# Ornithological Survey and Habitat Quality Study in Rara Lake, Nepal

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## Abstract

*Rara Lake is situated in mountain ecoregion serves as staging post for the long range migratory wetland birds. The lake ambient forest bears the restricted range and globally threatened species.Bird species in the park is reported as unrecorded while habitat quality of the Rara lake providing the refuge to migratory and native bird species is degrading. Adherence to the statement, study was carried to gather the descriptive and evidence-based information on bird species and habitat quality was carried to understand bird status, its activities and habitat quality. Bird count was carried through line transect. Bird behavior, activities, stay-length and lake riparian habitat was noted through direct sighting. Water quality was assessed following American Public Health Association water quality test guideline. The study counted a total of 2415 bird individuals from listed 104 species including 16 migratory Waterfowls, 13 wetland dependent birds and 75 forest birds. The observed bird species ranged from frequent to very uncommon winter visitor stop in Rara lake primarily for fueling during migration. Observed that most of time birds wereforaging at shallow water but merely outside lakes. Discarded trashes in the roosting and foraging site and around the lake circuit trail triggering threats to waterfowls and aquatic biodiversity while higher human movement through the trail causing disturbance to waterfowl. Water quality assessment revealed that Phosphorous and ammonia concentration in Rara lakewere higher than therecommended level for freshwater/aquatic ecosystem connoting lake in the process of eutrophication and acute ammonia toxicity affecting aquatic life. Regular assessment of water quality is required preventing aquatic life from detrimental effects .Contineous monitoring to study their migratory behavior and habitat qualities would be essential to inform conservation policies also linking with eco-tourism activities*

**Keywords**: *Wetland, Birds, Water Quality, Eutrophication, Trashes*

## Introduction

Rara lake is a high altitude wetland located in the Rara National Park of Nepal. It is the largest and deepest lake in Nepal (Okino & Satoh, 1986). It is home tothree endemic fish species (Terashima, 1984) and one endemic frog species (Dubios & Matsui, 1983). It inhabits several globally threatened; restricted-ranged; and biome-restricted bird species. Hence, Lake Rara was listed as Ramsar sites –a wetland of global importance in 2007 (Ramsar, 2007) and designated as an Important Bird Areas (IBA) in 2005 (Birdlife International, 2020). A total of 235 bird species was recorded in 2005 (Giri, 2005) whereas 284 in 2015 (BCN& DNPWC, 2015) and additional 6 species totaling 290 (Chaudhary, 2015 unpublished), but bird species in park is still under recorded (Birdlife International, 2020). Rara lake is alsovaluable staging post for migrating wetland birds. Around 40 species have been recorded so far (Birdlife International, 2020).However,understanding of ecosystem dynamics of high altitude wetland is poor (Baral & Bhandari, 2011). While the Rara lake is distant and thus maintained natural beauty, the lake is under threat of human flow, activities and pollutant (Cantonati et al., 2001, Battarbee, 2000; Battarbee et al., 2002a, 2002b;; Galassi et al., 1997; Grabherr et al., 2006; Rupakheti et al., 2017 ) as well as local pollution from settlements and mountain tourism (Chandan et al., 2008; Harris et al., 2009). High altitude wetlands in Himalayas are breeding areas for several globally threatened and common waterfowls, and staging area for many more (Mishra & Humbert-Droz, 1998). About 67 avifauna included of threatened bird species are reported associated with high altitude wetlands (Baral, 2005, 2007), large-sized high altitude wetland and glaciated broader valley with rivers and streams recorded with thriving population and diversity (Baral & Bhandari, 2011). Mention the importance of good water quality for avifauna, the timely monitoring helps to maintain the pristinely preventing biodiversity extirpation from the local area. This study is carried intending to provide descriptive and evidence-based information onbird species, their behavior and activities, interspecies interaction andthe present habitat conditions.

## Materials and Methods

### Study Area

Lake Rara located at 29° 24'N and 82° 05'E at an elevation of 2990masl (Ferro, 1978/79) is a Himalayan lake with 9.8 $km^2$ surface area and maximum water depth of 167m (Ferro, 1978/79; Okino & Satoh, 1986). Lake Rara has a small catchment area of 30 $Km^2$ with more than 30 brooks flow into the lake (Okino & Satoh, 1986) but only one outlet- Kater Khola (locally called Khatyad khola) (Terashima, 1984; Okino & Satoh, 1986) that flow through a very deep gorge around 7 km downstream and then flows into Karnali River 26 Km westwards of Lake Rara (Terashima, 1984).The lake is surrounded by mountains ranging from 3200 m asl in the south to 3,700-3,900 m asl in the north and south-west

forming a wide rhomboid-shaped valley that opens to the east (Yagi et al., 2009). The forest consists of several conifer species. The slopes below 3150 m are predominantly covered by Himalayan Pine (*Pinus wallichiana*) (ICIMOD, 2015). The north-slopes are covered with Himalayan Fir (*Abies spectabilis*)and Himalayan Birch (*Betula utilis*) forest, Rohododendron scrubs and alpine meadows; while the southern slopes have West Himalayan Spruce (*Picea smithiana*) Boiss., Himalayan pine and Brown oak (*Quercus semecarpifolia*) forests (Yasuda & Tabata, 1988). The lake and its catchment lie within the temperate subalpine climatic zone. The temperature in the Rara was recorded to minimum of -4.3°C and maximum of 16.4°C in 2016 while received an annual precipitation of 833.2 mm in 2017 (DHM, 2018). Limnological information in Nepalese lake is limited and even markedly limited is limnological information of Rara lake. Ferro (1978/79) gathered basic limnological and biological data and defined Rara lake as warm monomitic and oligotrophic. Later Swar (1979) reported cladocera from the lake. Chironomidae larvae, Grammaridae, Diaptomidae, Cydorinae, *Synedra* spp., *Gamphonmea* spp. *Cocconeis* sp. *Cymbella* sp. *Navicula* sp. *Oscillatoria* sp. were macroinvertebrates and macrophytes obtained in diet of fish species in Lake Rara (Terashima, 1984).

