetlands with the score of more than three were considered as an important wetlands and surveyed intensively with respect to the migratory birds and macrofauna (Table 7).

**Table 7:** Selection of wetlands on the basis of rank

Sr. No	Talukas	Number of Wetlands	Rank					
			0	1	2	3	4	5
1	Patan	12	4	7	1	0	0	0
2	Sarswati	10	4	4	2	0	0	0
3	Siddhpur	14	1	4	1	0	0	0
4	Chanasma	6	3	5	2	3	0	1
5	Harij	8	6	1	0	1	0	0
6	Sankheswar	20	2	1	5	4	5	3
7	Radhanpur	25	0	12	5	3	3	2
8	Santalpur	34	4	8	9	7	3	3
9	Sami	9	3	1	2	0	2	1

All the identified wetlands have been surveyed during the migratory period (Nov 2020 to February 2021) with respect to presence of bird as a macrofauna. A total of 206 species of birds belonging to 62 families and 138 genera have been recorded in the entire study area (Table 4). Among these birds, 50% of the species are wetlands birds. Out these aquatic birds, 7% of the species are wetland obligatory species recorded during the study period (Figure 9).



W=Waterfowl, WD= Wetland dependent, T= Terrestrial

**Figure 9:** Number of bird species recorded based on their habit from study area



## **Study on wetlands of Patan**

The water birds species (89) recorded are like Common Coot, Common Crane, Northern Shoveller, Northern Pintail, Little Cormorants, Grey-leg geese, and Gadwall were most commonly recorded waterfowls; however, 15 species of birds are wetland-dependent which includes Marsh harrier, Indian River Tern, Bluethroat, Barn Swallow, Wire-tailed swallows, etc. Along with the wetland birds, 102 species of terrestrial birds were also recorded during the survey. The results reveal the importance of wetlands in Patan district as 50% of the birds recorded in the district are the water birds which depicts the wetland facilitated them food as well as a good habitat to during migratory season. Wetland birds are considered as a biological indicator (Padmavathy *et al.*, 2010) of the environment reflecting the health of the natural ecosystem as well as the quality of the water and food available. Following table 8 illustrates the number of bird species recorded from different families.

**Table 8: Number of bird species recorded in Patan district in respective families**

Sr. No	Family	Number of Species		
1	Anatidae	19	31	Upupidae
2	Phoenicopteridae	2	32	Picidae
3	Podicipedidae	2	33	Ramphastidae
4	Rallidae	4	34	Meropidae
5	Gruidae	2	35	Coraciidae
6	Otididae	1	36	Alcedinidae
7	Ciconiidae	5	37	Falconidae
8	Pelecanidae	2	38	Psittaculidae
9	Ardeidae	9	39	Campephagidae
10	Threskiornithidae	3	40	Oriolidae
11	Phalacrocoracidae	3	41	Aegithinidae
12	Anhingidae	1	42	Dicruridae
13	Burhinidae	1	43	Rhipiduridae
14	Recurvirostridae	1	44	Laniidae
15	Charadriidae	6	45	Corvidae
16	Jacanidae	1	46	Nectariniidae
17	Scolopacidae	15	47	Ploceidae
18	Glareolidae	1	48	Estrildidae
19	Laridae	8	49	Passeridae
20	Phasianidae	4	50	Motacillidae
21	Columbidae	5	51	Emberizidae
22	Pteroclidae	1	52	Paridae
23	Caprimulgidae	2	53	Stenostiridae
24	Apodidae	1	54	Alaudidae
25	Cuculidae	2	55	Cisticolidae
26	Pandionidae	1	56	Hirundinidae
27	Accipitridae	17	57	Pycnonotidae
28	Tytonidae	1	58	Phylloscopidae
29	Strigidae	2	59	Zosteropidae
30	Bucerotidae	1	60	Leiothrichidae
			61	Sturnidae
			62	Muscicapidae

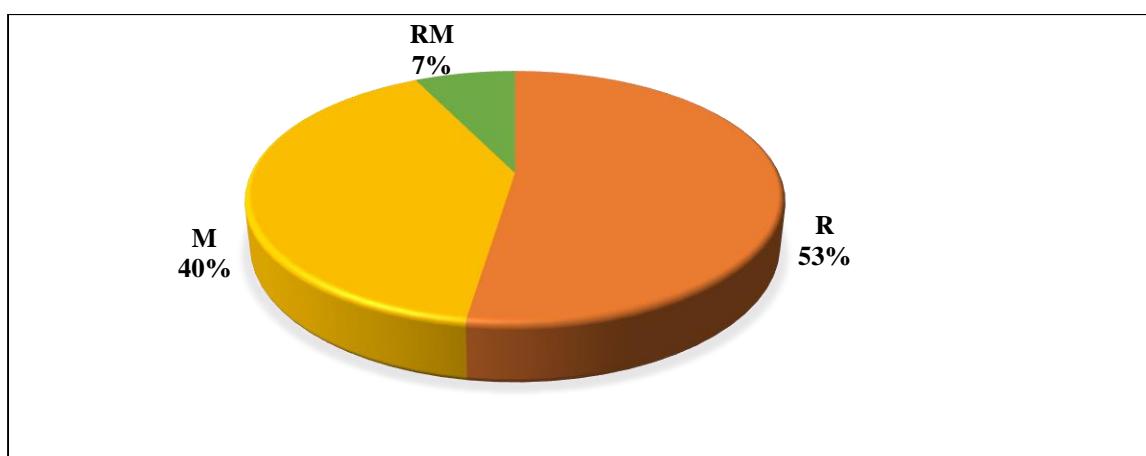


## **Study on wetlands of Patan**

Table 8 reveals that more species are belonging to the family *Anatidae* followed by *Accipitridae* and *Scolopacidae* whereas some other families are represented by either one or two species in the study area. The birds belongs to the *Anatidae* family are the ducks, which prefers shallow to deep water wetlands reflecting that wetlands of Patan are having shallow to deep water and supporting good number of ducks. Patel and Dharaiya, (2016) also recorded that the *Anatidae* family having the highest number of species. The previous studies in these area by Patel *et al.*, 2007; Patel *et al.*, 2008; Gajera *et al.*, 2009 and some other stray notes have reported that *Anatidae*, *Ardeidae*, *Scolopacidae*, *Accipitridae*, *Threskiornithidae*, and *Recurvirostridae* families are represented with more number of species in the wetlands of arid to semi-arid areas of Gujarat (Patel and Dharaiya, 2016). The reason behind the aggregation of this families is the availability of diverse food in the wetlands.

### **Migratory birds:**

Bird migration is the cyclic and seasonal movement of birds between their breeding and feeding ground. They fly hundreds or thousands of kilometres in the search of favourable ecological conditions and suitable habitat for feeding, breeding and raising their young. From the nine major migratory routes, one is West Asian-East African flyway passes through the north-western Gujarat (Birdlife International). As the areas of Patan district falling under this route, the birds stay here for a longer period as their feeding ground which is reflected by presence of 47% of migratory birds (Figure 10).



**R= Residential, M= Migratory, RM= Resident-Migrant**

**Figure 10: Migratory status of bird species found in Patan district**

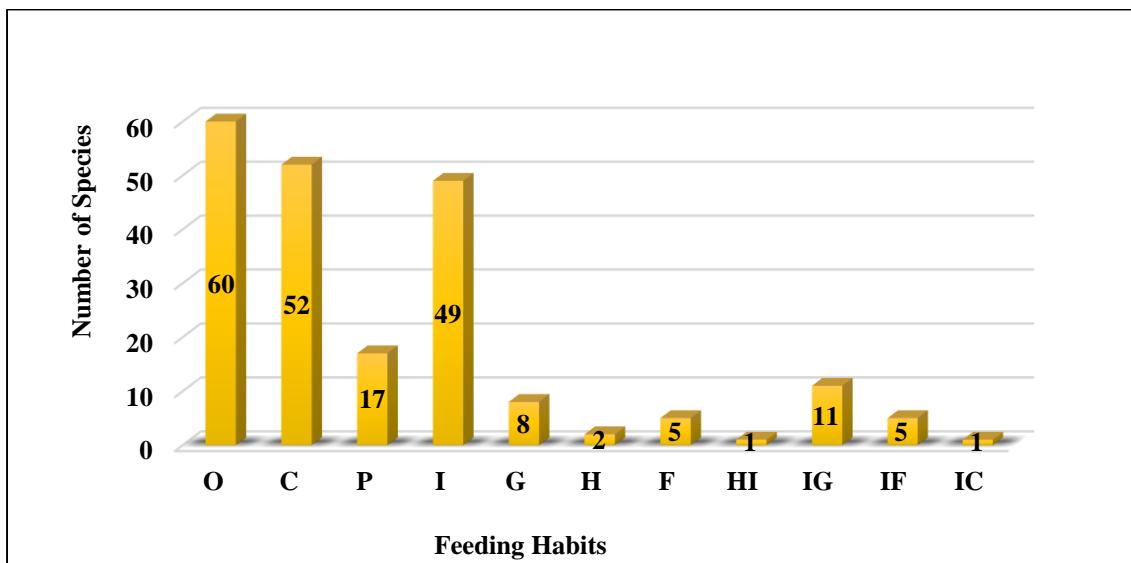
Being a semi-arid zone, its water scarcity encouraged local people to build village ponds and check dams as a watershed and soil-moisture conservation process and management. Such



## **Study on wetlands of Patan**

water bodies provide a good habitat for a variety of migratory and resident birds (Gajera *et al.*, 2007).

The presence of migratory birds is showing the fertility of the wetlands, migratory bird diversity increases with the availability of food. Following figure marked the wetland bird species with different feeding habit in Patan.



*O= Omnivore, C= Carnivore, P = Piscivore, I=Insectivore, H =Herbivore, F = Frugivore, G= Granivore, HI= Herbivore-insectivore, IG=Insectivore-Granivore, IF= Insectivore- Frugivore, IC= Insectivore- Carnivore.*

**Figure 11: Classification of birds according to their feeding guild in the study area**

According to Patel and Dharaiya, (2016) wetlands provide high productivity that provides ample food resources such as the growth of aquatic plants, phytoplankton, and aquatic macrofauna for the aquatic birds. Among the observed bird species in various wetlands have diverse food habits; figure 11 reveals that a maximum number of bird species are Omnivore (60 sp.) followed by Carnivore (52 sp.), Insectivores (49 sp.), Piscivores (17 sp.) and Insecti-granivores (11 sp.), Granivores (08 sp.), Frugivore(05sp.) and so on. This area supports the high number of omnivorous and prey bird species. Omnivores are also considered to have a generalist feeding niche and always found dominant over the other feeding habit which was also recorded by Gajera *et al.*, (2012) in Kachchh.

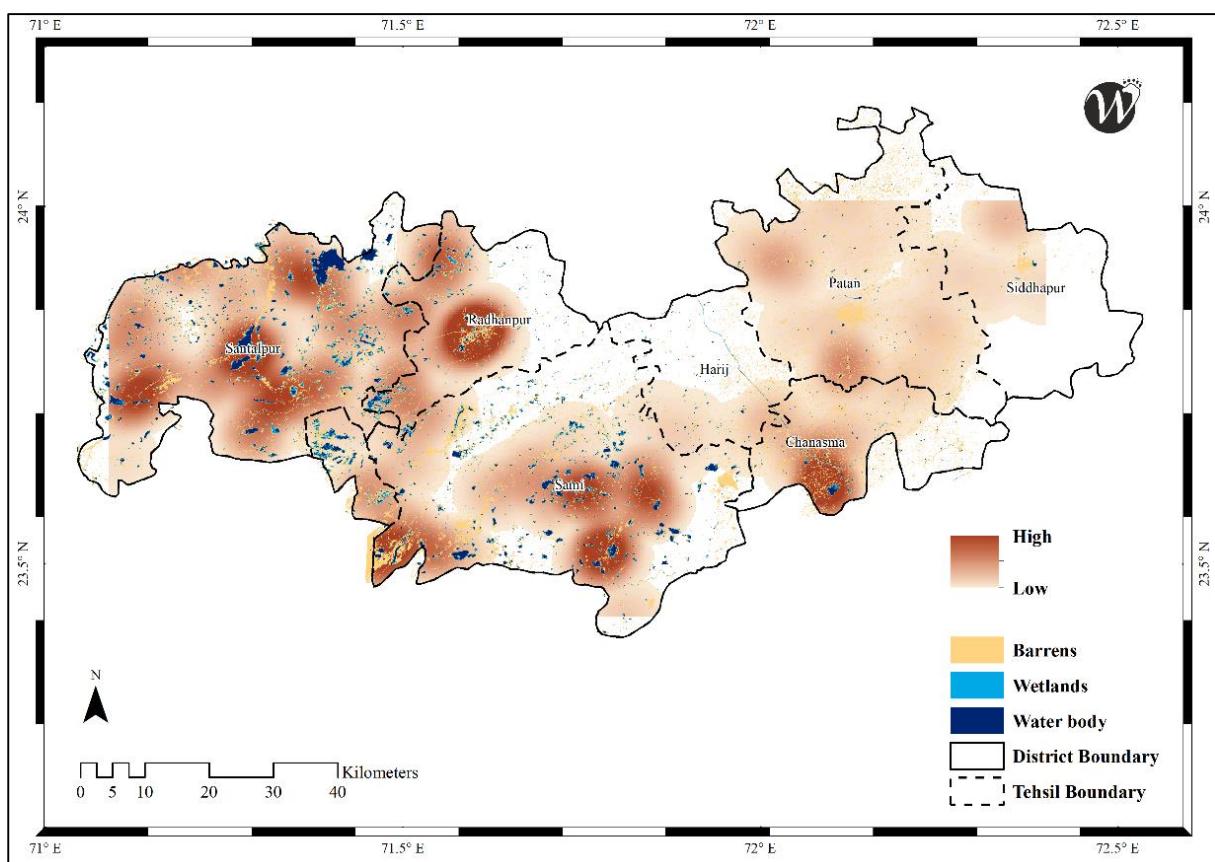
In the next section, taluka wise bird diversity and indices are presented for the future management and conservation of wetlands in the district.



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### **Patan District:**

Patan district is situated in the northern part of Gujarat state. The district is carved from Banaskantha and Mahesana districts and spread in the area of 5740 Km<sup>2</sup>, sharing its boundary with Banaskantha in north, Little Rann of Kachchh in the west, Mahesana district in the east and Surendranagar and Ahmedabad districts in the south. Rivers Banas, Rupen, and Saraswati drains in the western part of the district in the Little Rann of Kachchh. The surface water resources of the district are very limited and the groundwater is the main source of irrigation (Sinha, 2014).



**Figure 12: Map showing the congregation of bird species with respect to species richness in Patan district**

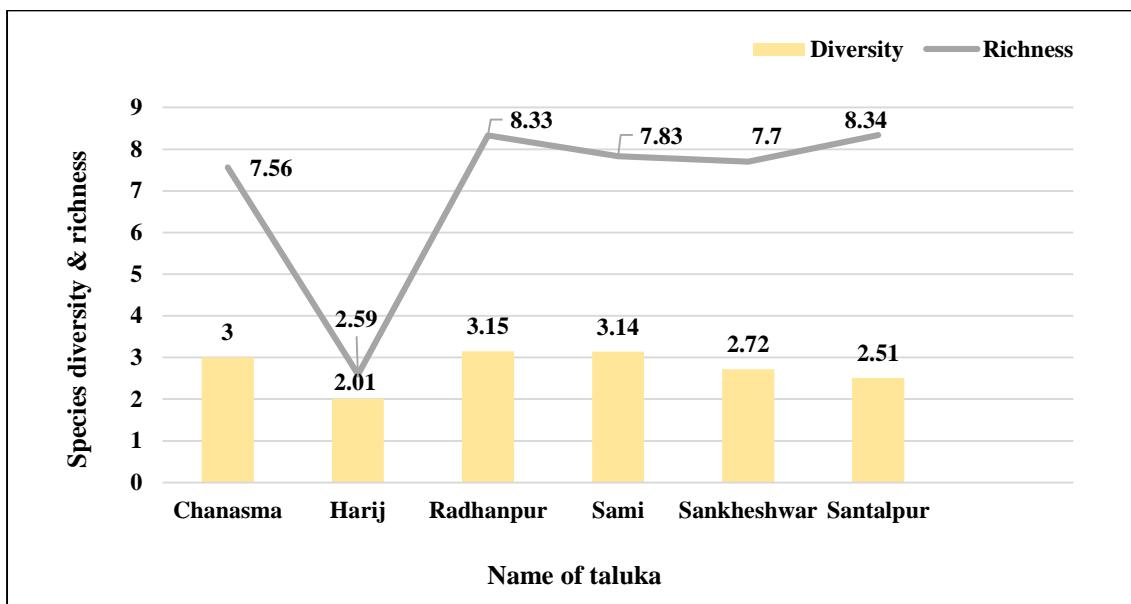
The GIS based map (figure 12) indicates the bird congregation in Patan district during the migratory season (November 2020- February 2021). The above results show that avifaunal diversity is distributed higher towards the western to central part of the district as these areas have more number of wetlands and less disturbance. The map depicts that wetlands present in Radhanpur, Santalpur, Chanasma, Sami, and Sankheshwar taluka have highest bird congregation and species richness and the wetlands of Sidhpur, Patan, Saraswati and Harij



## **Study on wetlands of Patan**

are recorded with lower species richness due to less congregation, less number of wetlands and may be high level of disturbance.