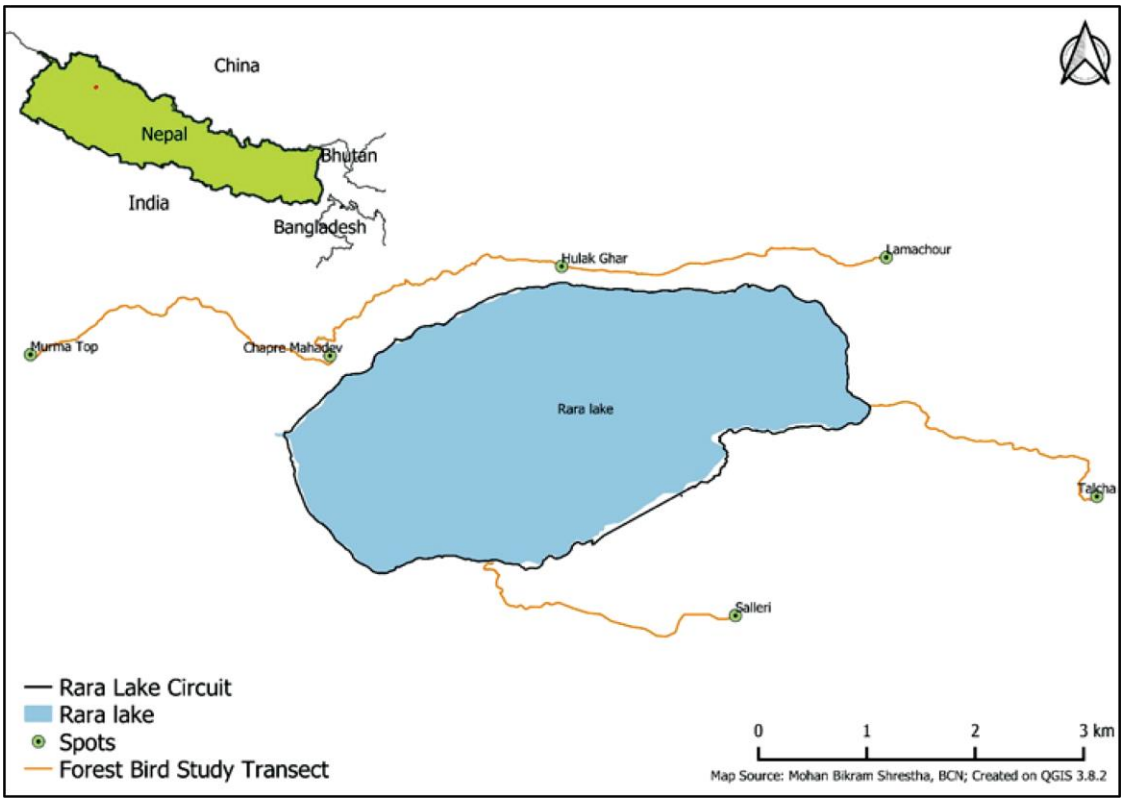



*Figure 1: Bird study transect in and around Rara lake*

## Methods

### Bird study

**Bird count and Analysis:** Thestudy was conducted from 12 December 2019 to 3 January2020 for 23 days. Two different study methods; i) Direct count of waterfowls (for duck, geese and grebe) and wetland dependent birds (for sandpiper, waterhen, moorhen and wagtail) ii) Mackinnon lists for forest birds in the Rara Lake periphery was applied (Bibby et al., 2000). The bird counts were performed during the daytime (0730-1130hrs & 1500-1800hrs). Binoculars (Opticron-10x42 COUNTRYMAN BGA HD WP, Field 6° and Vixon 10x32) and Telescope (AG80) for bird surveyandDigital Cameras (Canon EOS Kiss X80 with 55-250mm Zoom lens, Fujifilm 24-720 and Canon Power Shot SX60HS were used for taking photographs of the observed birds. Waterfowlsand wetland dependent birds were studied walking alongthe Rara lake circuit trail for 15 days while a total of 5 transects for the study of forest birds were carried spending a day in each transect. Transects were set starting from Rara Lake until end in range posts (Rara- Lamachour, Rara-Talcha and Rara-Salleri), used trails in the forest (Chhapre Mahadev-Hulak ghar) and hiking trail (Rara-Murma Top). Trails and transect followed were marked in Geographical Positioning System (Garmin GPS 64s Map). Bird congregation and habitats were noted during bird survey. Bird species identification was done following Helm Field Guide-Birds of Nepal(Grimmette et al., 2016). Scientific nomenclature and systematic positionof birds followedBird Conservation Nepal Checklist-2018 (DNPWC and BCN, 2018).Species diversity (H') and evenness (e) was accounted following Shannon - Weiner diversity index (Shannon and Weaver, 1949).

**Bird Activities:**Bird activities in and around the lake was noted for the whole day from dawn and dusk through vantage points. Activities such as; roosting, foraging, loafing, swimming, dabbling etc. were noted. Locations around the lake proximity mostly used by birds was recorded. Identified locations were marked in GPS for maps production. Maps were produced through Quantum Geographical Information System (QGIS) version 3.8.2.

**Feeding Behavior:** The food preference, food choice and locational shifting of water birds were carried through direct observation method/photography/videography. Besides, water bird dispersion, dispersion extent and time were analyzed. Association of several species for food resources and space was noted during the field visit. Bird and/ or flock association with the habitat and prey was noted walking throughout the lake area. Different habitat types were noted and the specific location was marked in GPS. The GPS point was extracted and imported in Google earth for delineation of area and map was produced through Quantum Geographical Information System (QGIS) version 3.8.2.

**Migratory bird stay-length:** Migratory birds and its length of stay staging in the Rara lake was noted during field study. Migration pattern of the birds observed in and around the Rara lake was categorized following the IUCN Red List (IUCN, 2020).The team observed the migratory bird presence/absence in the Rara Lake every morning and afternoon during the study period. The date of their departure was noted.

## Habitat Study

**Water Quality Assessment:**Water sampleswerecollected from five purposively selected locations; one of the Inlet at the extreme north of the lake, Outlet, Marshland vicinity, park office residence and undisturbed lake corner relatively with no human flow (Figure 2). Water quality parameters such as Water temperature ($^{o}$C) and transparency measured on site while for rest of water quality parameters, water samples of volume 500ml were collected in sampling bottles. To prevent the changes in Dissolved oxygen content of the collected samples, thesamples were fixed with Manganese sulfate ad Potassium hydroxide on site (reference needed). The collected water samples were stored in an ice box and transported to Nepal Environmental and Scientific Services Pvt. Ltd-(NESS) in Kathmandu for water quality analysis within 48 hours' time. Water quality parameters quantified employing Method described in American Public Health Association (APHA, 1998 ) (Table 1).

**Table 1: Water quality parameters and assessment method**

| S. N. | Parameters | Test Methods |
|---|---|---|
| 1. | Water Temperature ($^{o}$C)* | Thermometer |
| 2. | Transparency (m) * | Secchi disc |
| 3. | pH @ 15$^{o}$C | Electrometric |
| 4. | Electrical Conductivity (µS/cm) | Conductivity Meter |
| 5. | Turbidity, (NTU) | Nephelometric, |
| 6. | Total Alkalinity as write correctly (mg/L) | Titrimetric |
| 7. | Chloride (mg/L) | Argentometric Titration |
| 8. | Dissolved Oxygen (mg/L) | Winkler Azide Modification (Dilution & Seeding |
| 9. | Free Carbon Dioxide (mg/L) | Titrimetric |
| 10. | Total Nitrogen (mg/L) | Macro Kjeldahl |
| 11. | Ammoniacal - N (mg/L) | Direct Nesslerization |
| 12. | Total Phosphate (mg/L) | Ascorbic Acid |

**Examined in field*

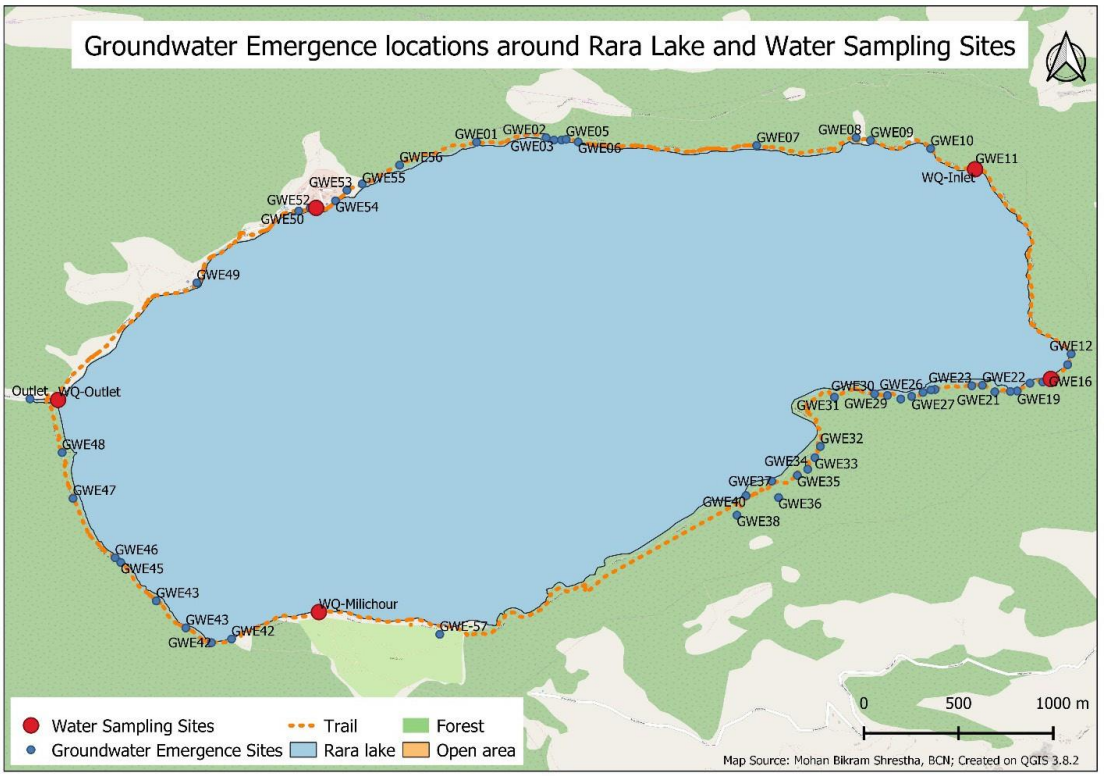
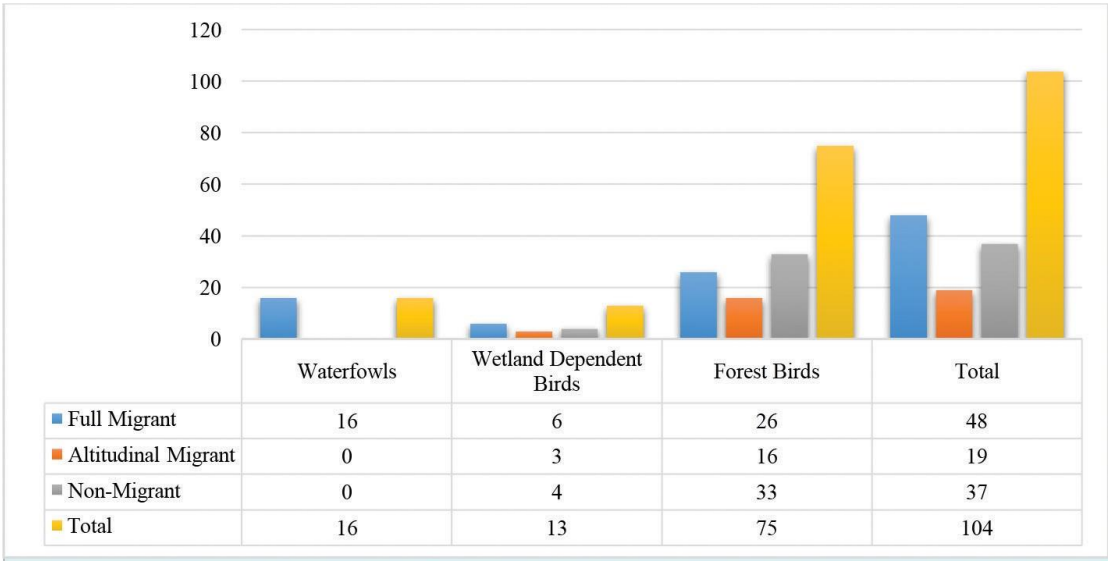