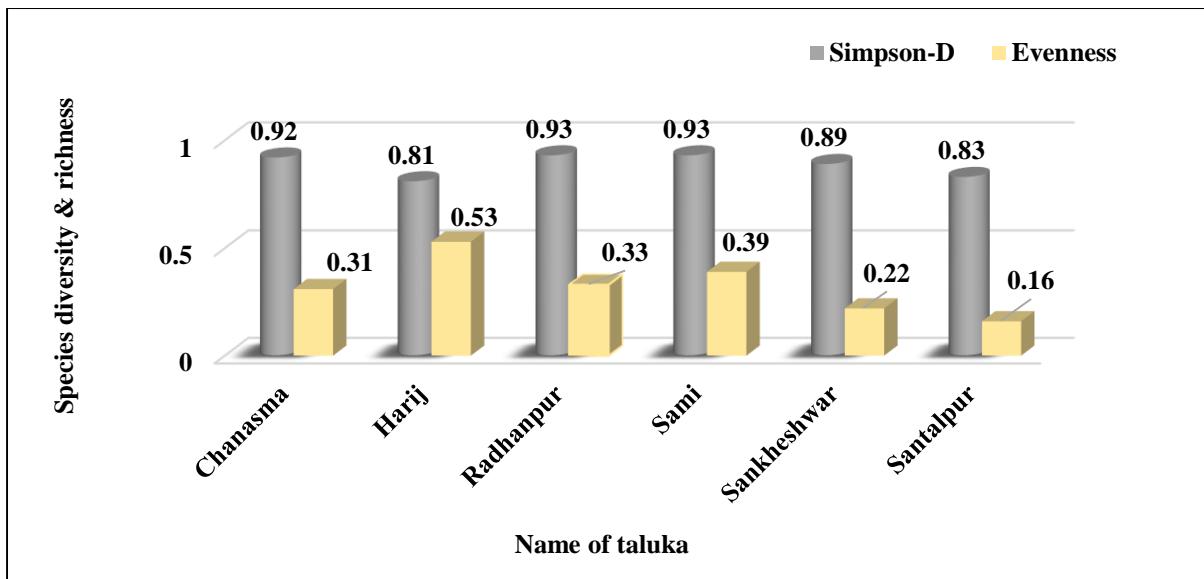
Based on the evaluation and ranking of wetland with respect to migratory birds (table 7) 41 wetlands from six taluka were extensively surveyed to study bird diversity.



**Figure 13: Wetland wise Species richness and Shannon Diversity of bird species in Patan district**

A species richness represents number of different species in a community. The results show highest species richness in Radhanpur and Santalpur taluka while moderate richness in Chanasma, Sami, and Sankheshwar taluka. As well as Shannon diversity index value range of 3 recorded in Chanasma, Radhanpur, and Sami (Figure 13). Sankheshwar and Santalpur are moderately diverse with respect to wetland bird diversity and the lowest diversity and richness observed in Harij taluka. Central to the western part of district represents significant avifaunal diversity may be due to an increase in salinity and water holding capacity of the soil. Patel and Dharaiya, 2016 observed that wetlands in the saline desert have high profitability that gives plentiful food assets to macrofauna just as the aquatic birds. As a result as we move from east to west in the district (Chanasma, Radhanpur, Sankheshwar, Sami, and Santalpur taluka), the bird congregation, diversity and richness is increasing.





**Figure 14:** Wetland wise Simpson diversity and Evenness of bird species in Patan District

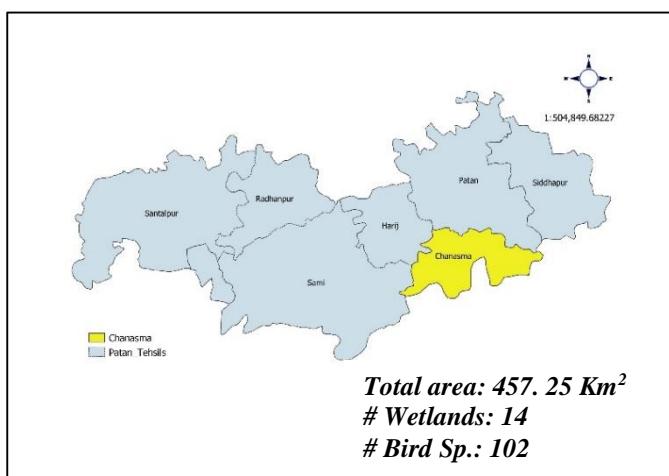
The highest species diversity during the study period was observed in the wetlands located in Chanasma, Radhanpur and Sami taluka; while, Sankheshwar, Santalpur, and Harij taluka wetlands had the least species diversity compared to the above taluka. Evenness is the extent of species or practical gatherings present on a site. The more equivalent species are with respect to one another, the more noteworthy the equality of the site. A site with low evenness demonstrates that a few species dominate the site. Evenness ranges from 0 to 1 and as it approaches 1, individuals are partitioned equally among species (Chatterjee *et al.*, 2018; Ulfah *et al.*, 2019). The highest evenness was observed in Harij showing more evenly distributed species within the community. Whereas Chanasma, Radhanpur, and Sami taluka have less evenness than Harij which represents there are dominating species present in wetlands of these taluka.



### **Taluka wise diversity of avifauna:**

The diversity indices were used to explore the status of wetlands in Patan district and to identify the most important wetlands from the study area. Shannon-Wiener and Simpson's index were used to evaluate the avifaunal diversity in wetlands of the district. Shannon-Wiener index assumes that individuals are randomly sampled from the study area. It has been a useful index to understand the profile of biodiversity across the study area (Bibi, 2013). A total of 41 wetlands were selected based on the abundance and richness of avifauna (Table 7). Additionally, analysis of 41 wetlands will lead toward the most diverse wetlands in Patan district for further study and implementing future conservation and management practices.

#### **Chanasma:**



Chanasma is located 18 km towards south from district head quarter, Patan. The taluka constitutes around 59 villages among them 14 wetlands were recorded during the study period. River Rupen passes through this taluka making deep ground water level and deep lakes (10-20m) which is a home of Greater flamingo, Red-crested

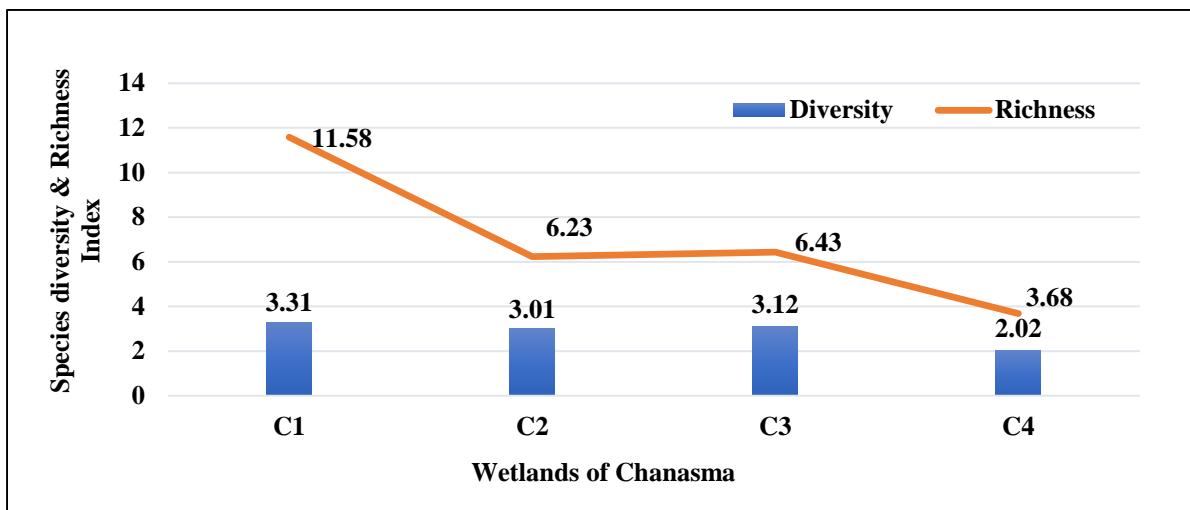
pochard, Ferruginous duck, Lesser whistling duck, Bar-headed geese, indicating a good habitat for diving ducks and surface feeder birds. Khokhala lake is recorded as a largest wetland and with high bird abundance in Chanasma. Four wetlands of Chanasma were selected for the analysis, and they are Khokhla, Mehmadpur, Maniyari, and Brahmanwada.

A total of 102 bird species were recorded from wetlands of Chanasma with a mean 3.33 Shannon diversity Index and 11.58 Richness Index. Results show that Khokhla village wetland have higher diversity as well as richness compared to the other three wetlands of Chanasma. The most abundant species were Grey leg geese, Gadwall, Northern Shoveler, Northern Pintail, Indian Spot-billed Duck, Common teal, Common coot, Little grebe, Little Cormorant, and Black wing stilt while least abundance species were Red-crested pochard, Ruddy shelduck, Cotton teal, Bar-headed geese, Asian openbill, Painted stork, Dalmatian, and Great white pelican, Eurasian spoonbill and great crested grebe. Submerge vegetation growth is also

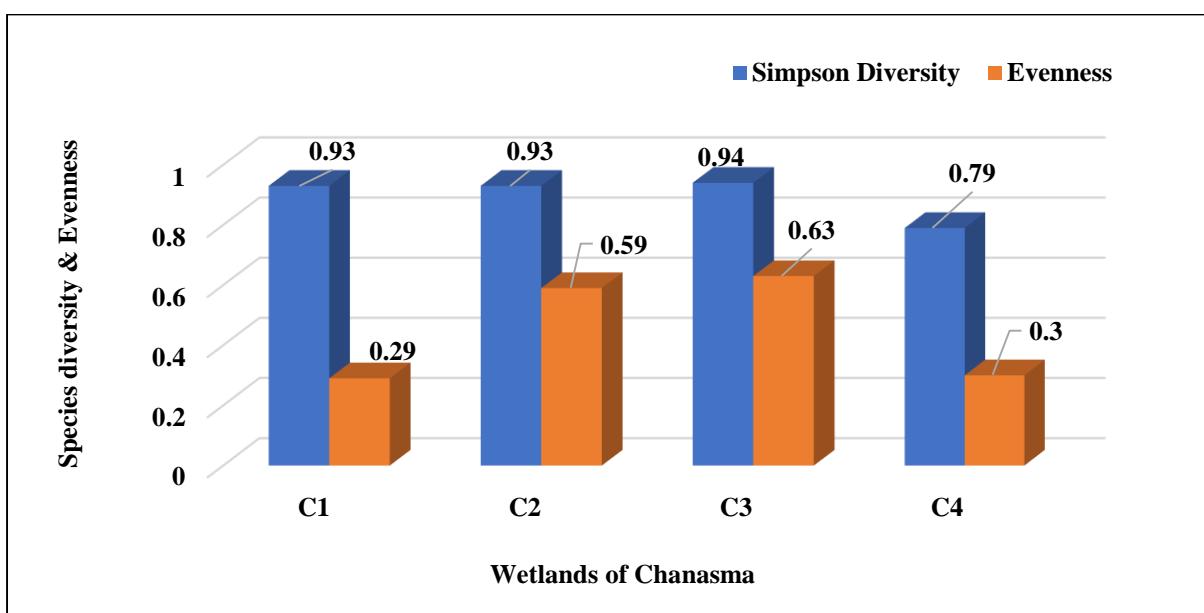


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recorded here, which can be the breeding ground for some resident birds. Few nests of great crested grebe were recorded from Khokhla wetland.



**Figure 15:** Wetland wise Species richness and Shannon diversity index of bird in Chanasma taluka



**Figure 16:** Wetland wise Simpson diversity and Evenness of bird species in Chanasma taluka

The diversity values ranging from 0.7 to 0.9 in Chanasma taluka, the highest value of Simpson diversity ranges 0.93 in C3 (Maniyari) and the lowest value ranges 0.79 in C4 (Brahmanwada).

The evenness index (E) describes the number of individual sizes between species in a wetland community, the more evenly distributed individuals between species, the more balanced the ecosystem will be (Ulfah, 2019). The result shows that low evenness in C1 (Khokhla) and C4

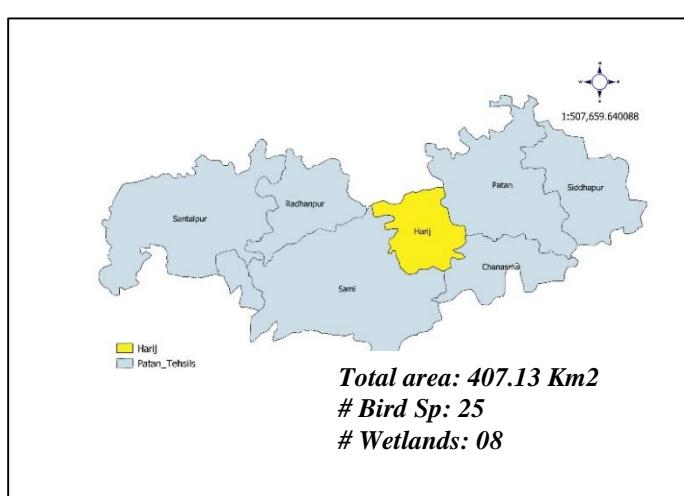


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(Brahmanwada), which depict that the dominance of different individuals in these wetlands. Whereas highest evenness in C2 (Mehmadpur) and C3 (Maniyari) represents the dominance of the same individuals in these wetlands.

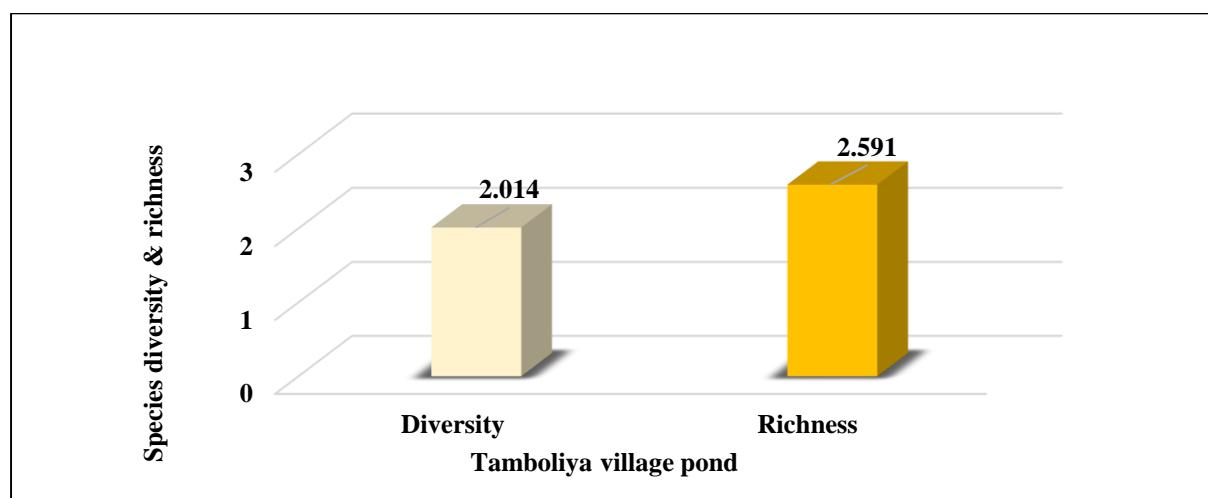
Out of the four important wetlands, Khokhala lake supports a higher number of species (95), with Shannon diversity ( $H=3.31$ ), and richness than that of other wetlands, mainly because of the larger area, mixed type of vegetation. Khokhala and Brahmanwada (C4) lakes having less evenness (0.2 & 0.3 respectively) compared to others, which indicate there are few dominant species in the habitat. Whereas C2 and C3 having less diversity with evenly distributed species in wetlands.

### **Harij:**

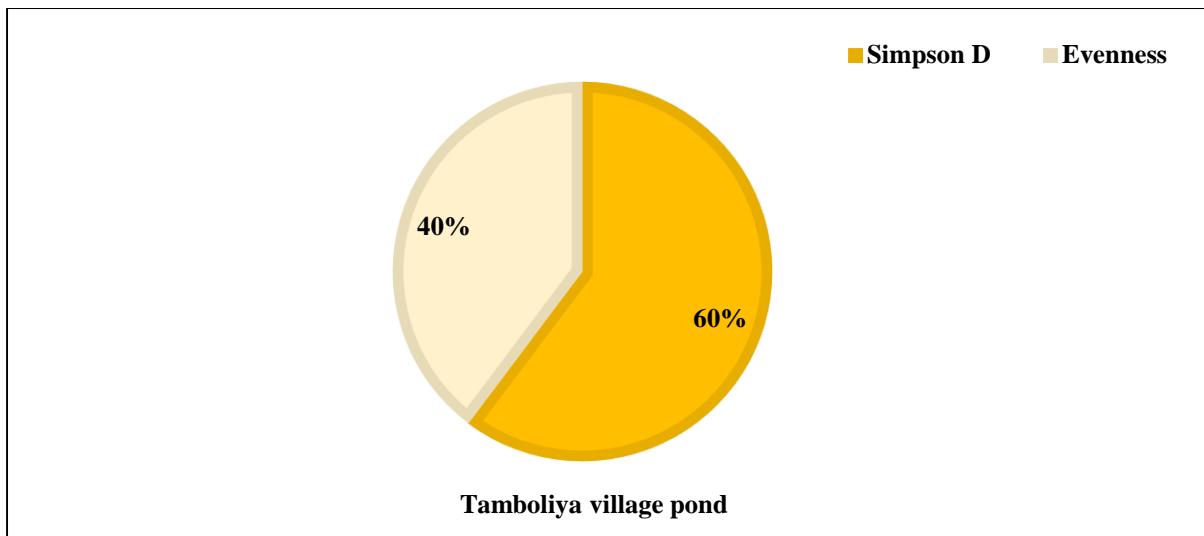


Harij located 32km towards west from district headquarter consist 41 villages which has basically saline-alkali type of water (Sinha, 2014). As on the western part, close to the saline desert, the climate is saline and semi-arid. A total of eight wetlands are recorded from Harij, out of which, only one wetland, Tamboliya village pond was selected for detailed study based on its

wetland evaluation score. Afterward, this wetland is further analyzed using diversity indices.



**Figure 17: Species richness and Shannon diversity of birds in Harij**



**Figure 18: Simpson diversity and Evenness of bird species in Harij**

Only 25 species were recorded from the Tamboliya wetland of Harij. Shannon's diversity index range is 2 which is very low compared to the other five taluka (Figure 17 and 18) with important wetlands. Although it has less richness and more evenness compared to other wetland.

#### **Sankheshwar:**

Sankheshwar is a taluka located near arid region of Kachchh. River Rupen passes from here. It is located 58.2 km towards south west region from Patan headquarter. Sankheshwar is considered in a Sami range and both Sami and Shankheshwar have a total of 99 villages. It is carved from Kachchh and Mehsana and established as an individual taluka. Wetlands of this taluka harboring birds like dabbling ducks and diving ducks as it has a shallow lakes and saline water. These wetlands have a very good aquatic vegetation supporting a good habitat for the migratory waterfowls. Following figure 19 shows the diversity indices in the wetlands of Sankheshwar.

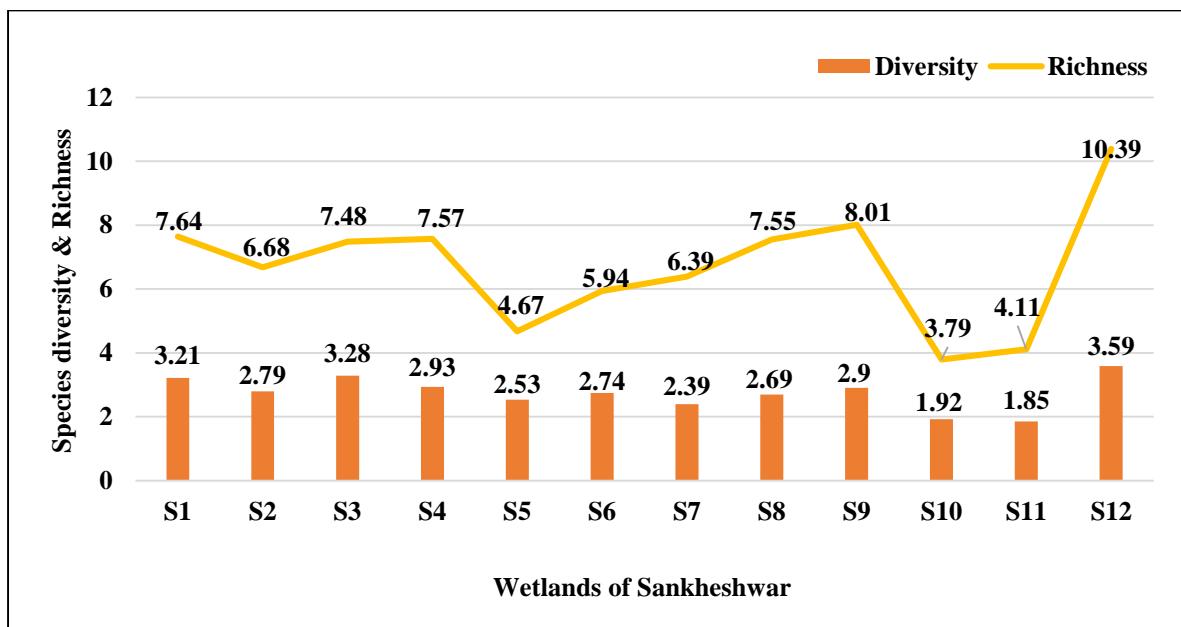
Total 129 bird species were recorded from the wetlands of Sankheshwar taluka with a mean 3.09 Shannon diversity Index and a richness index of 14.35. Wetland no. S12 (Bolera-Sankheshwar road) has much diversity and richness. Further, S1 (Sankheshwar village pond), S3 (Runi village lake), and S9 (Taranagar Rann side wetland) wetlands were recorded with a good richness. Hence, these wetlands showing a high diversity among all the 12 wetlands studied from Shankheswar.

The most abundant species are, Common moorhen, Grey leg geese, Common pochard, Eurasian wigeon, Common teal, Gadwall, Northern Shoveler, Northern Pintail, Indian Spot-

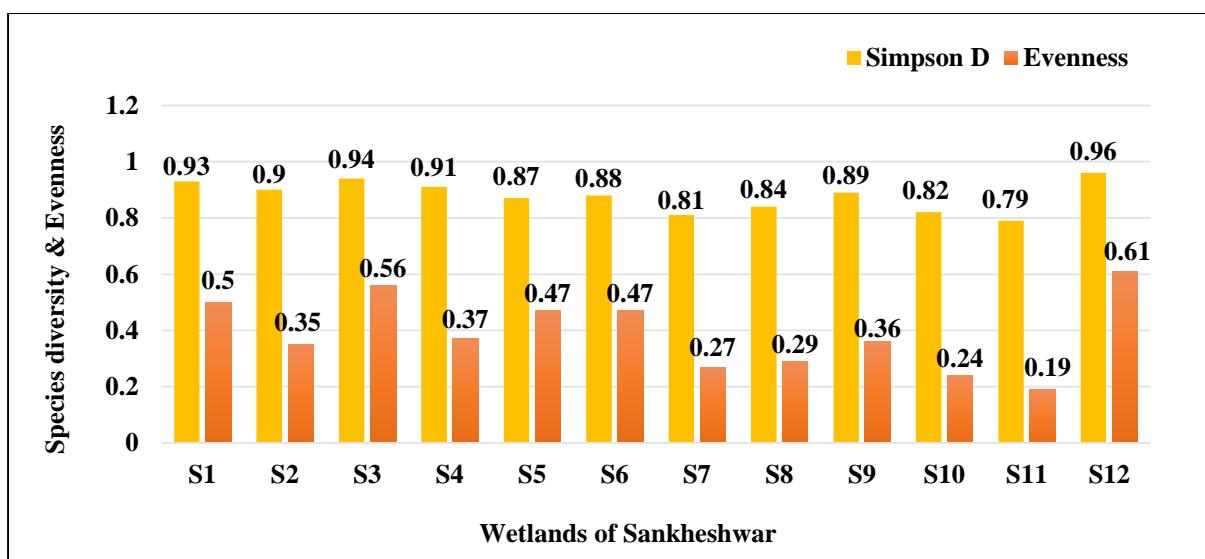


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billed Duck, Common coot, Little grebe, Common crane, Little Cormorant, Barn swallow, Rose-ringed parakeets, Rosy starling, and Black wing stilt while least abundance species are Purple swamphen, Variable and Desert wheatear, Shrikes, Common chiffchaff, Sarus crane, and Woolly-necked stork.



**Figure 19:** Wetland wise Species richness and Shannon diversity of bird species in Sankheshwar



**Figure 20:** Wetland wise Simpson diversity and Evenness of bird species in Sankheshwar

The diversity values ranging from 0.7 to 0.9 in Sankheshwar taluka, the highest value of Simpson diversity index is 0.95 in S12, followed by S2 (Harij-sankheshwar road farm), S1, and

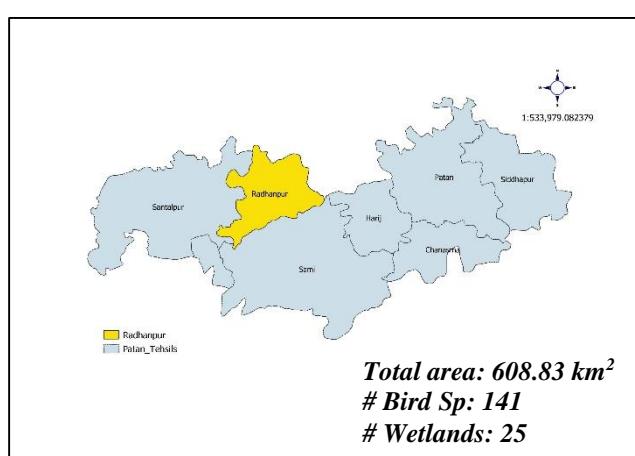


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S3 wetlands. On the other hand, these wetlands have evenness index of 0.5 to 0.6 which means half of the species have the same number of individuals. Lowest evenness recorded in Taranagar, Moti chandur, Palipur, and Meman village wetlands.

The study was conducted in 12 wetlands of Sankheshwar taluka. Among these, wetland located at Bolera-Sankheshwar road recorded with 60 species of birds and with the highest richness (10.3), Evenness (0.6) and diversity ( $H=3.6$ ) reflecting a healthy ecosystem. Subsequently, Taranagar Rann side wetland, Sankheshwar village pond, and Runi village wetlands show great richness and diversity. Taranagar Rann wetland has less evenness which is due to the dominancy of few species. Consequently, Hirapur Ashram and Palipur village wetlands, and farms near Harij-Sankheshwar road have a high richness; however, the species are not evenly distributed might be but due to high human activities and disturbance.

### **Radhanpur:**

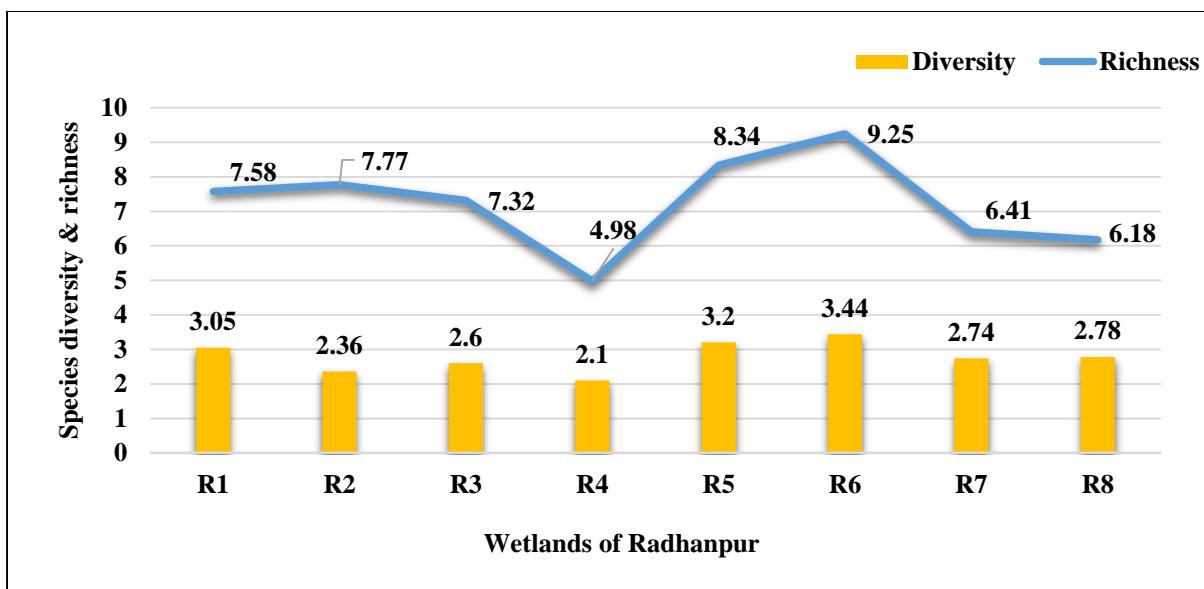


Radhanpur is located 56.1 km towards west from the district headquarter, Patan and closer to the Rann of Kchchh. A total of 25 wetlands were surveyed from 56 villages. The western part of Patan district is charged with high level of salinity and the wetlands here are shallow to deep lakes which harbors a very good diversity of microfauna and planktons and leads to

more pisces diversity. Because of this, waterbirds like pelicans, herons, grebes, shoveler, and other ducks are congregated more in this area. Following figure shows the diversity indices in the wetlands of Radhanpur taluka.



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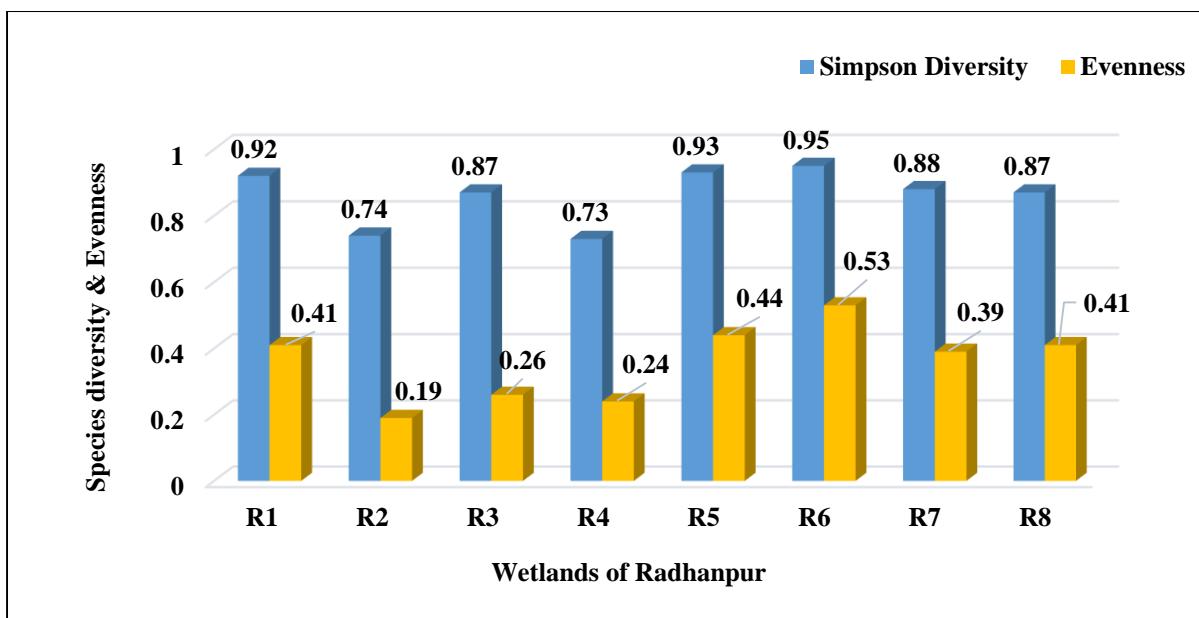


**Figure 21: Wetland wise Species richness and Shannon diversity of bird species in Radhanpur taluka**

Total 141 bird species were recorded from wetlands of Radhanpur taluka with has a mean 3.64 Shannon diversity Index and a richness of 16.4, which is the highest in entire Patan district. The result shows that the R6 (Madhupura dam) wetland has higher bird diversity as well as richness compared to the other seven wetlands studied from Radhanpur. This is followed by R5 (Satoon) and R1 (a wetland on Radhanpur-Varahi highway) recorded with a good diversity and richness. Whereas, the lowest diversity was recorded in Gotarka (R2), Javantri (R3), R4 Antarnes (R4), Gokhantar (R7) and a wetland located on Radhanpur-satoon road (R8).

The most abundant species here is Grey leg goose, Common pochard, Eurasian wigeon, Common teal, Gadwall, Northern Shoveler, Northern Pintail, Indian Spot-billed Duck, Common coot, Little grebe, Common crane, Little Cormorant, Barn swallow, Rose-ringed parakeets, Rosy starling, and Black wing stilt; while the least abundant species are Ruddy shelduck, Cotton teal, Asian openbill, Painted stork, Dalmatian, and Great white pelican, Greater spotted eagle, Eastern Imperial Eagle, Marsh sandpiper, Common redshank, Dunlin, Sanderling and Little stint.