*Figure 2: Water sample collection sites around the Rara lake*

**Assessment of Lake ripariancondition:**Lake riparian habitat was assessed based onfood availability and foraging area; Habitat condition(such as damp soil and puddles); Roosting sites (fallen trees, logs, sandy banks and marshland); Nesting sites;Congregation sites; time spent in particular site; activities (demarcating the most preferential habitat in and around the lake)and solid waste disposal at the lake proximity.Discarded non-degradable trashes by the visitors around the lake proximity was thoroughly examined in whole lake circuit to know the kinds/types while collection of trash in 1 kilometer stretch in the trail in circuit was collected to quantified amount.Existing sewage disposal mechanism from the nearby hotels, park office and residence quarters and park security army post was carried. Total number of toilets in the hotels, army camp and National Park Office and park staff quarters was counted and distance between septic tank and Rara Lake was measured

## Results and Discussion

The study accounted 104 bird species (Annex:1) and counted 2415 individuals belonging to 15 Orders and 39 Families. Of the total 104 species, 16 were counted as Waterfowls, 13 Wetland dependent and 75 were Forest birds. Among the recorded species 67 species shows some sort of migration. This included48 full migrants and 19 altitudinal migrants) whereas 37 bird species are non-migrant. The full migrants included of all 16 waterfowl species, 6 species of wetland dependent birds and 26 species of forest birds; while altitudinal migrants included of 3 species of wetland dependent birds and 16 species of forest birds. The majority of non-migrants are forest birds (33 species) (Figure 3).Of the total 2415 bird individuals counted, Common Coot (*Fulicia atra*) accounted for the highest count (489) followed by Plain Mountain Finch (*Leucosticte nemoricola*) (420).




| | Waterfowls | Wetland Dependent Birds | Forest Birds | Total |
|---|---|---|---|---|
| Full Migrant | 16 | 6 | 26 | 48 |
| Altitudinal Migrant | 0 | 3 | 16 | 19 |
| Non-Migrant | 0 | 4 | 33 | 37 |
| Total | 16 | 13 | 75 | 104 |

labels missing on axes!

*Figure 3: Migrant and non-migrant bird species observed in and around Rara lake*

Rara lake have been serving as stopover site, primarily as fueling ground during the migration for the winter migratory waterfowls. Bar-headed Goose (*Anser indicus*), Gadwall (*Anas stepera*), Mallard (*Anas platyrhynchos*), Red-crested Pochard (*Netta rufina*), Common Pochard (*Aythya ferina*), Tufted Duck (*Aythya fuligula*) are common winter visitors and passage migrants making stopover in Rara lake during the migration while Greylag Goose (*Anser anser*) is very uncommon passage migrant and rare winter visitor observed in the Rara lake. Similarly, Lesser Black-headed Gull (*Larus heuglini*) and Brown-headed Gull (*Chroicecephalus brunnicephalus*) is a rare passage migrant

visit in winter season. While, Pallas's Gull (*Ichthyaetus ichthyaetus*), Goosander (*Mergus merganser*), Great Creasted Grebe (*Podiceps cristatus*), Great Cormorant, (*Phalacrocorax carbo*), Common Moorhen (*Gallinula chloropus*) and Common Coot (*Fulica atra*) are common and frequent winter visitors. Black-necked Grebe (*Podiceps nigricollis*) is localized scarce winter visitor (Grimmett et al, 2016; IUCN, 2020). Rara is evident to be the stop over primarily as fueling ground to the observed waterfowls. The recorded waterfowls congregate in Rara Lake as wintering ground or stopover observing the stay length of waterfowl.The number of waterfowls and wetland dependent birds during study time (winter season) were observed comparatively lower than those of the forest birds. Diverse forest bird species (75) were observed in the lake proximity. The bird diversity in and around Rara lake proximity is highly diverse (H'-3.364) and bird species almost equally distributed (e-0.724). Despite diverse forest bird encounter rate, asymptotetype curve was obtained for forest bird implying the need of accounting theunder recorded forest birds (Figure 4).

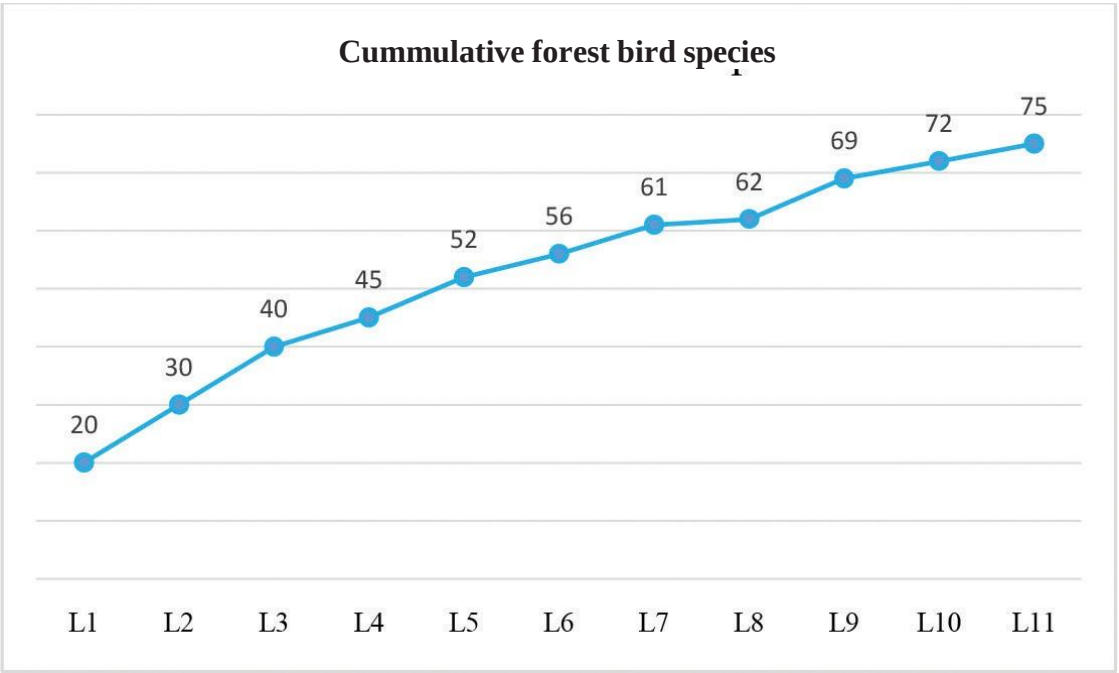



*Figure 4: Species richness curve for forest birds*

A total of 284 bird species were recorded from Rara National Park and its surrounding area (BCN & DNPWC, 2015) and 6 new species for the National Park was recorded with total of 290 species by Chaudhary et al. in 2015. In this study, 6 more species were observed. These are Mountain scops-owl (*Otus spilocephalus*), White-tailed sea-

eagle (*Haliaeetus albicilla*), Peregrine falcon (*Falco peregrinus*), Green shrike-babbler (*Pteruthius xanthochlorus*), Barn swallow (*Hirundo rustica*) and Tree pipit (*Anthus trivialis*).The revised and updated checklist of bird of Rara National Park and its bufferzone area with 296 bird species was published in 2020 (BCN & DNPWC, 2020).