**Figure 22:** Wetland wise Simpson diversity and Evenness of bird species in Radhanpur

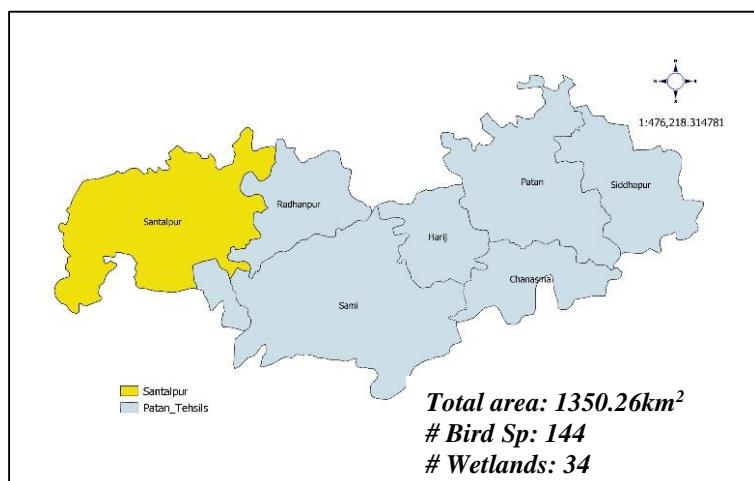
The diversity values range from 0.7 to 0.9 in Radhanpur taluka, the highest value of Simpson diversity ranges 0.95 of R6, followed by R5, R1, and lowest value ranges 0.7 in R2 and R4 wetland. On the other hand, R6 range 0.5 evenness which means half of the species have the same individuals. Lowest evenness present in R2, R3, and R4.

In Radhanpur taluka, a total of 8 wetlands were selected for analysis, and more than 140 species of birds were recorded from this taluka during the study period. Among all the wetlands, richness, Shannon diversity, and evenness were found higher in Madhupura dam ( $r=9.2$ ,  $H=3.4$ ,  $E=0.5$ ) which indicate that this wetland is very important for aquatic birds. Follow to Madhupura dam, the village pond of Satoon village possesses the highest in species richness (8.3), evenness (0.4), and species diversity ( $H=3.2$ ). During the study, high biotic pressure was observed around these two wetlands and need more attention and protection measures. The other three wetlands located on Radhanpur-Varahi highway, Gokhantar forest, and Anternes are also found with high richness (7.5, 7.7, and 7.3 respectively). Some of the rare species such as Black stork, Black-necked stork, Lesser flamingos, and tufted pochard were recorded in these wetlands. Salinity enhances the productivity of the aquatic ecosystem, increases the growth of submerged vegetation, plankton, and other invertebrates which make these wetland as a vital feeding ground during the migratory period (Patel and Dharaiya, 2016).



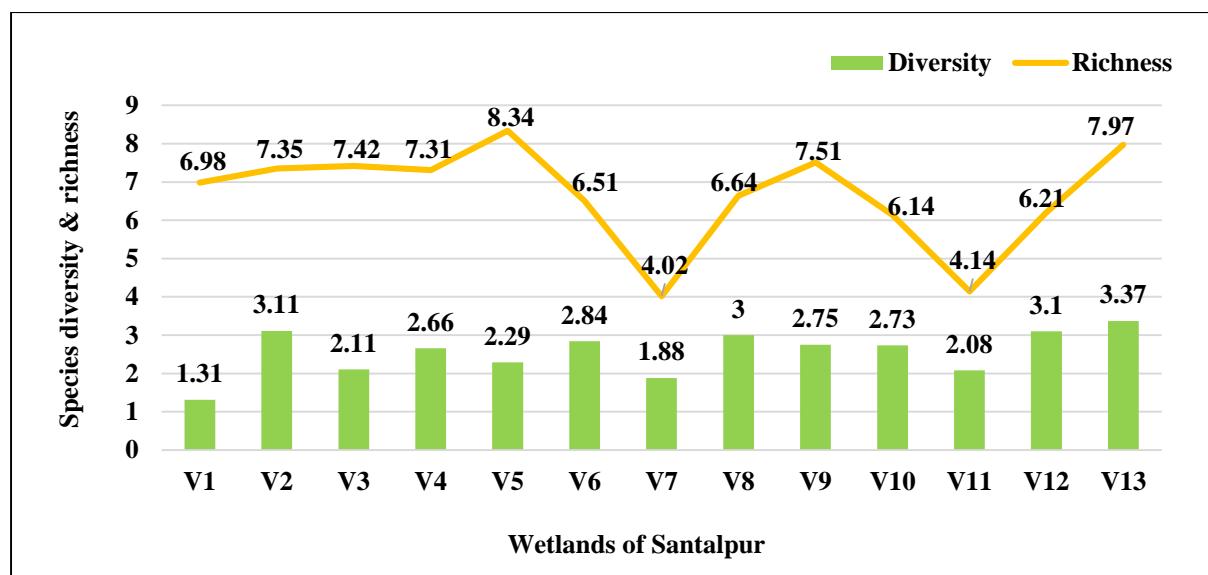
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### Santalpur:



Santalpur is located 105 km on western side from district headquarter. The taluka consists 73 villages with the total area of 1350.26 sq km. A total of 34 wetlands were surveyed during study. Santalpur taluka forms the western tip of the district and merges in the Little Rann of

Kachchh, which makes it an important bird area. High salinity in soil and water and lower evaporation rate of water allows the water retain on the ground for longer period with favorable conditions for growth of aquatic plants and invertebrate as a food for wetland birds. Santalpur covers major area in the district with a greater number of wetlands. Following figure shows the diversity indexes of Santalpur taluka wetlands.



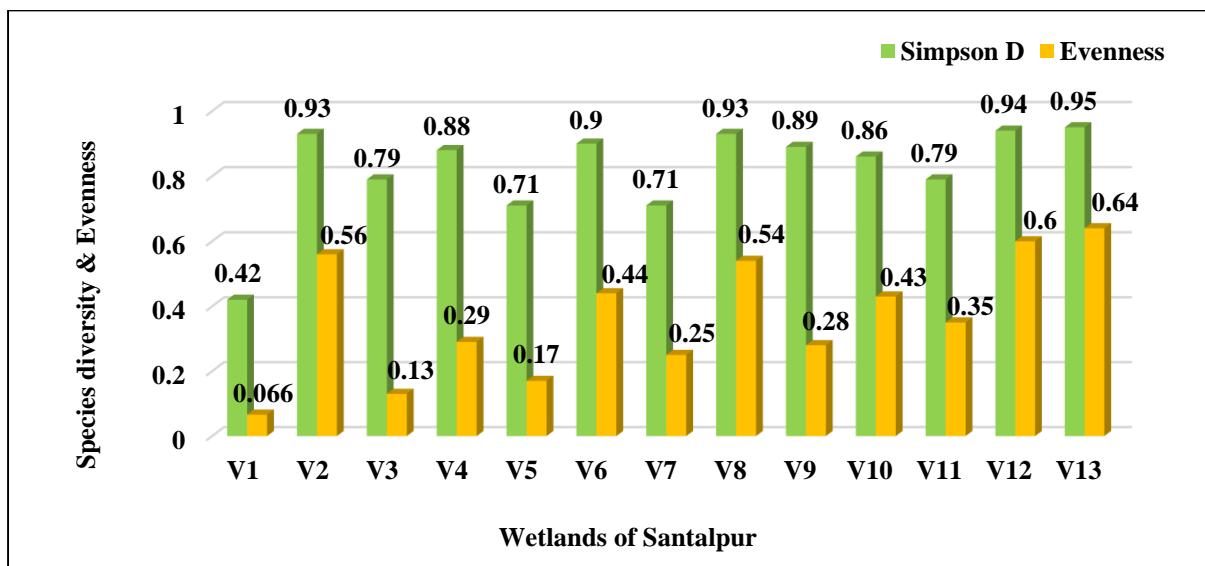
**Figure 23: Wetland wise Species richness and Shannon diversity of bird species in Santalpur taluka**

Total 144 bird species were recorded from the wetlands of Santalpur taluka with a mean 2.8 Shannon diversity index and 15.16 richness index which is the third highest in Patan district. High species richness were recorded from the wetlands of Garamdi (V5), Charanka (V13), and Rampura (V9) village, while the other wetlands have moderate richness and diversity. The least richness was recorded in Chhanasara (V7) and Koliwada (V9) wetlands.



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The most abundant species of these wetlands were Indian shag, Little cormorant, Little egret, Common coot, Common Moorhen, Little egret, Grey leg geese, Gadwall, Common teal, Northern pintail, Northern shoveler, Eurasian wigeon, etc., while the least abundant species were Ferruginous duck, lesser whistling duck, Mallard, Comb-duck, Lesser flamingo, etc.,



**Figure 24: Wetland wise Simpson diversity and Evenness of bird species in Santalpur taluka**

The above graph shows that Simpson's diversity index value ranges from 0.4 to 0.95 in Santalpur taluka. The highest diversity value range is 0.9 in six wetlands viz. V2 (Gokhantar), V6 (Rozu highway), V8 (Rajusara), V8 (Rampura), V12 (Barara), and V13 (Charanka). Other wetlands such as V3 (Chhanasra-Rajusara wetlands), V4 (Jamvada), V5 (Garamdi), V9 (Koliwada) having moderate types of diversity. Evenness value ranges from 0.05 to 0.6, and the highest value range in V13, V12, V8, V2 which shows that more than half of the species have equal number of individuals.

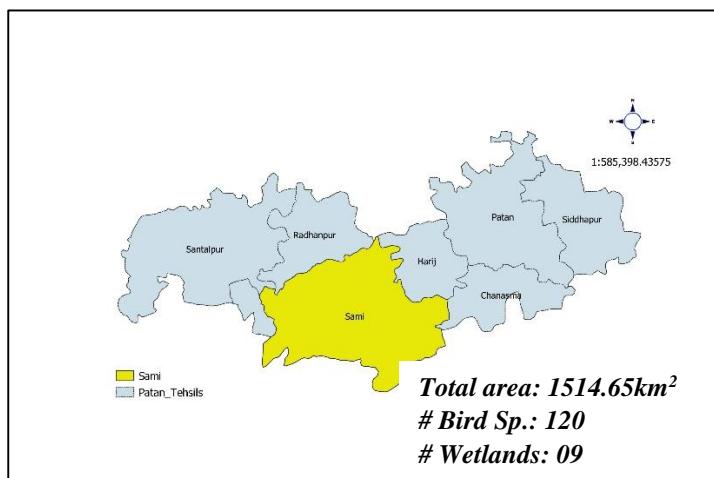
The study reveals that Santalpur is one of the most diverse taluka of Patan district with 13 important water bodies. Out of these 13 wetlands, highest richness noted in V5 (8.3) and V13 (7.9) village wetlands. The wetland, V5 of Garamdi village is a large habitat and has great aquatic vegetation for feeding and breeding. Due to its location on national highway, immense disturbance of transportation was observed. Despite of these disturbance, Great crested grebe is breeding in this wetland and it is home for many waterfowls includes Grey leg goose, Great white and Dalmatian pelicans and other important species like Black Eagle. Dam part of V13 (Charanka) is also having good diversity and evenness, though the biotic pressure and development of Solar park can be the important threats to this wetland.



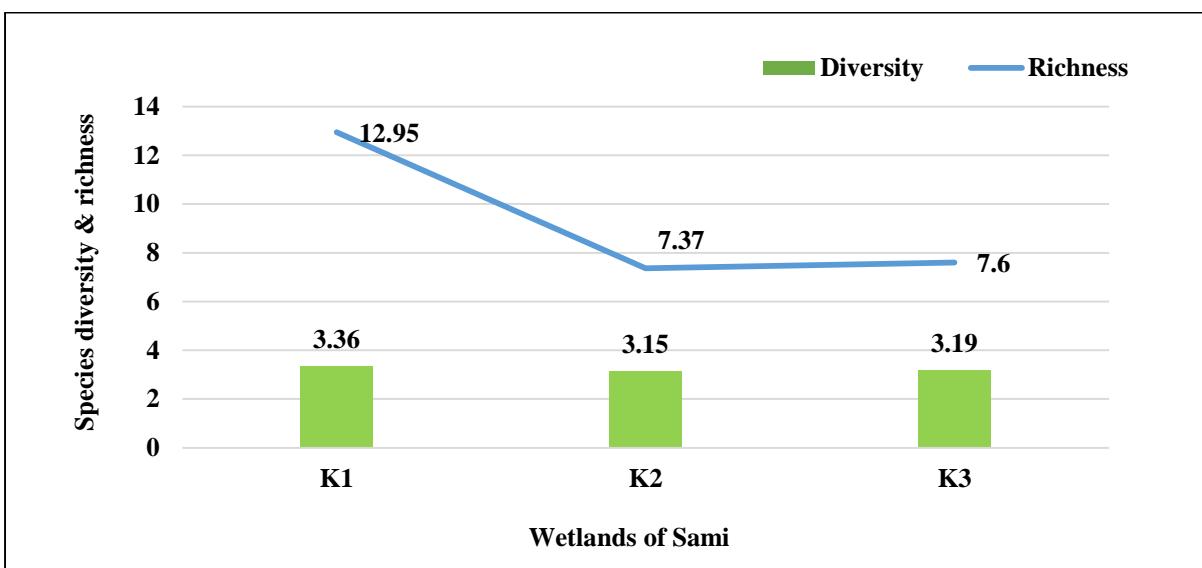
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The other wetlands located in Rampura, Jamvada, Gokhantar, and Siddhada also reported with high species diversity and good population of waterfowl; however the anthropogenic activities around these wetlands is the reason for low evenness of bird species. We have also recorded the nesting of Painted stork near the lake of Barara

### **Sami:**



Sami located 46 km towards west from Patan, which is surrounded by Sankheshwar, Radhanpur, and Harij. All these talukas having saline soil and retain water for longer period. However, more migratory birds attracted towards these areas. Following figure shows the diversity indexes of Sami taluka wetlands.



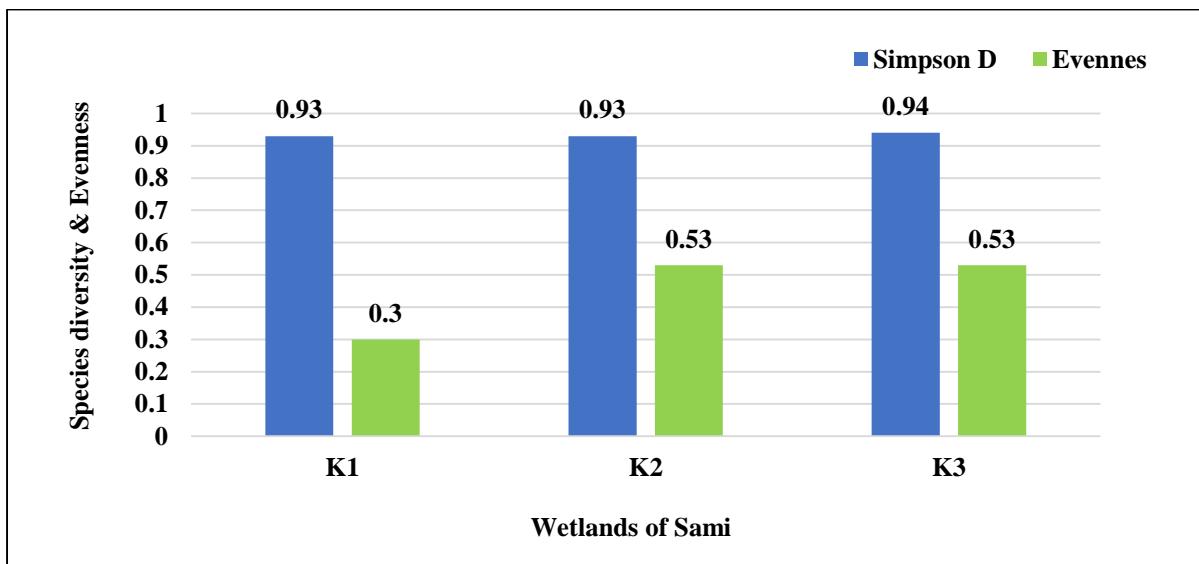
**Figure 25: Wetland wise Species richness and Shannon diversity of bird species in Sami taluka**

A total of 120 bird species was recorded from the wetlands of Sami taluka with a mean 3.7 Shannon diversity index and a mean 15.53 species richness index which is the second-highest in Patan district. The result shows the highest species diversity and richness in the K1 (Vadilal dam). Whereas K2 and K3 (Kodadha village and Amrapur) village wetlands have almost similar values of Shannon diversity index and richness index too.



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The most abundant species recorded from these wetlands are Gadwall, Common pochard, Northern pintail, Common coot, Rosy starling, Yellow-legged green pigeon, Common coot, Common crane, and Painted stork. The least abundant species were Red-crested pochard, Tufted duck, Eurasian wigeon, Black stork, Common moorhen, Oriental darter, and cormorants.



**Figure 26: Wetland wise Simpson diversity and Evenness of bird species in Sami taluka**

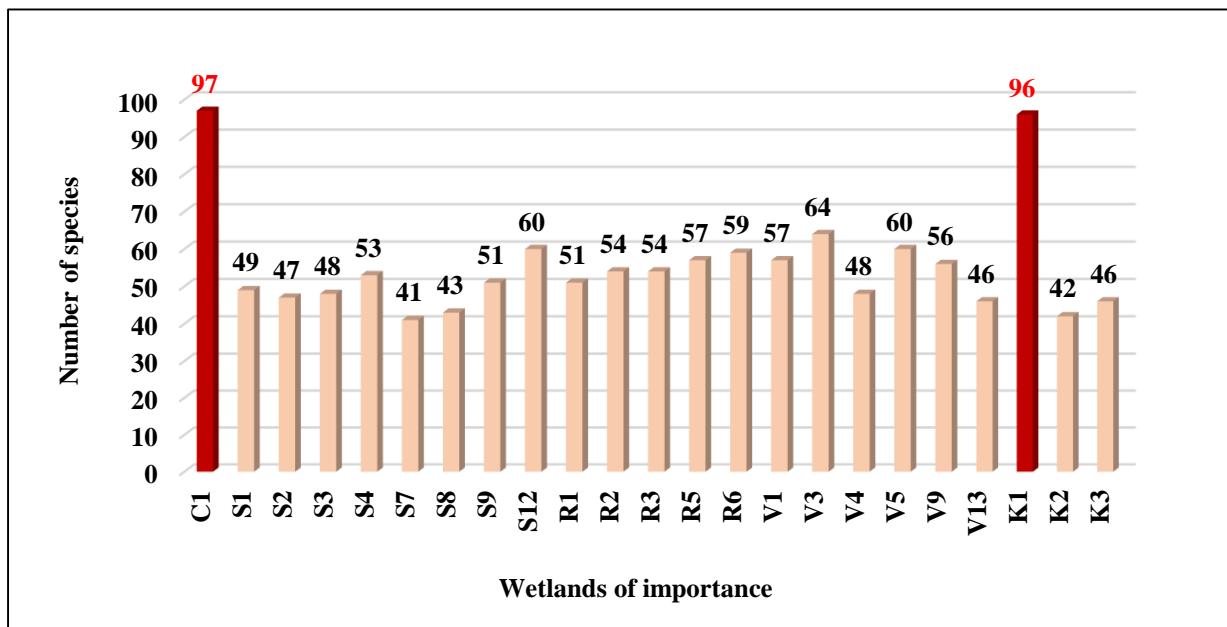
Simpson diversity index of all the three wetlands are almost same; whereas the evenness of K1 (Vadilal dam) is lower indicating that the bird species individuals are not evenly distributed in this area. While K2 and K3 show that half of the species have similar number of individuals.

Three important wetlands are located in Sami taluka, viz. Vadilal dam, Kodadha village pond, and a lake of Amrapur village presenting greater bird diversity. Vadilal dam harboring more than 90 bird species with the species richness index of 12.95; however lower evenness value (0.3) indicate the fewer dominant species found in the wetland. Higher evenness values in the wetlands of Kodadha Village and Amrapur village showing more stable and evenly distributed species.



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Figure 27 shows the presentation of all the 23 out of 41 extensively surveyed wetlands of Patan district with respect to the number of bird species recorded and the diversity indices. These 23 wetlands can be considered as important wetlands of the district which needs regular monitoring, habitat management and conservation actions. The detailed list of these wetlands and the bird species recorded is provided in Annexure-III.



**Figure 27: Wetlands of importance in Patan based on the number of bird species**

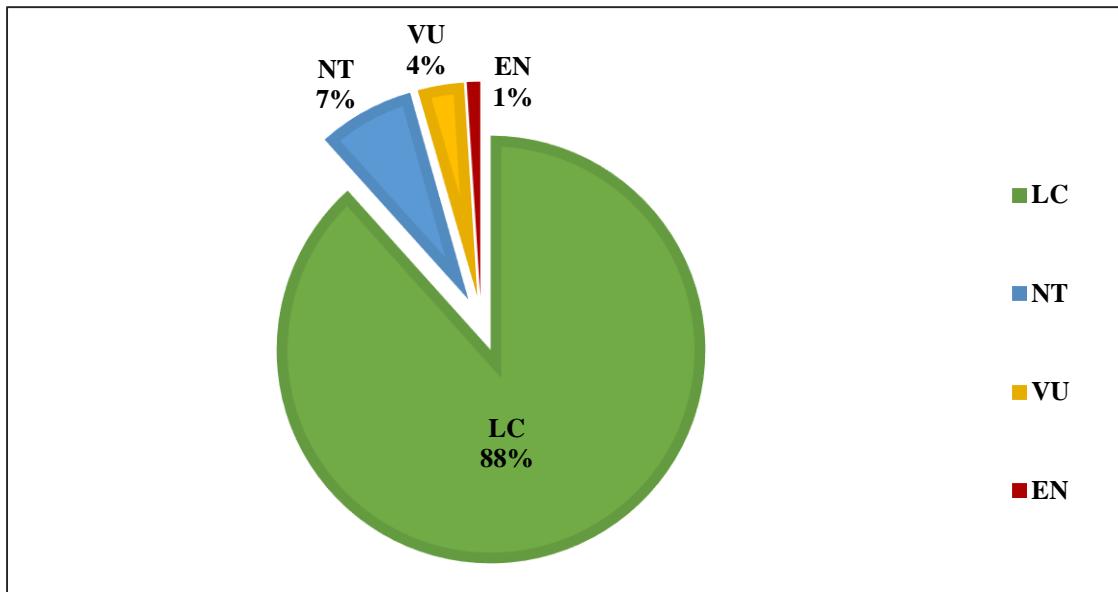
Wetlands of Khokhla (C1) and Vadilal dam (K1) are recorded with highest number of species and high species richness followed by Chhanasra-Rajusara wetland (V3), Garamdi(V5), and Bolera-Sankheshwar wetland (S12). Patel, (2009) reported that the bird diversity indicates the eutrophic condition of wetland because greater availability of food resources in productive lake attracting more bird species, hence regular monitoring and wetland management and conservation measures are required in these wetlands.



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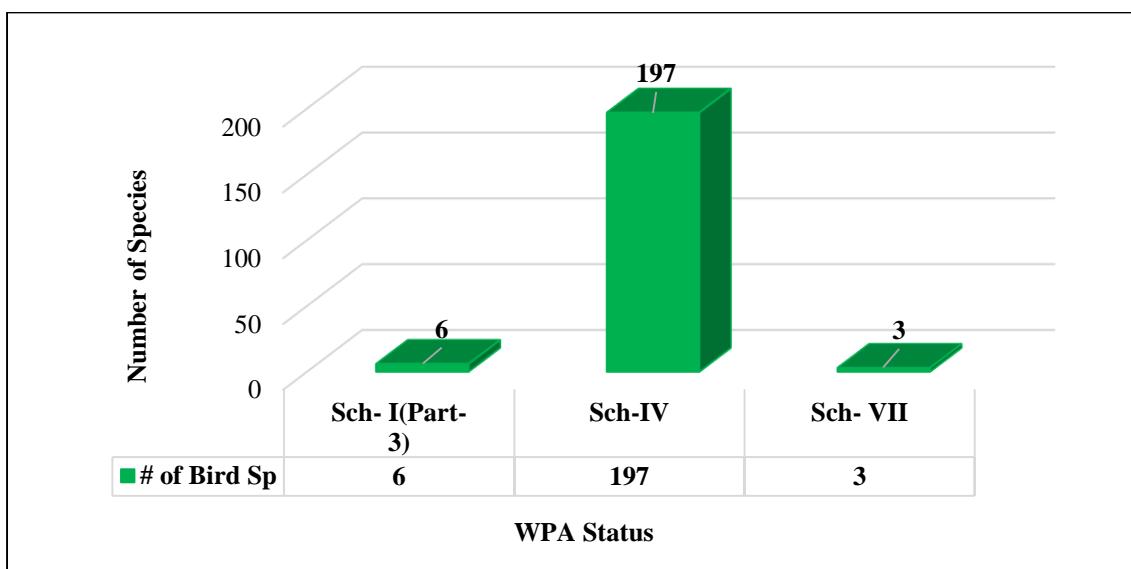
### **Threats to the wetland and birds:**

The following images shows the threatened bird species recorded in study area during the migratory season of the year 2020 (Figure 22 and 23).



*LC= Least Concern, NT=Near Threatened, VU= Vulnerable, EN= Endangered*

**Figure 28: Bird species recorded in Patan district based on their conservation status**



**Figure 29: Graph showing the bird species based on the Indian wildlife (protection) Act 1972**

The figures above depicts that 12% of the total birds recorded in Patan district are under the threatened category of IUCN (2011). These bird species includes Ferruginous Duck (*Aythya nyroca*), Lesser Flamingo (*Phoeniconaias minor*), Great Thick-knee (*Esacus recurvirostris*),

## **Study on wetlands of Patan**

Pallid Harrier (*Circus macrourus*) are near threatened, Sarus Crane (*Antigone Antigone*), Woolly-necked Stork (*Ciconia episcopus*) are Vulnerable and Steppe Eagle (*Aquila nipalensis*) and Egyptian Vulture (*Neophron percnopterus*) are the endangered birds recorded in the district. Moreover, six bird species are falling under Schedule -I (Part-III) of the Indian Wildlife (Protection) Act (1972), which includes Indian peafowl, Osprey and Peregrine falcon, Macqueen's Bustard, Egyptian vulture, Steppe Eagle.

Following are some of the important threats observed in the study area during the wetland survey that can be addressed and managed as a conservation action for the protection of globally threatened species.

List of Important threats to the birds and biological diversity of Patan district

- Mining
- Cattle grazing
- Cattle bathing
- Fishing
- Garbage dumps from the religious places
- Domestic use such as washing of cloths and utensils
- Dumping of domestic waste near wetlands

The important threat for the wetlands is urbanization and developmental activities, these are two main activities that directly or indirectly cause wetland loss. The Food and Agriculture Organization (FAO) corporate Statistical database confirmed that the disappearance of wetlands was principally attributable to human activities. Hu et al. (2017) have added that the most of the populations, which are always accompanied by high level of demand for food and housing and which results in the acceleration of the development of agriculture and urbanization. The bird species observed during study need more attention for conservation and protection.



## **Study on wetlands of Patan**

### **Other faunal diversity observed at the study sites:**

The aquatic ecosystem is always described for its unique wildlife as it provides habitat to many fauna other than the birds. Table 8 depicts the list of other wildlife observed during the wetland survey.

**Table 8: Other faunal diversity near wetlands**

Sr. No.	Common Name	Scientific Name
1	Asiatic Wildass	<i>Equus hemionus khur</i>
2	Jungle Cat	<i>Felis chaus</i>
3	Jackal	<i>Canis aureus</i>
4	Stripped Hyena	<i>Hyaena hyaena</i>
5	Stripped squirrel	<i>Fanambulus pennanti</i>
6	Common Mongoose	<i>Herpestes edwardsi</i>
7	Blue bull	<i>Boselaphus tragocamelus</i>
8	Indian hare	<i>Lepus nigri collis</i>
9	Indian soft-shell turtle	<i>Nilssonia gangetica</i>
10	Checkered keelback	<i>Fowlea piscator</i>



## **Conclusion**

The present study can be considered as a preliminary survey for the long-term wetland monitoring program aimed with the preparation of wetland management and conservation action plan for Patan district with special reference to migratory birds and aquatic ecosystem. The study was conducted during the peak migratory season (November 2020 to February 2021) during which a total of 206 bird species of 62 families were recorded from 138 small and large wetlands and their surroundings. 138 wetlands of the district were further evaluated with respect to the bird diversity and abundance and finally 23 important wetlands were listed in the district. The diversity of birds reported from these 23 important wetlands reveals the high abundance of family Anatidae. 47% of the bird species recorded during the study are the migratory birds, and the majority of them are omnivore according to their feeding niche.

12% of the birds are reported as threatened species according to the IUCN threat categories. The major threats observed during the study are dumping of domestic and religious waste, domestic use of wetlands, development and human activities around wetlands and the pressure of mining, agriculture and tourist activities. Few of the wetland sites are also a good breeding ground for the birds like Great crested grebe, Painted stork and other ducks, which demands the high protection and conservation actions.

23 most diverse wetlands with respect to wetland obligatory birds are located in the western part of the district in Radhanpur, Santalpur, Sankheshwar, Chanasma, and Sami taluka. The wetlands of the villages like Khokhala (Chanasma), Vadilal dam (Sami), Satoon (Radhanpur) Madhupura dam (Radhanpur), Bolera-Sankheshwar road wetland (Shankheshwar), Garamdi (Santalpur) are reported with high species diversity, species richness and evenness. This study also suggested that these 23 wetlands need further attention with special emphasis by regular monitoring of birds, nutrient load and lake productivity for their better conservation and management practice. Further, the present study reveals that the research study on bird composition and diversity indices on annual basis should be carried out that will be helpful to predict the overall condition of the wetland and threats on the ecosystem can be identified.

Wetland map of Patan, annotated checklist of birds, list of important wetlands of Patan district with respect to migratory birds are some of the important deliverables of this study and will be served as a baseline information for future research, monitoring, management and conservation. This study would also explain the ecological relationship between wetlands and



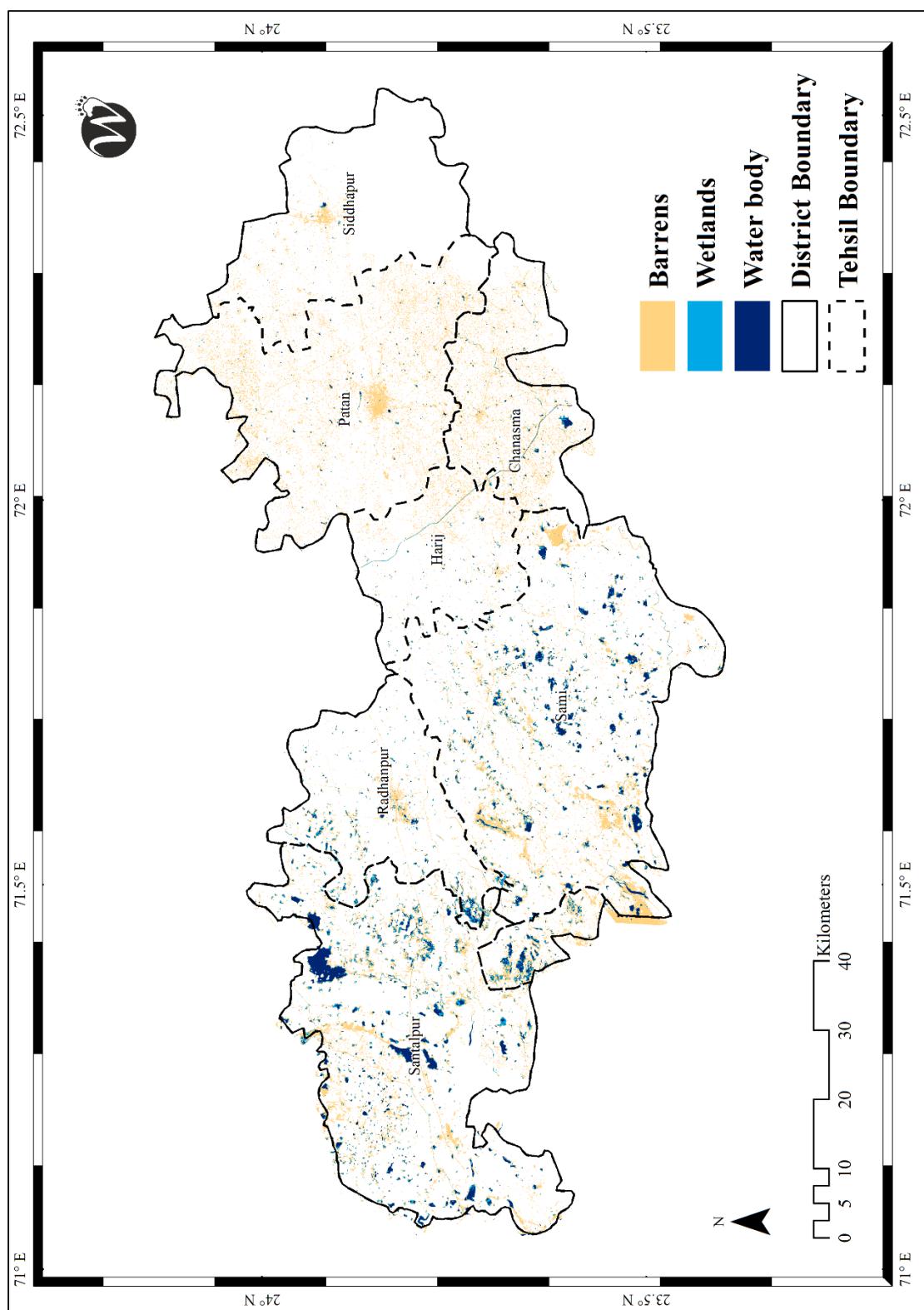
### ***Study on wetlands of Patan***

adjacent habitats in arid region. In addition, it would provide a strong base and support for conserving some of the most important wetlands. The threats listed in this report may be studied further in details through quantitative study for future management and minimizing threats on the aquatic ecosystems of Patan district. This study is the first ever systematic and exclusive study of its kind in the district supported by the forest department which reflect the wide vision of the forest department towards the conservation and management of wetland resources in the district, which is highly appreciated. Similar studies on impact of climate change, progression of desert, floral and faunal diversity assessment and annual wetland monitoring should be initiated and encouraged by the forest authorities as they are very important for formulating the conservation and management action plan for future.