Birds were active and feeding during the morning hours and in the late afternoon. Within birds, Eurasian Coot makes morning call between 0540-0615hrs. Generally, birds are active in dawn and dusk foraging and singing (forest birds). However, bird activities varied from species to species and with the season-winter season and breeding season. The winter season bird activity study found waterfowls spending majority of time foraging, revitalizing protein content for migration. Eurasian Coot, Black-necked Grebe, Tufted Duck, Gadwall, Common Pochard and Red-crested Pochard observed active and feeding closer to the lake bank. These waterfowls found feeding on floating weeds or dive under water to collect submerged weeds. Great crested grebe was observed solitary, and occasionally observed in flock (up to 22 individuals). Great crested grebe was observed highly sensitive human disturbance and does not appear closer to the lake bank. Often occasionally appear to human disturbance closer at the bank, it dives underwater and move away to safer places. It is observed swimming and feeding on fish. Likewise, Gulls were observed staying away from human disturbances like Great crested grebe. Gulls were noted soaring above the lake in the afternoon. Mostly gulls are seen messing with Eurasian coot and confiscating fish feeding by Eurasian coot. Gulls are highly active during windy weather causing wave on the lake. The wave in the lake bring dead fishes drifting. Similarly, Mallard, Goosander, Greylag Goose, Bar-headed Goose and Gadwall are the most sensitive to human disturbances. These birds observed loitering on land or observed roosting and pruning on fallen dead trees.Much perimeter of Rara lake (15Km) is surrounded by Pine-Rhododendron mixed forest with marshland and sandy deposit in scattered patches, boulders (at Eastern bank) and park office, lodges and Army camp (at Northern Bank). These waterfowls were noted loafing, roosting and foraging in marshland while common Pochard were roosting at sand deposited bank. Common Coots, Great Cormorant and mallard were roosting on the fallen tree/stump. Lake riparian is providing nice space for various activities. However, discarded trashes were observed in the roosting and foraging site. In addition, Rara lake circuit trail is closed the riparian habitat with continual human passerby. Upon disturbance (human movement), it escapes away to safe distance and get back to same spot (Figure 5).

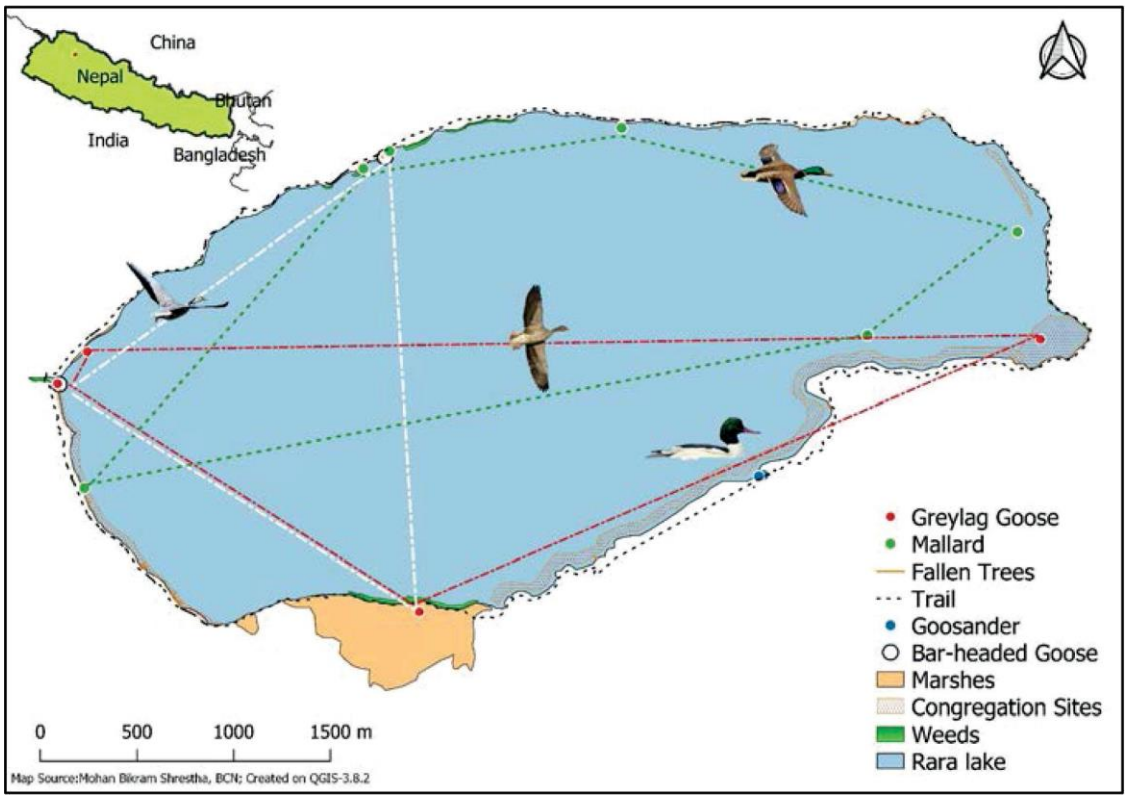



*Figure 5: Waterfowls (Greylag goose, Mallard, Bar-headed goose and Goosander) movement in Rara lake periphery*

Larger part of littoral zoneof the Rara Lake is highly productive with floating aquatic weed, emergent reeds and submerged algae . Hence, waterfowls are observed congregated the shallow water zone, shallow water marshes, marshland and sand banks. The depth of Rara Lake at the middle is higher where waterfowls entirely depending on fishes such as Great Crested Grebe and Gulls. On windy afternoon, majority of waterfowls are found shifting the location toward wind direction in Northeastern bank (Dufechour – Thakurnath). Primarily, carnivore waterfowls (Gulls, Cormorant) were observed feeding on the fish, while omnivore waterfowls such as Common Coot and Black-necked Grebe were found foraging on aquatic weed and fish upon availability. Dabbling Ducks such as Gadwall, Mallard, Bar-headed Goose and Graylag goose were observed foraging on aquatic insects, mollusks and insects found in the marshland. Similarly, Common Moorhen was observed feeding on aquatic insects. Breeding/foraging places outside lakes is not found. The waterfowls observed in the lake are more confined within the lake proximity. However, forest birds such as Snow Pigeon and Bearded vulture was observed away from Rara lake periphery to Murma village locating at the West of Rara

Lake. Waterfowls were observed confined to Rara lake proximity. No such alternative habitat found or delineated besides Rara lake periphery during this winter season survey. However, it is wetland dependent birds use multiple habitats since majority of wetland dependent birds are altitudinal migrants and anticipated these birds could be foraging in nearby farmland in Lamachour-Gamgadi area (Figure 6).