## Deliverables

### 1. Wetland map of Patan District



## 2. Annotated checklist of birds of Patan district

Sr. No	Common Name	Scientific Name
1	Lesser Whistling Duck	<i>Dendrocygna javanica</i>
2	Bar-headed Goose	<i>Anser indicus</i>
3	Greylag Goose	<i>Anser anser</i>
4	Smew	<i>Mergus albellus</i>
5	Ruddy Shelduck	<i>Tadorna ferruginea</i>
6	Red-crested Pochard	<i>Netta rufina</i>
7	Common Pochard	<i>Aythya ferina</i>
8	Tufted Duck	<i>Aythya fuligula</i>
9	Ferruginous Duck	<i>Aythya nyroca</i>
10	Eurasian Wigeon	<i>Aythya fuligula</i>
11	Garganey	<i>Spatula querquedula</i>
12	Northern Shoveler	<i>Spatula clypeata</i>
13	Gadwall	<i>Mareca strepera</i>
14	Mallard	<i>Anas platyrhynchos</i>
15	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i>
16	Northern Pintail	<i>Anas acuta</i>
17	Common Teal	<i>Anas crecca</i>
18	Comb Duck	<i>Sarkidiornis melanotos</i>
19	Cotton Teal	<i>Nettapus coromandelianus</i>
20	Greater Flamingo	<i>Phoenicopterus roseus</i>
21	Lesser Flamingo	<i>Phoeniconaias minor</i>
22	Little Grebe	<i>Tachybaptus ruficollis</i>
23	Great Crested Grebe	<i>Podiceps cristatus</i>
24	Purple Swamphen	<i>Porphyrio porphyrio</i>
25	White-breasted Waterhen	<i>Amaurornis phoenicurus</i>
26	Common Moorhen	<i>Gallinula chloropus</i>
27	Common Coot	<i>Fulica atra</i>
28	Sarus Crane	<i>Antigone Antigone</i>
29	Common Crane	<i>Grus grus</i>
30	Macqueen's Bustard	<i>Chlamydotis macqueenii</i>
31	Painted Stork	<i>Mycteria leucocephala</i>
32	Asian Openbill	<i>Anastomus oscitans</i>
33	Black Stork	<i>Ciconia nigra</i>
34	Woolly-necked Stork	<i>Ciconia episcopus</i>
35	Black-necked stork	<i>Ephippiorhynchus asiaticus</i>
36	Great White Pelican	<i>Pelecanus onocrotalus</i>



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<b>37</b>	Dalmatian Pelican	<i>Pelecanus crispus</i>
<b>38</b>	Black-crowned Night Heron	<i>Nycticorax nycticorax</i>
<b>39</b>	Indian Pond Heron	<i>Ardeola grayii</i>
<b>40</b>	Cattle Egret	<i>Bubulcus ibis</i>
<b>41</b>	Grey Heron	<i>Ardea cinerea</i>
<b>42</b>	Purple Heron	<i>Ardea purpurea</i>
<b>43</b>	Great Egret	<i>Ardea alba</i>
<b>44</b>	Intermediate Egret	<i>Ardea intermedia</i>
<b>45</b>	Little Egret	<i>Egretta garzetta</i>
<b>46</b>	Eurasian Spoonbill	<i>Platalea leucorodia</i>
<b>47</b>	Indian Black Ibis	<i>Pseudibis papillosa</i>
<b>48</b>	Glossy Ibis	<i>Plegadis falcinellus</i>
<b>49</b>	Black-headed Ibis	<i>Threskiornis melanocephalus</i>
<b>50</b>	Little Cormorant	<i>Microcarbo niger</i>
<b>51</b>	Great Cormorant	<i>Phalacrocorax carbo</i>
<b>52</b>	Indian Cormorant	<i>Phalacrocorax fuscicollis</i>
<b>53</b>	Oriental Darter	<i>Anhinga melanogaster</i>
<b>54</b>	Great Thick-knee	<i>Esacus recurvirostris</i>
<b>55</b>	Black-winged Stilt	<i>Himantopus himantopus</i>
<b>56</b>	Common Ringed Plover	<i>Charadrius hiaticula</i>
<b>57</b>	Little Ringed Plover	<i>Charadrius dubius</i>
<b>58</b>	Kentish Plover	<i>Charadrius alexandrinus</i>
<b>59</b>	Greater Sand Plover	<i>Charadrius leschenaultia</i>
<b>60</b>	Yellow-wattled Lapwing	<i>Vanellus malabaricus</i>
<b>61</b>	Red-wattled Lapwing	<i>Vanellus indicus</i>
<b>62</b>	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i>
<b>63</b>	Bar-tailed godwit	<i>Limosa lapponica</i>
<b>64</b>	Black-tailed godwit	<i>Limosa limosa</i>
<b>65</b>	Ruff	<i>Calidris pugnax</i>
<b>66</b>	Sanderling	<i>Calidris alba</i>
<b>67</b>	Dunlin	<i>Calidris alpina</i>
<b>68</b>	Little Stint	<i>Calidris minuta</i>
<b>69</b>	Pintail Snipe	<i>Gallinago stenura</i>
<b>70</b>	Common Snipe	<i>Gallinago gallinago</i>
<b>71</b>	Common sandpiper	<i>Actitis hypoleucos</i>
<b>72</b>	Green Sandpiper	<i>Tringa ochropus</i>
<b>73</b>	Spotted Redshank	<i>Tringa erythropus</i>
<b>74</b>	Common Greenshank	<i>Tringa nebularia</i>
<b>75</b>	Common Redshank	<i>Tringa tetanus</i>
<b>76</b>	Wood Sandpiper	<i>Tringa glareola</i>
<b>77</b>	Marsh Sandpiper	<i>Tringa stagnatilis</i>
<b>78</b>	Indian Courser	<i>Cursorius coromandelicus</i>
<b>79</b>	Caspian Gull	Larus cachinnans



## **Study on wetlands of Patan**

<b>80</b>	Brown-headed Gull	<i>Chroicocephalus brunnicephalus</i>
<b>81</b>	Black-headed Gull	<i>Chroicocephalus ridibundus</i>
<b>82</b>	Pallas's Gull	<i>Ichthyaetus ichthyaetus</i>
<b>83</b>	Little Tern	<i>Sternula albifrons</i>
<b>84</b>	River Tern	<i>Sterna aurantia</i>
<b>85</b>	Caspian Tern	<i>Hydroprogne caspia</i>
<b>86</b>	Gull-billed Tern	<i>Gelochelidon nilotica</i>
<b>87</b>	Indian Peafowl	<i>Pavo cristatus</i>
<b>88</b>	Common Quail	<i>Coturnix coturnix</i>
<b>89</b>	Painted Francolin	<i>Francolinus pictus</i>
<b>90</b>	Grey Francolin	<i>Francolinus pondicerianus</i>
<b>91</b>	Yellow-legged Green Pigeon	<i>Treron phoenicopterus</i>
<b>92</b>	Rock Pigeon	<i>Columba livia</i>
<b>93</b>	Eurasian Collared Dove	<i>Streptopelia decaocto</i>
<b>94</b>	Red Collared Dove	<i>Streptopelia tranquebarica</i>
<b>95</b>	Laughing Dove	<i>Streptopelia senegalensis</i>
<b>96</b>	Chestnut-bellied Sandgrouse	<i>Pterocles exustus</i>
<b>97</b>	Indian Nightjar	<i>Caprimulgus asiaticus</i>
<b>98</b>	Sykes's Nightjar	<i>Caprimulgus mahrattensis</i>
<b>99</b>	Little swift	<i>Apus affinis</i>
<b>100</b>	Greater Coucal	<i>Centropus sinensis</i>
<b>101</b>	Asian Koel	<i>Eudynamys scolopaceus</i>
<b>102</b>	Osprey	<i>Pandion haliaetus</i>
<b>103</b>	Black-winged Kite	<i>Elanus caeruleus</i>
<b>104</b>	Egyptian Vulture	<i>Neophron percnopterus</i>
<b>105</b>	Oriental Honey Buzzard	<i>Pernis ptilorhynchus</i>
<b>106</b>	Black Eagle	<i>Ictinaetus malaiensis</i>
<b>107</b>	Indian Spotted Eagle	<i>Clanga hastate</i>
<b>108</b>	Greater Spotted Eagle	<i>Clanga clanga</i>
<b>109</b>	Tawny Eagle	<i>Aquila rapax</i>
<b>110</b>	Steppe Eagle	<i>Aquila nipalensis</i>
<b>111</b>	Eastern Imperial Eagle	<i>Aquila heliacal</i>
<b>112</b>	Western Marsh Harrier	<i>Circus aeruginosus</i>
<b>113</b>	Pallid Harrier	<i>Circus macrourus</i>
<b>114</b>	Montagu's Harrier	<i>Circus pygargus</i>
<b>115</b>	Shikra	<i>Accipiter badius</i>
<b>116</b>	Eurasian Sparrowhawk	<i>Accipiter nisus</i>
<b>117</b>	Brahminy Kite	<i>Haliastur indus</i>
<b>118</b>	Black Kite	<i>Milvus migrans</i>
<b>119</b>	White-eyed Buzzard	<i>Butastur teesa</i>
<b>120</b>	Common Barn Owl	<i>Tyto alba</i>
<b>121</b>	Spotted Owlet	<i>Athene brama</i>
<b>122</b>	Mottled Wood Owl	<i>Strix ocellata</i>



## **Study on wetlands of Patan**

<b>123</b>	Indian Grey Hornbill	<i>Ocyceros birostris</i>
<b>124</b>	Common Hoopoe	<i>Upupa epops</i>
<b>125</b>	Brown-capped Pygmy Woodpecker	<i>Dendrocopos moluccensis</i>
<b>126</b>	Lesser Golden-backed Woodpecker	<i>Dinopium javanense</i>
<b>127</b>	Brown-headed Barbet	<i>Psilopogon zeylanicus</i>
<b>128</b>	Coppersmith Barbet	<i>Psilopogon haemacephalus</i>
<b>129</b>	Green Bee-eater	<i>Merops orientalis</i>
<b>130</b>	Blue-cheeked Bee-eater	<i>Merops persicus</i>
<b>131</b>	Indian Roller	<i>Coracias benghalensis</i>
<b>132</b>	European Roller	<i>Coracias garrulus</i>
<b>133</b>	Common Kingfisher	<i>Alcedo atthis</i>
<b>134</b>	Pied Kingfisher	<i>Ceryle rudis</i>
<b>135</b>	White-throated Kingfisher	<i>Halcyon smyrnensis</i>
<b>136</b>	Common Kestrel	<i>Falco tinnunculus</i>
<b>137</b>	Red-necked Falcon	<i>Falco chicquera</i>
<b>138</b>	Merlin	<i>Falco columbarius</i>
<b>139</b>	Laggar Falcon	<i>Falco jugger</i>
<b>140</b>	Peregrine Falcon	<i>Falco peregrinus</i>
<b>141</b>	Plum-headed Parakeet	<i>Psittacula cyanocephala</i>
<b>142</b>	Rose-ringed Parakeet	<i>Psittacula krameri</i>
<b>143</b>	Large Cuckoo-shrike	<i>Coracina javensis</i>
<b>144</b>	Indain Golden Oriole	<i>Oriolus kundoo</i>
<b>145</b>	Common Iora	<i>Aegithina tiphia</i>
<b>146</b>	Black Drongo	<i>Dicrurus macrocercus</i>
<b>147</b>	White-bellied Drongo	<i>Dicrurus caerulescens</i>
<b>148</b>	White-browed Fantail	<i>Rhipidura aureola</i>
<b>149</b>	Brown Shrike	<i>Lanius cristatus</i>
<b>150</b>	Isabelline Shrike	<i>Lanius isabellinus</i>
<b>151</b>	Bay-backed Shrike	<i>Lanius vittatus</i>
<b>152</b>	Long-tailed Shrike	<i>Lanius schach</i>
<b>153</b>	Great Grey Shrike	<i>Lanius excubitor</i>
<b>154</b>	Rufous Treepie	<i>Dendrocitta vagabunda</i>
<b>155</b>	House Crow	<i>Corvus splendens</i>
<b>156</b>	Large-billed Crow	<i>Corvus macrorhynchos</i>
<b>157</b>	Purple Sunbird	<i>Cinnyris asiaticus</i>
<b>158</b>	Baya Weaver	<i>Ploceus philippinus</i>
<b>159</b>	Indian Silverbill	<i>Euodice malabarica</i>
<b>160</b>	Scaly-breasted Munia	<i>Lonchura punctulata</i>
<b>161</b>	House Sparrow	<i>Passer domesticus</i>
<b>162</b>	Yellow-throated Sparrow	<i>Gymnoris xanthocollis</i>
<b>163</b>	Tree Pipit	<i>Anthus trivialis</i>
<b>164</b>	Tawny Pipit	<i>Anthus campestris</i>
<b>165</b>	Western Yellow Wagtail	<i>Motacilla flava</i>



## **Study on wetlands of Patan**

<b>166</b>	Grey Wagtail	<i>Motacilla cinerea</i>
<b>167</b>	Citrine Wagtail	<i>Motacilla citreola</i>
<b>168</b>	White-browed Wagtail	<i>Motacilla maderaspatensis</i>
<b>169</b>	White Wagtail	<i>Motacilla alba</i>
<b>170</b>	Red-headed Bunting	<i>Granativora bruniceps</i>
<b>171</b>	Cinereous Tit	<i>Parus cinereus</i>
<b>172</b>	Grey-headed Canary-flycatcher	<i>Culicicapa ceylonensis</i>
<b>173</b>	Ashy-crowned Sparrow Lark	<i>Eremopterix griseus</i>
<b>174</b>	Sand Lark	<i>Alaudala raytal</i>
<b>175</b>	Greater Short-toed Lark	<i>Calandrella brachydactyla</i>
<b>176</b>	Oriental Skylark	<i>Alauda gulgula</i>
<b>177</b>	Crested Lark	<i>Galerida cristata</i>
<b>178</b>	Indian Bushlark	<i>Mirafra erythroptera</i>
<b>179</b>	Ashy Prinia	<i>Prinia socialis</i>
<b>180</b>	Plain Prinia	<i>Prinia inornata</i>
<b>181</b>	Common Tailorbird	<i>Orthotomus sutorius</i>
<b>182</b>	Wire-tailed Swallow	<i>Hirundo smithii</i>
<b>183</b>	Barn Swallow	<i>Hirundo rustica</i>
<b>184</b>	Dusky Crag Martin	<i>Ptyonoprogne concolor</i>
<b>185</b>	White-eared Bulbul	<i>Pycnonotus leucotis</i>
<b>186</b>	Red-vented Bulbul	<i>Pycnonotus cafer</i>
<b>187</b>	Common Chiffchaff	<i>Phylloscopus collybita</i>
<b>188</b>	Oriental White-eye	<i>Zosterops palpebrosus</i>
<b>189</b>	Large Grey Babbler	<i>Argya malcolmi</i>
<b>190</b>	Common Babbler	<i>Argya caudate</i>
<b>191</b>	Jungle Babbler	<i>Turdoides striata</i>
<b>192</b>	Rosy Starling	<i>Pastor roseus</i>
<b>193</b>	Brahminy Starling	<i>Sturnia pagodarum</i>
<b>194</b>	Common Myna	<i>Acridotheres tristis</i>
<b>195</b>	Bank Myna	<i>Acridotheres ginginianus</i>
<b>196</b>	Indian Robin	<i>Saxicoloides fulicatus</i>
<b>197</b>	Oriental Magpie Robin	<i>Copsychus saularis</i>
<b>198</b>	Tickell's Blue Flycatcher	<i>Cyornis tickelliae</i>
<b>199</b>	Bluethroat	<i>Luscinia svecica</i>
<b>200</b>	Red-breasted Flycatcher	<i>Ficedula parva</i>
<b>201</b>	Black Redstart	<i>Phoenicurus ochruros</i>
<b>202</b>	Pied Bushchat	<i>Saxicola caprata</i>
<b>203</b>	Isabelline Wheatear	<i>Oenanthe isabellina</i>
<b>204</b>	Desert Wheatear	<i>Oenanthe deserti</i>
<b>205</b>	Variable Wheatear	<i>Oenanthe picata</i>
<b>206</b>	Variable Wheatear	<i>Oenanthe picata capistrata</i>



### **3. Capacity building through**

#### **A workshop on wetland conservation “We, water and wetlands”**



**Water Restoration Field at  
Kodadha village by Dr. Jagruti**

As a part of this project, Patan Forest Division and WCB Research Foundation have jointly organized a two-day hands-on field-based workshop entitled ‘WE, Water and Wetland’ on 20-21<sup>st</sup> February 2021. The workshop was organized at Kodadha ecotourism site, with the main goal to enhance the capacity of students and forest staff and generating awareness about wetland conservation. A total of 40 graduate and postgraduate students from all over the country and 10 frontline forest staff of Patan forest division have participated in this workshop. The workshop was conducted through classroom sessions following by hands-on experience and field sessions.

The workshop was inaugurated by Mr. J.J.Rajput, the Hon’ble DCF of Patan he welcomed all the participants and shared his great work experience, also inspired the students by his powerful words. The first session was conducted by Dr. Jagruti Rathod, Associate Ecologist, Gujarat Ecology Society, Vadodara, and an internationally known and certified ecological restoration expert. Dr. Jagruti has delivered her talk on water rehabilitation and restoration. The session aimed to provide insight on making existing wetland a better ecosystem with the involvement of science and local communities for wildlife depending on wetland and humans. The second session was on water and water pollution by Dr. Hardik Patel, Assistant Professor from Parul University, Vadodara.



**Morning field with Dr. Nishith, Mr. Supreet Singh and  
Former CCF Mr. Uday Vora**

Dr. Patel explained water pollution and measures to improve water quality.



### **Study on wetlands of Patan**

The last session was conducted by former Chief Conservator of Forest Mr. Uday Vora explaining the importance of wetland ecosystem and the avifaunal diversity that directly or indirectly dependent on it with a scientific approach.

As a part of the workshop, the field study was conducted for water bird count, wetland restoration practice, and interaction with the local community. During the field survey, total 85 species of birds were recorded by all the participants. Also, participants recorded the pugmark of Macqueen's bustard, a den of hyena and spotted the endemic wildass. Field work encouraged all the participants to work together belonging to different fields and exchange of knowledge happened.

The concluding session of the workshop was chaired by Mr. Supreet Singh Gulati, the Hon'ble Collector of Patan and he addressed the students about birding practices, building career in the field of their interest and he also congratulated the organizers and added that such events must be organized in every season so that we can monitor and maintain the biodiversity of this district.



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**Some of the important wetland birds recorded during the study period**



*1. Black winged kite*



*2. Indian Roller*



*3. Common kingfisher*



*4. Painted Stork*



*5. Great cormorant*



*6. Dalmatian Pelican*



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**7. Open-bill stork with other ducks**



**8. Tufted pochard**



**9. Palla's gull**



**10. Western Yellow wagtail**



**11. Purple heron**



**12. Grey leg geese**

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**13. Common Pochard**



**14. Wood sandpiper**



**15. Egyptian vulture**



**16. Grey heron**



**17. Sarus crane**



**18. Coppersmith barbet**

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**19. Indian grey hornbill**



**20. Yellow-wattled lapwing**



**21. Tickle's blue flycatcher**



**22. Spotted owlet**



**23. Black-headed ibis**

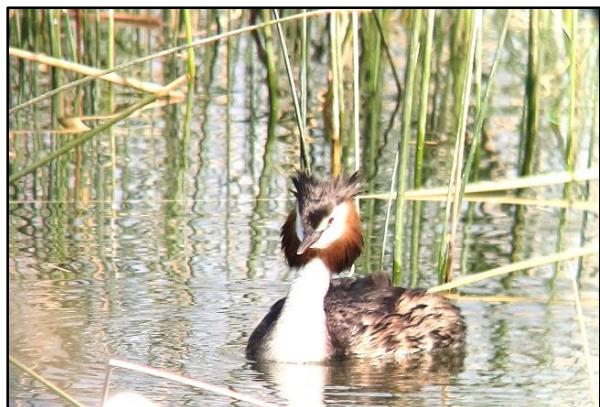


**24. Oriental darter**

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25. Black necked stork



26. Great crested grebe



27. Rufous treepie



28. White wagtail



29. Gargany



30. Greater coucal

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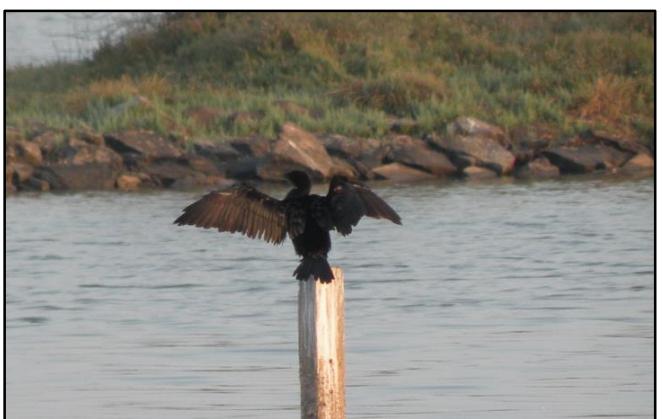
*31. Pied kingfisher*



*32. Grey francolin*



*33. Cotton pygmy goose*



*34. Little cormorant*



*35. Pheasant tail jacana*



*36. Ruddy shelduck*

## **Wetlands**



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## Threats



## Annexure I

### **Check list of all the bird species in Patan district during the study period (November 2020-February 2021)**

Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
	<b>Anseriformes</b>						
1	Anatidae	<i>Dendrocygna javanica</i>	Lesser Whistling Duck	R	LC	O	Sch IV
2		<i>Anser indicus</i>	Bar-headed Goose	M	LC	O	Sch IV
3		<i>Anser anser</i>	Greylag Goose	M	LC	I	Sch IV
4		<i>Mergellus albellus</i>	Smew	M	LC	P	Sch IV
5		<i>Tadorna ferruginea</i>	Ruddy Shelduck	M	LC	O	Sch IV
6		<i>Netta rufina</i>	Red-crested Pochard	M	LC	O	Sch IV
7		<i>Aythya ferina</i>	Common Pochard	M	<b>VU</b>	O	Sch IV
8		<i>Aythya fuligula</i>	Tufted Duck	M	LC	O	Sch IV
9		<i>Aythya nyroca</i>	Ferruginous Duck	M	<b>NT</b>	O	Sch IV
10		<i>Aythya fuligula</i>	Eurasian Wigeon	M	LC	O	Sch IV
11		<i>Spatula querquedula</i>	Garganey	M	LC	G	Sch IV
12		<i>Spatula clypeata</i>	Northern Shoveler	M	LC	O	Sch IV
13		<i>Mareca strepera</i>	Gadwall	M	LC	O	Sch IV
14		<i>Anas platyrhynchos</i>	Mallard	M	LC	O	Sch IV
15		<i>Anas poecilorhyncha</i>	Indian Spot-billed Duck	R	LC	O	Sch IV
16		<i>Anas acuta</i>	Northern Pintail	M	LC	O	Sch IV
17		<i>Anas crecca</i>	Common Teal	M	LC	G	Sch IV
18		<i>Sarkidiornis melanotos</i>	Comb Duck	R	LC	O	Sch IV
19		<i>Nettapus coromandelianus</i>	Cotton Teal	R	LC	O	Sch IV
	<b>Phoenicopteriformes</b>						
20	Phoenicopteridae	<i>Phoenicopterus roseus</i>	Greater Flamingo	RM	LC	O	Sch IV
21		<i>Phoeniconaias minor</i>	Lesser Flamingo	RM	<b>NT</b>	I	Sch IV
22	Podicipedidae	<i>Tachybaptus ruficollis</i>	Little Grebe	RM	LC	O	Sch IV
23		<i>Podiceps cristatus</i>	Great Crested Grebe	M	LC	P	Sch IV
	<b>Gruiformes</b>						
24	Rallidae	<i>Porphyrio porphyrio</i>	Purple Swamphen	R	LC	O	Sch IV
25		<i>Amaurornis phoenicurus</i>	White-breasted Waterhen	R	LC	O	Sch IV
26		<i>Gallinula chloropus</i>	Common Moorhen	R	LC	O	Sch IV
27		<i>Fulica atra</i>	Common Coot	RM	LC	O	Sch IV



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Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
28	Gruidae	<i>Antigone antigone</i>	Sarus Crane	R	<b>VU</b>	O	Sch IV
29		<i>Grus grus</i>	Common Crane	M	LC	O	Sch IV
	<b>Otidiformes</b>						
30	Otididae	<i>Chlamydotis macqueenii</i>	Macqueen's Bustard	M	<b>VU</b>	O	<b>Sch I (Part 3)</b>
	<b>Pelecaniformes</b>						
31	Ciconiidae	<i>Mycteria leucocephala</i>	Painted Stork	RM	<b>NT</b>	C	Sch IV
32		<i>Anastomus oscitans</i>	Asian Openbill	R	LC	C	Sch IV
33		<i>Ciconia nigra</i>	Black Stork	M	LC	C	Sch IV
34		<i>Ciconia episcopus</i>	Woolly-necked Stork	R	<b>VU</b>	C	Sch IV
35		<i>Ephippiorhynchus asiaticus</i>	Black-necked stork	R	<b>NT</b>	C	Sch IV
36	Pelecanidae	<i>Pelecanus onocrotalus</i>	Great White Pelican	RM	LC	C	Sch IV
37		<i>Pelecanus crispus</i>	Dalmatian Pelican	M	<b>NT</b>	C	<b>Sch VII</b>
38	Ardeidae	<i>Nycticorax nycticorax</i>	Black-crowned Night Heron	R	LC	C	Sch IV
39		<i>Ardeola grayii</i>	Indian Pond Heron	R	LC	C	Sch IV
40		<i>Bubulcus ibis</i>	Cattle Egret	R	LC	C	Sch IV
41		<i>Ardea cinerea</i>	Grey Heron	M	LC	C	Sch IV
42		<i>Ardea purpurea</i>	Purple Heron	R	LC	C	Sch IV
43		<i>Ardea alba</i>	Great Egret	R	LC	C	Sch IV
44		<i>Ardea intermedia</i>	Intermediate Egret	R	LC	C	Sch IV
45		<i>Egretta garzetta</i>	Little Egret	R	LC	C	Sch IV
46		<i>Platalea leucorodia</i>	Eurasian Spoonbill	R	LC	C	Sch IV
47	Threskiornithidae	<i>Pseudibis papillosa</i>	Indian Black Ibis	R	LC	C	Sch IV
48		<i>Plegadis falcinellus</i>	Glossy Ibis	R	LC	C	Sch IV
49		<i>Threskiornis melanocephalus</i>	Black-headed Ibis	R	<b>NT</b>	C	Sch IV
50	Phalacrocoracidae	<i>Microcarbo niger</i>	Little Cormorant	R	LC	P	Sch IV
51		<i>Phalacrocorax carbo</i>	Great Cormorant	R	LC	P	Sch IV
52		<i>Phalacrocorax fuscicollis</i>	Indian Cormorant	R	LC	P	Sch IV
53	Anhingidae	<i>Anhinga melanogaster</i>	Oriental Darter	R	<b>NT</b>	P	Sch IV
	<b>Charadriiformes</b>						
54	Burhinidae	<i>Esacus recurvirostris</i>	Great Thick-knee	R	<b>NT</b>	C	Sch IV
55	Recurvirostridae	<i>Himantopus himantopus</i>	Black-winged Stilt	R	LC	O	Sch IV
56	Charadriidae	<i>Charadrius hiaticula</i>	Common Ringed Plover	RM	LC	C	Sch IV
57		<i>Charadrius dubius</i>	Little Ringed Plover	RM	LC	O	Sch IV
58		<i>Charadrius alexandrinus</i>	Kentish Plover	RM	LC	C	Sch IV



## *Study on wetlands of Patan*

Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
59		<i>Charadrius leschenaultii</i>	Greater Sand Plover	M	LC	C	Sch IV
60		<i>Vanellus malabaricus</i>	Yellow-wattled Lapwing	R	LC	O	Sch IV
61		<i>Vanellus indicus</i>	Red-wattled Lapwing	R	LC	O	Sch IV
62	Jacanidae	<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	R	LC	O	Sch IV
63	Scolopacidae	<i>Limosa lapponica</i>	Bar-tailed godwit	M	NT	O	Sch IV
64		<i>Limosa limosa</i>	Black-tailed godwit	M	NT	O	Sch IV
65		<i>Calidris pugnax</i>	Ruff	M	LC	O	Sch IV
66		<i>Calidris alba</i>	Sanderling	M	LC	O	Sch IV
67		<i>Calidris alpina</i>	Dunlin	M	LC	O	Sch IV
68		<i>Calidris minuta</i>	Little Stint	M	LC	O	Sch IV
69		<i>Gallinago stenura</i>	Pintail Snipe	M	LC	O	Sch IV
70		<i>Gallinago gallinago</i>	Common Snipe	RM	LC	C	Sch IV
71		<i>Actitis hypoleucos</i>	Common sandpiper	RM	LC	O	Sch IV
72		<i>Tringa ochropus</i>	Green Sandpiper	M	LC	O	Sch IV
73		<i>Tringa erythropus</i>	Spotted Redshank	M	LC	C	Sch IV
74		<i>Tringa nebularia</i>	Common Greenshank	M	LC	C	Sch IV
75		<i>Tringa totanus</i>	Common Redshank	M	LC	O	Sch IV
76		<i>Tringa glareola</i>	Wood Sandpiper	M	LC	O	Sch IV
77		<i>Tringa stagnatilis</i>	Marsh Sandpiper	M	LC	O	Sch IV
78	Glareolidae	<i>Cursorius coromandelicus</i>	Indian Courser	R	LC	O	Sch IV
79	Laridae	Larus cachinnans	Caspian Gull	M	LC	O	Sch IV
80		<i>Chroicocephalus brunnicephalus</i>	Brown-headed Gull	M	LC	P	Sch IV
81		<i>Chroicocephalus ridibundus</i>	Black-headed Gull	M	LC	P	Sch IV
82		<i>Ichthyaetus ichthyaetus</i>	Pallas's Gull	M	LC	P	Sch IV
83		<i>Sternula albifrons</i>	Little Tern	M	LC	P	Sch IV
84		<i>Sterna aurantia</i>	River Tern	R	NT	P	Sch IV
85		Hydroprogne caspia	Caspian Tern	M	LC	P	Sch IV
86		<i>Gelochelidon nilotica</i>	Gull-billed Tern	M	LC	P	Sch IV
	<b>Galliformes</b>						
87	Phasianidae	<i>Pavo cristatus</i>	Indian Peafowl	R	LC	O	<b>Sch I (Part 3)</b>
88		<i>Coturnix coturnix</i>	Common Quail	R	LC	G	Sch IV
89		<i>Francolinus pictus</i>	Painted Francolin	R	LC	IG	Sch IV
90		<i>Francolinus pondicerianus</i>	Grey Francolin	R	LC	O	Sch IV



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Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
	<b>Columbiformes</b>						
91	Columbidae	<i>Treron phoenicopterus</i>	Yellow-legged Green Pigeon	R	LC	H	Sch IV
92		<i>Columba livia</i>	Rock Pigeon	R	LC	G	Sch IV
93		<i>Streptopelia decaocto</i>	Eurasian Collared Dove	R	LC	G	Sch IV
94		<i>Streptopelia tranquebarica</i>	Red Collared Dove	R	LC	G	Sch IV
95		<i>Streptopelia senegalensis</i>	Laughing Dove	R	LC	G	Sch IV
	<b>Pterocliformes</b>						
96	Pteroclidae	<i>Pterocles exustus</i>	Chestnut-bellied Sandgrouse	R	LC	G	Sch IV
	<b>Caprimulgiformes</b>						
97	Caprimulgidae	<i>Caprimulgus asiaticus</i>	Indian Nightjar	R	LC	I	Sch IV
98		<i>Caprimulgus mahrattensis</i>	Sykes's Nightjar	R	LC	I	Sch IV
	<b>Apodiformes</b>						
99	Apodidae	<i>Apus affinis</i>	Little swift	R	LC	I	Sch IV
	<b>Cuculiformes</b>						
100	Cuculidae	<i>Centropus sinensis</i>	Greater Coucal	R	LC	O	Sch IV
101		<i>Eudynamys scolopaceus</i>	Asian Koel	R	LC	O	Sch IV
	<b>Accipitriformes</b>						
102	Pandionidae	<i>Pandion haliaetus</i>	Osprey	M	LC	P	<b>Sch I (Part 3)</b>
103	Accipitridae	<i>Elanus caeruleus</i>	Black-winged Kite	M	LC	C	Sch IV
104		<i>Neophron percnopterus</i>	Egyptian Vulture	R	EN	C	<b>Sch I (Part 3)</b>
105		<i>Pernis ptilorhynchus</i>	Oriental Honey Buzzard	R	LC	C	Sch IV
106		<i>Ictinaetus malaiensis</i>	Black Eagle	R	LC	C	Sch IV
107		<i>Clanga hastata</i>	Indian Spotted Eagle	M	VU	C	Sch IV
108		<i>Clanga clanga</i>	Greater Spotted Eagle	M	VU	C	Sch IV
109		<i>Aquila rapax</i>	Tawny Eagle	M	LC	C	Sch IV
110		<i>Aquila nipalensis</i>	Steppe Eagle	M	EN	C	<b>Sch I (Part 3)</b>
111		<i>Aquila heliaca</i>	Eastern Imperial Eagle	M	VU	C	Sch VII
112		<i>Circus aeruginosus</i>	Western Marsh Harrier	M	LC	C	Sch IV
113		<i>Circus macrourus</i>	Pallid Harrier	M	NT	C	Sch IV
114		<i>Circus pygargus</i>	Montagu's Harrier	M	LC	C	Sch IV
115		<i>Accipiter badius</i>	Shikra	R	LC	C	Sch IV
116		<i>Accipiter nisus</i>	Eurasian Sparrowhawk	M	LC	C	Sch IV