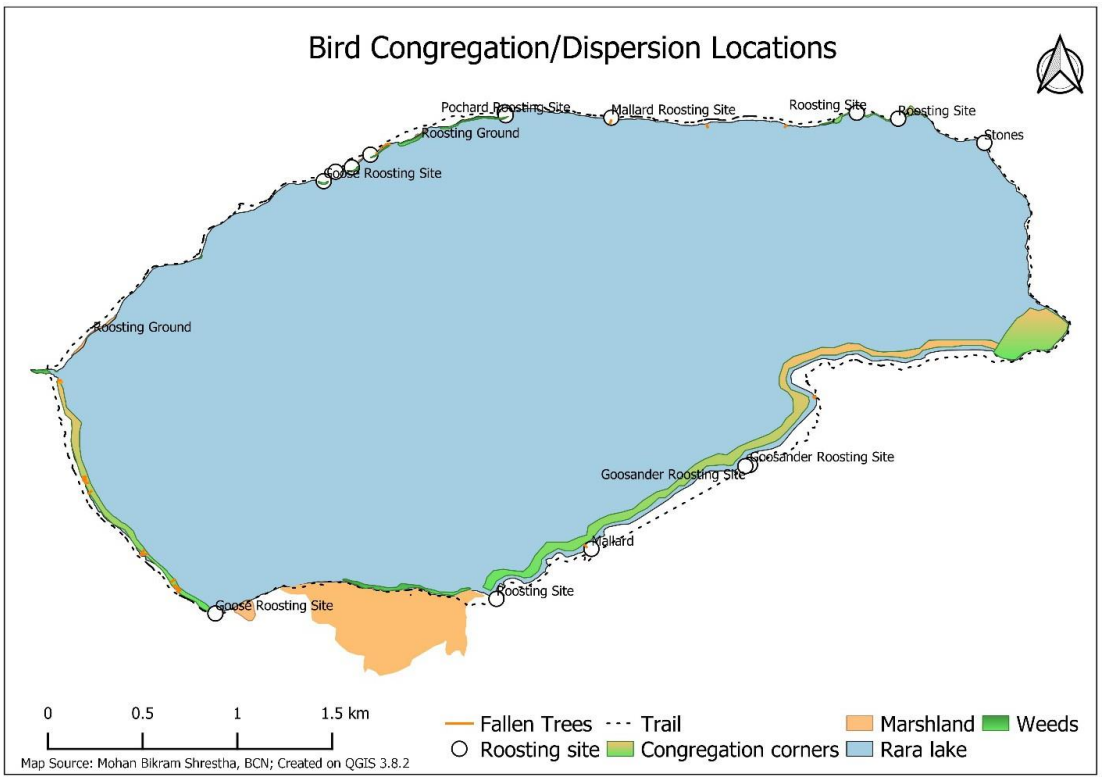



*Figure 6: Bird congregation and roosting and dispersion location in Rara Lake*

The length of stay of the majority of observed migratory birds could not be ascertained since waterfowls was seen during whole field study tenure. However, departure date of Bar-headed Goose was noted. Bar-headed Goose were observed for 9 days (12-20 December, 2019) in Rara lake. Among waterfowls, Bar-headed goose was not noted while only 4 individuals of Goosander were counted in later count. Waterfowls migration is related with day length, lower temperatures, changes in food supplies and genetic predisposition.The foraging ground of Bar-headed Goose was covered by snowfall hence have migrated from the Rara lake in search of preferred habitat. For further understanding of migration goose required the application of advance scientific tools such as banding, satellite tracking or geo-locator. This will locate other migration stopover/wintering locations for protection of birds and saving the habitat.

The surface water temperature of Rara Lake ranged between minimum of 11°C to maximum of 13°C during the water sample collection. Travelling from one site to another took time hence water collection time was different, thus the temperature was obtained different. Transparency of water in Rara Lake ranged from 12.6-16.3m with an average of 14.28.The water quality test result (for the winter season) are; average pH at 15°C-7.90 ±0.23; Turbidity <1-3 NTU; Total alkalinity range (mg/l) 129.20±2.68; Residual Chloride (mg/l) 3.17±0.83; Dissolved oxygen (mg/l) 7.67±0.58or 101±8.41% saturation considering conversion factors temperature (11°C and 12°C) and elevation (2990m); Free Carbon dioxide (mg/l) 15.92±8.06; Total Nitrogen range (mg/l) 8.01±2.27; Ammonia content (mg/l) 0.06±0.03 and Total Phosphate range (mg/l) 1.01±2.23. Detailed water quality analysis results are present in table 2.

**Table 2: Water quality analysis results of Rara Lake (4January, 2020)**

| S. N | Water Quality Test Parameters | Site-wise Observed Values | | | | | Min | Max | Mean ± SD |
|---|---|---|---|---|---|---|---|---|---|
| | | GH | MC | OL | DC | TN | | | |
| 1 | Water Temperature (°C) | 12 | 11 | 11 | 13 | 13 | 11 | 13 | 12.00±1.00 |
| 2 | pH @ 15°C | 7.6 | 8.1 | 8.1 | 7.7 | 8 | 7.6 | 8.1 | 7.90 ±0.23 |
| 3 | Electrical Conductivity (µS/cm) | 183 | 187 | 184 | 196 | 182 | 182 | 196 | 186.40±5.68 |
| 4 | Turbidity (NTU) | 3 | <1 | 1 | 2 | 2 | 1 | 3 | 2.00±1.14 |
| 5 | Total Alkalinity as CaCO3, (mg/L) | 128 | 128 | 134 | 128 | 128 | 128 | 134 | 129.20±2.68 |
| 6 | Residual Chloride (mg/L) | 3.97 | 4 | 2.97 | 1.98 | 2.97 | 1.98 | 3.97 | 3.17±0.83 |
| 7 | Dissolved Oxygen (mg/L) | 8 | 7 | 8 | - | - | 7 | 8 | 7.67±0.58 |
| | Dissolved Oxygen (% saturation)* | 108* | 92* | 105.3* | - | - | 92* | 108* | 101±8.41* |
| 8 | Free Carbon Dioxide (mg/L) | 12.6 | 8.4 | 16.75 | 29.3 | 12.6 | 8.37 | 29.3 | 15.92±8.06 |
| 9 | Total Nitrogen (mg/L) | 11.9 | 7.4 | 7.41 | 7.41 | 5.92 | 5.92 | 11.9 | 8.01±2.27 |
| 10 | Ammonia (mg/L) | 0.06 | 0 | 0.05 | 0.11 | 0.06 | 0.04 | 0.11 | 0.06±0.03 |
| 11 | Total Phosphate (mg/L) | 0.02 | 0 | 0.01 | 5 | 0.03 | 0.01 | 5 | 1.01±2.23 |

**GH**-Gulma Headquarter; **MC**-Milichour; **OL**-Outlet; **DC**-Duphechour; **TN**-Thakurnath

*Value after Conversion

There are limited studies on water quality analysis of Rara lake. Within available studies, parameters considered in water quality analysis are not uniform and methods applied varied. Water quality test parameters are dependent on the interest of agencies, institutions or involved in water quality research (Sharma et al., 2005). The water quality studies on Rara lake could be obtained from late 1970s. Ferro in 1978/79 gathered limnological and biological data for the first time and measured depth of the Rara Lake as 167m,surface water quality parameters (Transparency, temperature, electrical conductivity and pH and other water quality parameters such as Dissolved Oxygen, Phosphate, Ammonia, Nitrite, Nitrate, Silica and EDTA hardness.Later in 2015/16, Hydrochemical study was conducted by graduate student from Kathmandu University. In 2018, Paani Project from USAID carried water quality test. And the recent in 2019, Bird Conservation Nepal (BCN) conducted a water quality analysis of selected parameters as a part of its Study-Ornithological Survey to understand migratory behavior and threats to bird of Rara Lake.

While comparing water quality test result in this study corresponded with the results obtained by Okino and Satoh (1986) and Gurung et al. (2018) whereas water quality results relatively differed with results obtained by Paani Project carried (2018) with no justified reasons for the results mentioned in the report.

**Table 3: State of Water Quality of Rara Lake over time**

| **Water Quality Test Parameters** | May 1983* | October 2015** | April 2016** | April 2018*** | January 2020 |
|---|---|---|---|---|---|
| Transparency | 15.55 | 18.9 | 17.53 | - | 14.28 |
| Water Temperature (°C) | 12.71 | 18.79 ± 1.7 | 14.83 ± 1.8 | - | 12.00±1.00 |
| Electrical Conductivity (µS/cm) | 131.28 | 189.93 ± 5.3 | 189.22 ± 15.8 | - | 186.40±5.68 |
| pH | 8.53 | 8.42 ± 0.3 | 8.32 ± 0.22 | 6.7[a] | 7.90 ±0.23[b] |
| Turbidity, (NTU) | - | 2.43 ± 3.48 | 1.71 ± 0.86 | 30 | 2.00±1.14 |
| Dissolved Oxygen (mg/L) | 7.56 | 6.73 ± 0.6 | 10.6 ± 1.5 | - | 7.67±0.58 |
| Dissolved Oxygen (% saturation) | 101.71 | 105.46±9.4 | 160.31±22.84 | - | 101±8.41 |
| Total Alkalinity as CaCO3, (mg/L) | - | - | - | 241 | 129.20±2.68 |
| Residual Chloride (mg/L) | - | - | - | - | 3.17±0.83 |
| Free Carbon Dioxide, (mg/L) | - | - | - | - | 15.92±8.06 |
| Total Nitrogen, (mg/L) | ND | - | - | 15.2 | 8.01±2.27 |
| Ammonia, (mg/L) | ND | - | - | 2.02 | 0.06±0.03 |
| Total Phosphate, (mg/L) | Low | 0.0 ± 0.01 | 0.06 ± 0.01 | 3.68 | 1.01±2.23 |

Water temperature varies with season and day time. Hence, temperature of water observed different. Rara lake proximity will be filled with snow during winter and last till spring. The temperature seems almost similar from January till April. Temperature data of October recorded higher than temperature record of other time with slight change in temperature. The temperature coefficient value ($R^2$) deviated by 0.06 or 6% implying some temperature fluctuated with season. The future temperature data is predicated to be in between 12°C and 14°C referring to the regression line obtained (Figure 7).

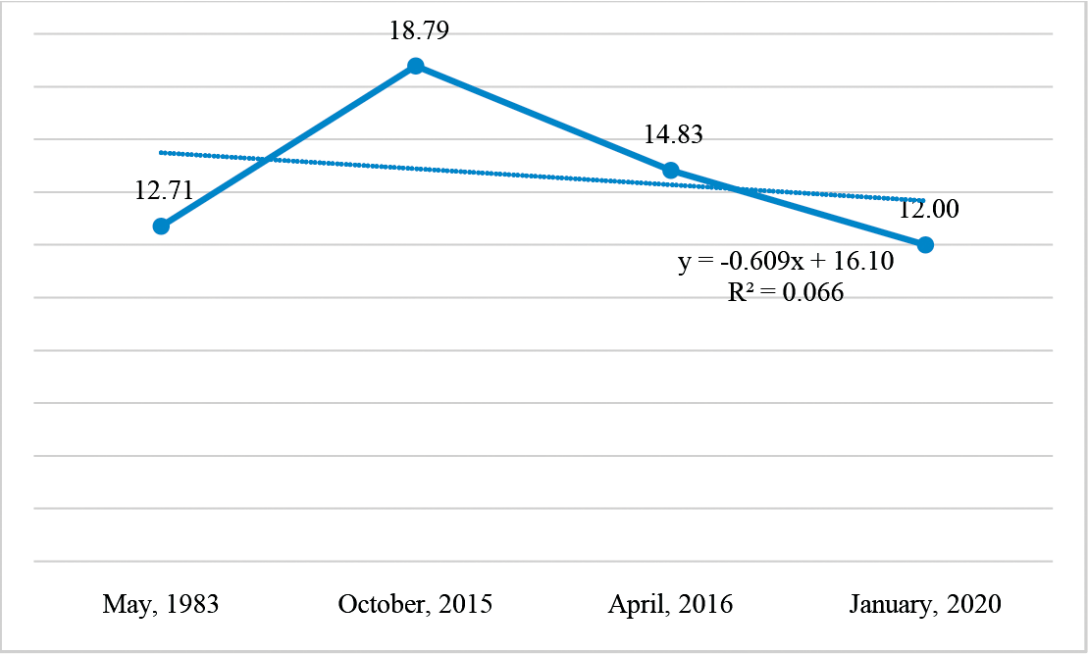



*Figure 7: State of water temperature of Rara lake over time (1983-2020)*

Transparency of water of Rara lake seems almost equal. The coefficient of determinant of transparency fit to the regression equation by 0.10 or 10 % implying slight change in transparency (Figure 8).

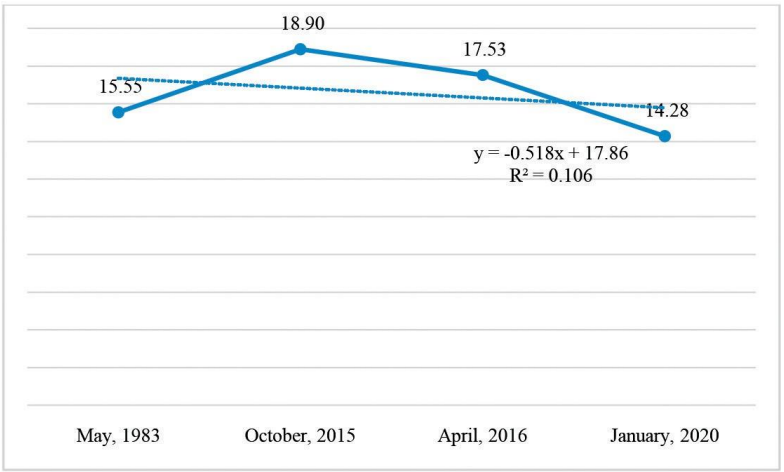



*Figure 8: Water transparency of Rara lake over time (1983-2020)*

Turbidity besides water quality analysis of April, 2018 are in similar range. Turbidity of water analysis of April is highly deviated from other water quality results (Figure 9). The obtained low coefficient of determinant ($R^2$) value (0.06 or 6%) clearly implied the test result is unconvincing. Or the water sample must have taken from the shore during windy day. During windy day the water becomes highly turbid at the shoreline due to the wave striking bank with sand and clay.

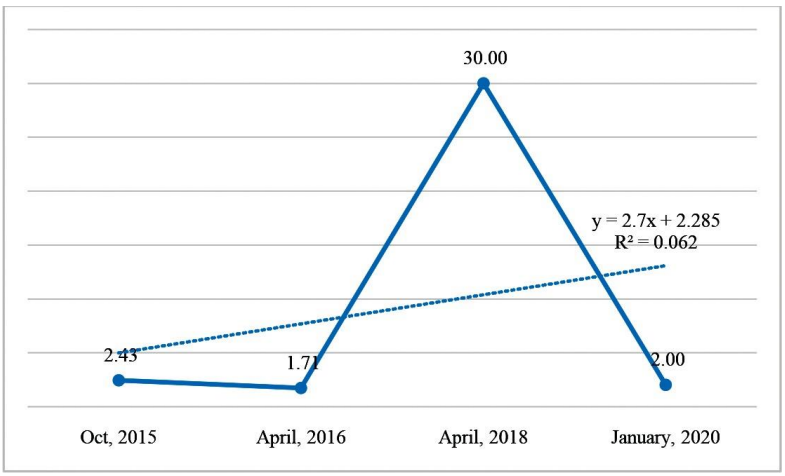



*Figure 9: Water turbidity assessment result over time 2015-2020*

Electrical conductivity is rising. The electrical conductivity coefficient is increased by 0.55 or 55%. The reason could be the increase in cations and anions in the water (Figure 10).

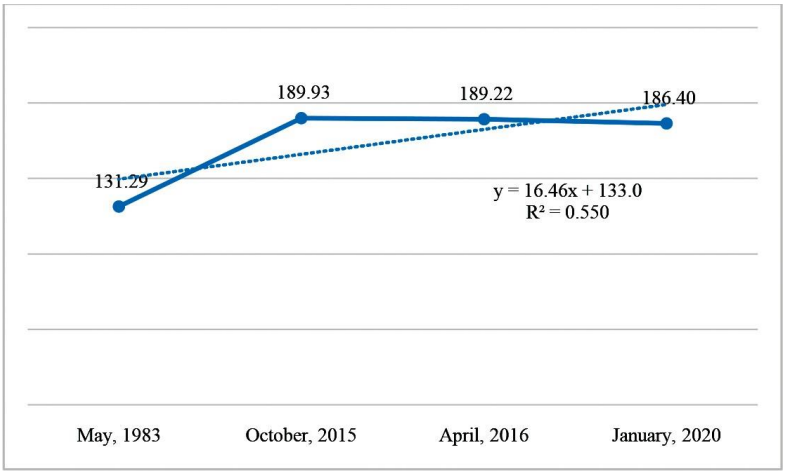



*Figure 10: Electrical conductivity test result of water of Rara Lake over time 1983-2020*

pH remained almost same range besides April, 2018 test result (Figure 11).