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Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
117		<i>Haliastur indus</i>	Brahminy Kite	R	LC	C	Sch IV
118		<i>Milvus migrans</i>	Black Kite	M	LC	C	Sch IV
119		<i>Butastur teesa</i>	White-eyed Buzzard	M	LC	C	Sch IV
	<b>Strigiformes</b>						
120	Tytonidae	<i>Tyto alba</i>	Common Barn Owl	R	LC	C	Sch IV
121	Strigidae	<i>Athene brama</i>	Spotted Owlet	R	LC	IC	Sch IV
122		<i>Strix ocellata</i>	Mottled Wood Owl	R	LC	C	Sch IV
	<b>Bucerotiformes</b>						
123	Bucerotidae	<i>Ocypterus birostris</i>	Indian Grey Hornbill	R	LC	O	Sch IV
124	Upupidae	<i>Upupa epops</i>	Common Hoopoe	M	LC	I	Sch IV
	<b>Piciformes</b>						
125	Picidae	<i>Dendrocopos moluccensis</i>	Brown-capped Pygmy Woodpecker	R	LC	I	Sch IV
126		<i>Dinopium javanense</i>	Lesser Golden-backed Woodpecker	R	LC	I	Sch IV
127	Ramphastidae	<i>Psilopogon zeylanicus</i>	Brown-headed Barbet	R	LC	F	Sch IV
128		<i>Psilopogon haemacephalus</i>	Coppersmith Barbet	R	LC	F	Sch IV
	<b>Coraciiformes</b>						
129	Meropidae	<i>Merops orientalis</i>	Green Bee-eater	R	LC	I	Sch IV
130		<i>Merops persicus</i>	Blue-cheeked Bee-eater	RM	LC	I	Sch IV
131	Coraciidae	<i>Coracias benghalensis</i>	Indian Roller	R	LC	I	Sch IV
132		<i>Coracias garrulus</i>	European Roller	RM	LC	I	Sch IV
133	Alcedinidae	<i>Alcedo atthis</i>	Common Kingfisher	R	LC	P	Sch IV
134		<i>Ceryle rudis</i>	Pied Kingfisher	R	LC	P	Sch IV
135		<i>Halcyon smyrnensis</i>	White-throated Kingfisher	R	LC	P	Sch IV
	<b>Falconiformes</b>						
136	Falconidae	<i>Falco tinnunculus</i>	Common Kestrel	M	LC	C	Sch IV
137		<i>Falco chicquera</i>	Red-necked Falcon	M	NT	C	Sch IV
138		<i>Falco columbarius</i>	Merlin	M	NT	C	Sch IV
139		<i>Falco jugger</i>	Laggar Falcon	M	NT	C	Sch VII
140		<i>Falco peregrinus</i>	Peregrine Falcon	M	LC	C	<b>Sch I (Part 3)</b>
	<b>Psittaciformes</b>						
141	Psittaculidae	<i>Psittacula cyanocephala</i>	Plum-headed Parakeet	R	LC	F	Sch IV
142		<i>Psittacula krameri</i>	Rose-ringed Parakeet	R	LC	F	Sch IV
	<b>Passeriformes</b>						
143	Campephagidae	<i>Coracina javensis</i>	Large Cuckooshrike	R	LC	I	Sch IV



## **Study on wetlands of Patan**

Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
144	Oriolidae	<i>Oriolus kundoo</i>	Indain Golden Oriole	R	LC	F	Sch IV
145	Aegithinidae	<i>Aegithina tiphia</i>	Common Iora	R	LC	I	Sch IV
146	Dicruridae	<i>Dicrurus macrocercus</i>	Black Drongo	R	LC	I	Sch IV
147		<i>Dicrurus caerulescens</i>	White-bellied Drongo	R	LC	I	Sch IV
148	Rhipiduridae	<i>Rhipidura aureola</i>	White-browed Fantail	R	LC	I	Sch IV
149		<i>Lanius cristatus</i>	Brown Shrike	M	LC	I	Sch IV
150	Laniidae	<i>Lanius isabellinus</i>	Isabelline Shrike	M	LC	I	Sch IV
151		<i>Lanius vittatus</i>	Bay-backed Shrike	R	LC	I	Sch IV
152		<i>Lanius schach</i>	Long-tailed Shrike	M	LC	I	Sch IV
153		<i>Lanius excubitor</i>	Great Grey Shrike	M	LC	I	Sch IV
154	Corvidae	<i>Dendrocitta vagabunda</i>	Rufous Treepie	R	LC	O	Sch IV
155		<i>Corvus splendens</i>	House Crow	R	LC	C	Sch IV
156		<i>Corvus macrorhynchos</i>	Large-billed Crow	R	LC	C	Sch IV
157	Nectariniidae	<i>Cinnyris asiaticus</i>	Purple Sunbird	R	LC	H	Sch IV
158	Ploceidae	<i>Ploceus philippinus</i>	Baya Weaver	R	LC	I	Sch IV
159	Estrildidae	<i>Euodice malabarica</i>	Indian Silverbill	R	LC	IG	Sch IV
160		<i>Lonchura punctulata</i>	Scaly-breasted Munia	R	LC	IF	Sch IV
161	Passeridae	<i>Passer domesticus</i>	House Sparrow	R	LC	IG	Sch IV
162		<i>Gymnoris xanthocollis</i>	Yellow-throated Sparrow	R	LC	IG	Sch IV
163	Motacillidae	<i>Anthus trivialis</i>	Tree Pipit	M	LC	I	Sch IV
164		<i>Anthus campestris</i>	Tawny Pipit	M	LC	I	Sch IV
165		<i>Motacilla flava</i>	Western Yellow Wagtail	M	LC	I	Sch IV
166		<i>Motacilla cinerea</i>	Grey Wagtail	M	LC	I	Sch IV
167		<i>Motacilla citreola</i>	Citrine Wagtail	M	LC	I	Sch IV
168		<i>Motacilla maderaspatensis</i>	White-browed Wagtail	M	LC	I	Sch IV
169		<i>Motacilla alba</i>	White Wagtail	M	LC	I	Sch IV
170	Emberizidae	<i>Granatavora bruniceps</i>	Red-headed Bunting	M	LC	O	Sch IV
171	Paridae	<i>Parus cinereus</i>	Cinereous Tit	R	LC	I	Sch IV
172	Stenostiridae	<i>Culicicapa ceylonensis</i>	Grey-headed Canary-flycatcher	R	LC	I	Sch IV
173	Alaudidae	<i>Eremopterix griseus</i>	Ashy-crowned Sparrow Lark	R	LC	IG	Sch IV
174		<i>Alaudala raytal</i>	Sand Lark	R	LC	IG	Sch IV
175		<i>Calandrella brachydactyla</i>	Greater Short-toed Lark	R	LC	IG	Sch IV
176		<i>Alauda gulgula</i>	Oriental Skylark	R	LC	IG	Sch IV
177		<i>Galerida cristata</i>	Crested Lark	R	LC	IG	Sch IV



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Sr. No	Order/Family	Scientific Name	Common Name	MS	IUCN Status	FH	WPA 1972
178		<i>Mirafra erythroptera</i>	Indian Bushlark	R	LC	IG	Sch IV
179	Cisticolidae	<i>Prinia socialis</i>	Ashy Prinia	R	LC	I	Sch IV
180		<i>Prinia inornata</i>	Plain Prinia	R	LC	I	Sch IV
181		<i>Orthotomus sutorius</i>	Common Tailorbird	R	LC	I	Sch IV
182	Hirundinidae	<i>Hirundo smithii</i>	Wire-tailed Swallow	M	LC	I	Sch IV
183		<i>Hirundo rustica</i>	Barn Swallow	R	LC	I	Sch IV
184		<i>Ptyonoprogne concolor</i>	Dusky Crag Martin	R	LC	I	Sch IV
185	Pycnonotidae	<i>Pycnonotus leucotis</i>	White-eared Bulbul	R	LC	O	Sch IV
186		<i>Pycnonotus cafer</i>	Red-vented Bulbul	R	LC	O	Sch IV
187	Phylloscopidae	<i>Phylloscopus collybita</i>	Common Chiffchaff	M	LC	I	Sch IV
188	Zosteropidae	<i>Zosterops palpebrosus</i>	Oriental White-eye	R	LC	I	Sch IV
189	Leiothrichida	<i>Argya malcolmi</i>	Large Grey Babbler	R	LC	O	Sch IV
190		<i>Argya caudata</i>	Common Babbler	R	LC	O	Sch IV
191		<i>Turdoides striata</i>	Jungle Babbler	R	LC	O	Sch IV
192	Sturnidae	<i>Pastor roseus</i>	Rosy Starling	RM	LC	O	Sch IV
193		<i>Sturnia pagodarum</i>	Brahminy Starling	R	LC	O	Sch IV
194		<i>Acridotheres tristis</i>	Common Myna	R	LC	O	Sch IV
195		<i>Acridotheres ginginianus</i>	Bank Myna	R	LC	O	Sch IV
196	Muscicapidae	<i>Saxicoloides fulicatus</i>	Indian Robin	R	LC	I	Sch IV
197		<i>Copsychus saularis</i>	Oriental Magpie Robin	R	LC	I	Sch IV
198		<i>Cyornis tickelliae</i>	Tickell's Blue Flycatcher	RM	LC	IF	Sch IV
199		<i>Luscinia svecica</i>	Bluethroat	M	LC	O	Sch IV
200		<i>Ficedula parva</i>	Red-breasted Flycatcher	M	LC	IF	Sch IV
201		<i>Phoenicurus ochruros</i>	Black Redstart	M	LC	I	Sch IV
202		<i>Saxicola caprata</i>	Pied Bushchat	M	LC	I	Sch IV
203		<i>Oenanthe isabellina</i>	Isabelline Wheatear	M	LC	IG	Sch IV
204		<i>Oenanthe deserti</i>	Desert Wheatear	M	LC	HI	Sch IV
205		<i>Oenanthe picata</i>	Variable Wheatear	M	LC	IF	Sch IV
206		<i>Oenanthe picata capistrata</i>	Variable Wheatear	M	LC	IF	Sch IV

**Note:** **R**= Residential, **M**= Migratory, **RM**= Resident-Migrant **O**= Omnivore, **C**= Carnivore, **P** = Piscivore, **I**=Insectivore, **H** =Herbivore, **F** = Frugivore, **G**= Granivore, **HI**= Herbivore-insectivore, **IG**=Insectivore-Granivore, **IF**= Insectivore- Frugivore, **IC**= Insectivore- Carnivore, **LC**= Least concern, **NT**= Near threatened, **VU**= Vulnerable, **T**= Terrestrial, **W**=Water fowl, **WD**=Water dependent



## Annexure II

### List of Wetlands in Different taluka of Patan district 2020-2021

No.	Taluka (# Wetlands)	Name of Wetland	No.	Taluka (# Wetlands)	Name of Wetland
1	<b>Patan</b> <b>(12)</b>	Khimiyana	29	<b>Chanasma</b> <b>(14)</b>	Khokhala
2		Mithivavdi	30		Mehmadpur
3		Balisana	31		Mehmad pur 2
4		Pitambar	32		Mandlop
5		Babasan	33		Islampur
6		Anand Sarovar	34		Ganget
7		Dharpur	35		Karoda
8		Motaramdan	36		Maniyari
9		Ranuj	37		Brahmanwada
10		Kharivavdi	38		Ruppur
11		Makhaniya	39		Bhatvasana
12		Khansarovar	40		Bhatsar
13	<b>Sarswati</b> <b>(10)</b>	Nayata	41		Khorsam
14		Sariyad(mithu talav)	42		Khorsam sim
15		Sariyad(Bholwada)	43	<b>Harij</b> <b>(08)</b>	Harij lake
16		Sariyad(Salvadi)	44		Jaska village lake
17		Sariyad(kharu talav)	45		Juna rampura lake 1
18		Charup	46		Juna rampura lake 2
19		Bhilvan	47		Jaska harij road lake
20		Aendala	48		Sodhav lake
21		Volavi	49		Tambodiya
22		Vaghasar	50		Bhim lake
23	<b>Siddhpur</b> <b>(06)</b>	Bilia	51	<b>Sankheswar</b> <b>(20)</b>	Sankheswar lake(nearpostoffice)
24		Nedra	52		Sankheswar wetland
25		Hishor1	53		Harij-Sankheswar road (Farm)
26		Hishor 2	54		Runi Road lake
27		Sedarana1	55		Runi village lake
28		Sedarana2	56		Loteswar lake
			57		Palipur lake



**Study on wetlands of Patan**

No.	Taluka (# Wetlands)	Name of Wetland	No.	Taluka (# Wetlands)	Name of Wetland
58		Panchasar	88		Javantari 2
59		Dudka nani chandur road lake	89		Lotiya talav-1
60		Dudka Village lake	90		Lotiya talav-2
61		Nani chandur village lake	91		Nani pipli 1
62		Meman village lake	92		Nani pipli 2
63		Moti chandur lake 1	93		Joravarganj
64		Moti chandur lake 2	94		Gotarka 1
65		Hirapur ashram	95		Gotarka 2
66		Jaynagar village lake	96	<b>Santalpur (34)</b>	Sidhada wetland
67		Taranagar Rann wetland	97		Sidhada lake 2
68		Taranagar(3 river)	98		Agichana
69		Taranagar village wetland	99		Abhiyana
70		Bolera-sankheshwar road	100		Gokhantar 1
71	<b>Radhanpur (25)</b>	Radhanpur varahi near 3 highway	101		Gokhantar 2
72		Dumping site lake	102		Chanasara-Rajusara wetland
73		Radhanapur near APMC lake	103		Sherpura
74		Patni gate lake ( Vad pasar)	104		Daldi
75		Patni gate lake 2	105		Jamvada
76		Patni Gate 3	106		Garamdi
77		Gokhantar forest wetland	107		Rozu highway
78		Aantarnes ni khadi	108		Piprala
79		Radhanpur satoon road lake 3	109		Chhanasra
80		Satoon village lake 5	110		Rajusara
81		Kamlasadan satoon road 2	111		Jarusha
82		Satoon road 1	112		Jarusha 2
83		Satoon Road 4	113		Rampura
84		Parsund	114		Koliwada wetland 1
85		Madhupura dem	115		Koliwada wetland 2
86		Bhilot	116		Near varnosari (by road)
87		Javantari 1	117		Korda
			118		Zazam
			119		Ranmal pura
			120		Datrana



*Study on wetlands of Patan*

No.	Taluka (# Wetlands)	Name of Wetland	No	Taluka (# Wetlands)	Name of Wetland
121		Vauva	130	Sami (09)	Vadilal dam
122		Barara	131		Kodadha
123		Santalpur highway 1	132		Vavol village lake
124		Santalpur highway 2	133		Sonar village lake
125		Santalpur highway 3	134		Nayka village lake
126		Patanka	135		Vachhraj
127		Fangli	136		Amrapur talav
128		Charanka	137		Ved aadbandalh
129		Eval	138		Jakhel



## **Annexure III**

### **List of Important Wetlands in Patan district 2020-2021**

<b>Sr.No</b>	<b>Name of Important Wetland</b>	<b>Code</b>
<b>1</b>	Khokhla	C1
<b>2</b>	Sankheshwar	S1
<b>3</b>	Harij-Sankheshwar road	S2
<b>4</b>	Runi village lake	S3
<b>5</b>	Palipur lake	S4
<b>6</b>	Moti chandur lake 2	S7
<b>7</b>	Hirapur ashram	S8
<b>8</b>	Taranagar Rann wetland	S9
<b>9</b>	Bolera-sankheshwar road	S12
<b>10</b>	Rhadhanpur varahi near 3 highway	R1
<b>11</b>	Gokhantar forest wetland	R2
<b>12</b>	Aantarnes ni khadi	R3
<b>13</b>	Satoon village lake 5	R5
<b>14</b>	Madhupura dem	R6
<b>15</b>	Sidhada wetland	V1
<b>16</b>	Chanasara-Rajusara wetland	V3
<b>17</b>	Jamvada	V4
<b>18</b>	Garamdi	V5
<b>19</b>	Rampura	V9
<b>20</b>	Charanka	V13
<b>21</b>	Vadilal dam	K1
<b>22</b>	Kodadha	K2
<b>23</b>	Amrapur talav	K3