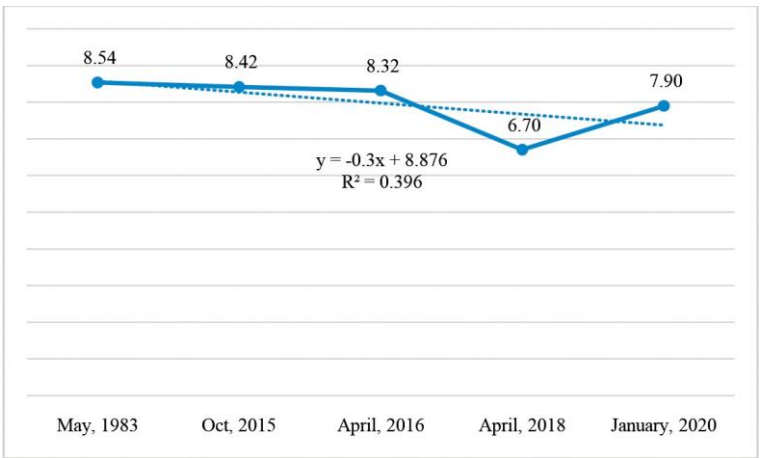



*Figure 11: pH result of water of Rara lake over time 1983-2020*

Dissolved Oxygen ranged almost similar beside test result of April, 2016. The resulted higher amount of oxygen in April could be of higher photosynthesis rate (Figure 12).

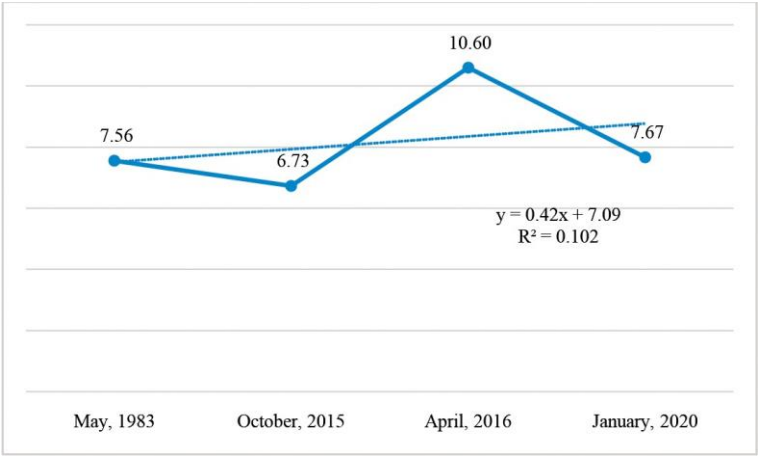



*Figure 12: Dissolve oxygen content in water of Rara lake over time 1983-2020*

High deviation in total phosphate amount is observed. Phosphate amount is required to be checked and justified by further water quality analysis (Figure 13)

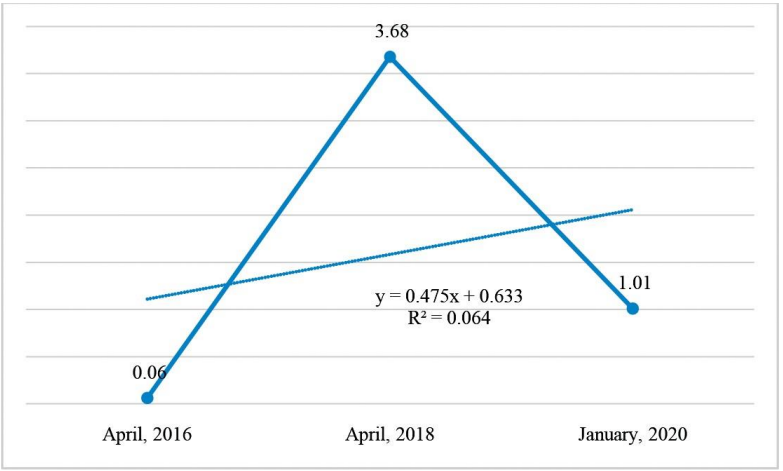



*Figure 13: Total Phosphate content in water of Rara lake over time 2016-2020*

Total nitrogen amount differed highly. The amount need to be checked and justified by further water quality analysis (Figure 14).

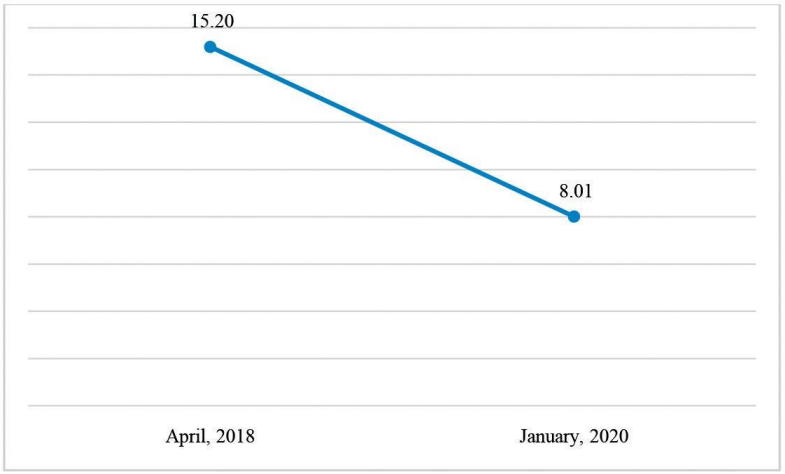



*Figure 14: Total Nitrogen content in water of Rara lake over time 2018-2020*

Ammonia amount differed highly. The amount need to be checked and justified by further water quality analysis (Figure 15).

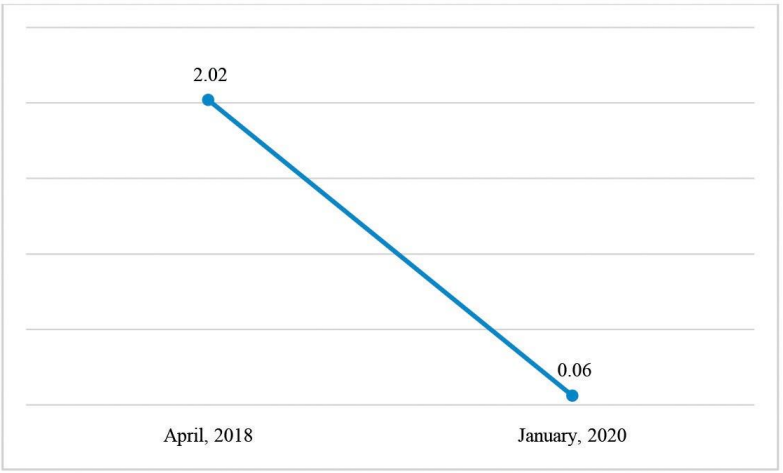



*Figure 15: Ammonia content in water of Rara lake over time 2018-2020*

Water quality in aquatic ecosystem is dependent on photosynthetic process, physical interactions and biochemical cycles. Additionally, anthropogenic stresses, particularly the introduction of chemicals in water, may adversely affect many species of aquatic flora and fauna that are dependent on both abiotic and biotic conditions. Water quality parameters of concern are traditionally dissolved oxygen (because it may cause fish kills at low concentrations) as well as phosphates, ammonia and nitrate (because they may cause significant changes in community structures if released into aquatic ecosystems in excessive amounts (WHO, 2020). Similarly, Water temperature has significant influence

in metabolic rate in fishes, dissolve oxygen and carbon dioxide in water (Kapila et al., 2002). However, an abrupt change in temperature alter the behavior, hematology and serum enzyme activities of the fish. United States Environmental Protection Agency (USEPA) suggested freshwater temperature should be within limit that protect against mortality of important species or site-specific temperature limit that preserves normal species diversity or prevent appearance of nuisance organism (USEPA, 1986). Nepal Water Quality Guideline (NWQG) for the Protection of Aquatic Ecosystem set pH value relative to background suggesting pHvalue of aquatic ecosystem should not be allowed to vary from the range of the background (CBS, 2008). However, pH value of Rara lake water is within the recommended range (6.5-9.0) set by USEPA and Canadian Water Quality Guidelines (CWQG)-Water Quality Standards for Aquatic life and Recreation (CWQG, 2008). NPQG do not have absolute value for total phosphate and total nitrogen content rather provided relative value suggesting all surface waters should not be changed by greater than 15% from that of the water body under local, un-impacted conditions at time of the year. Likewise, USEPA have not set absolute value of total phosphate phosphorous and total nitrogen. Increase above 25 µg/l (0.025mg/l) total phosphate phosphorous in lake accelerate eutrophication and develop biological nuisances (Mackenthun,1973). Lake trigger to ultra-oligotrophic lake upon total phosphate phosphorous content below 0.004mg/l and trigger to oligotrophic lake upon phosphate content increase to 0.01mg/l (CWQG, 2008). Total phosphate content in Rara lake for the winter season ranged 0.01-5 mg/l implying Rara lake in the process of eutrophication . Dung of grazing horses at the lake riparian was noted. The mixing phosphorous content with melting ice during winter is assumed as the possible source. However,this will be further justified by regular seasonal water quality test result. Total nitrogen content in Rara lake for the winter season ranged 5.92-11.9 mg/l. Alike total phosphate phosphorous, NWQG total nitrogen content criteria as surface waters should not be changed by greater than 15% from that of the water body under local, un-impacted conditions at time of the year. Likewise, USEPA and CWQG have not set absolute Nitrogen value for freshwater/ aquatic ecosystem. The toxic effects of total nitrogen are rarely occurred in nature hence restrictive criteria is not recommended. Ammonia concentration (0.04-0.11mg/l) in Rara lake appear much higher than recommended ammonia limit. NWQG suggested ammonia content should be below 7µg/l (0.007mg/l). Upon ammonia concentration increase to 15µg/l (0.015 mg/l), aquatic life suffers chronic effect and suffer by acute effect above 0.1 mg/l (µg/l). Concentration of ammonia acutely toxic to fishes cause loss of equilibrium, hyper-excitability, increase breathing, cardiac output and oxygen uptake and in extreme cases convulsions, coma and death. Decrease in water temperature and/ or pH enhances to acute ammonia toxicity to aquatic life.

Lake riparian is providing nice space for various bird activities. However, discarded trashes were observed in the roosting and foraging site. In addition, Rara lake circuit trail is closed the riparian habitat. The human movement through the trail however has caused

disturbance to waterfowl. Wetland dependent birds use multiple habitats since majority of wetland dependent birds are altitudinal migrants and anticipated these birds could be foraging in nearby farmland in Lamachour-Gamgadi area.Despite numerous trash pits (60) and trash bins (17) for safe disposal of trashes, the trashes are observed discarded in the trail and in the lake. Higher amount of trashes is in the trail surrounding the Rara Lake and some in the lake. Observed trash types are plastics, aluminum, garments and glass. The water quality test result for the season obtained showed phosphorous and ammonia concentration in Rara Lake above the permissible limit implying the lake in the process of eutrophication and acute ammonia toxicity affecting aquatic life. Ammonia content in aquatic ecosystem should be below 0.007mg/l (7microgram).

## Conclusion

The study accounted a total of 2415 bird individuals from listed 104 species including 16 migratory Waterfowls. 13 wetland dependent and 75 forest birds.The observed waterfowls ranged from frequent and common to occasional and very uncommon winter visitor stop in Rara lake primarily for fueling during migration. Waterfowls are observed foraging majority of time congregating at shallow water and merely outside lakes since, lake riparian is highly productive and providing secure space for various activities. However, discarded trashes in the roosting and foraging site and around the lake circuit trail triggering threats to waterfowls and aquatic biodiversity while higher human movement through the trail causing disturbance to waterfowl. Phosphorous and ammonia concentration in Rara lake is crossed recommended level for freshwater/ aquatic ecosystem connoting lake in the process of eutrophication and acute ammonia toxicity affecting aquatic life. Higher human movement and trashes in the Rara lake trail seem to pose threat to aquatic biodiversity. Therefor trashes around the lake is required to be cleaned and in addition display board with instruction to visitors and trash pit/bin location map should be installed minimizing litter the area. Incineration of trashes would be environmental friendly rather than open burning of trashes in trash pits. Regular assessment of water quality is required preventing aquatic life from detrimental effects.

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## Annex

**Bird species sighted during the study time**

| S.N | Order/ Family/ Common Name | Scientific Name | Nepali Name | IUCN/Migratory Status |
|---|---|---|---|---|
| **GALLIFORMES** | | | | |
| **Phasianidae** | | | | |
| 1 | Chukar | *Alectoris chukar* | r's/ | LC, Ex(br) |
| 2 | Hill Partidge | *Arborophila torqueola* | lkp/f | LC, Ex(r) |
| 3 | Himalayan Monal | *Lophophorus impejanus* | 8fkm] | LC, Ex(r) |
| 4 | Kalij Pheasant | *Lophura leucomelanos* | sflnh | LC, Ex(br) |
| **ANSERIFORMES** | | | | |
| **Anatidae** | | | | |
| 5 | Greylag Goose | *Anser anser* | snxfF; | LC, M(f), Ex(v) |
| 6 | Bar-headed Goose | *Anser indicus* | vf]ofxfF; | LC, M(f), Ex(v) |
| 7 | Gadwall | *Mareca strepera* | v8v8] xfF; | LC, M(f), Ex(v) |
| 8 | Mallard | *Anas platyrhynchos* | xl/of] 6fps] xfF; | LC, M(f), Ex(v) |
| 9 | Red-crested Pochard | *Netta rufina* | ;'gh'/] xfF; | LC, M(f), Ex(v) |
| 10 | Common Pochard | *Aythya ferina* | s}nf]6fps] xfF; | VU, M(f), Ex(nbr) |
| 11 | Tufted Duck | *Aythya fuligula* | sfnLh'/] xfF; | LC, M(f), Ex(v) |
| 12 | Goosander | *Mergus merganser* | dl0ft'08s | LC, M(f), Ex(v) |
| **PODICIPEDIFORMES** | | | | |
| **Podicipedidae** | | | | |
| 13 | Great crested Grebe | *Podiceps cristatus* | सिउरेडुबुल्कीचरा | LC, M(f), Ex(v) |
| 14 | Black-necked Grebe | *Podiceps nigricollis* | ्ालीण्ठडुबुल्कीचरा | LC, M(f), Ex(v) |
| **COLUMBIFORMES** | | | | |
| **Columbidae** | | | | |
| 15 | Rock Pigeon | *Columba livia* | dn]jf | LC, Ex(r) |
| 16 | Snow Pigeon | *Columba leuconota* | lxdfnL dn]jf | LC, M(f), Ex(r) |

| | | | | |
|---|---|---|---|---|
| 17 | Oriental Turtle Dove | *Streptopelia orientalis* | tfd] 9's'/ | LC, M(f), Ex(br) |
| **CAPRIMULGIFORMES** | | | | |
| **Caprimulgidae** | | | | |
| 18 | Grey Nightjar | *Caprimulgus (indicus) jotaka* | km';|f] r}t]r/f | LC, M(f), Ex(r) |
| **GRUIFORMES** | | | | |
| **Rallidae** | | | | |
| 19 | Common Moorhen | *Gallinula chloropus* | aufn] l;ds'v'/f | LC, M(f), Ex(v) |
| 20 | Eurasian Coot | *Fulicia atra* | d?n | LC, M(f), Ex(r) |
| **PELECANIFORMES** | | | | |
| **Ardeidae** | | | | |
| 21 | Black-crowned Night Heron | *Nycticorax nycticorax* | afs] as'Nnf | LC, M(f), Ex(v) |
| **SULIFORMES** | | | | |
| **Phalacrocoracidae** | | | | |
| 22 | Great Cormorant | *Phalacrocorax carbo* | hn]jf | LC, M(f), Ex(nbr) |
| **CHARADRIIFORMES** | | | | |
| **Scolopacidae** | | | | |
| 23 | Common Snipe | *Gallinago gallinago* | kfgL rfxf | LC, M(f), Ex(nbr) |
| 24 | Common Redshank | *Tringa totanus* | nfnv'§] l6dl6df | LC, M(f), Ex(v) |
| 25 | Green Sandpiper | *Tringa ochropus* | ?v ;'8\;'l8of | LC, M(f), Ex(v) |
| 26 | Common Sandpiper | *Actitis hypoleucos* | r~rn] ;'8;'l8of | LC, M(f), Ex(v) |
| **Laridae** | | | | |
| 27 | Lesser Black-backed Gull | *Larus fuscus* | सिउस्लन u+ufrLn | LC, M(f), Ex(v?) |
| 28 | Pallas's Gull | *Larus ichthyaetus* | /fhf u+ufrLn | LC, M(f), Ex(v) |
| 29 | Brown-headed Gull | *Larus brunnicephalus* | v}/f]6fps] u+ufrLn | LC, M(f), Ex(nbr) |
| **STRIGIFORMES** | | | | |
| **Strigidae** | | | | |
| 30 | Mountain Scops-owl* | *Otus spilocephalus* | n]sfnL pn"s | LC, M(a), Ex(br) |
| 31 | Himalayan Owl | *Strix nivicolum* | s}nf] kxf8L pn"s | LC, Ex(r) |
| **ACCIPITRIFORMES** | | | | |
| **Accipitridae** | | | | |

| | | | | |
|---|---|---|---|---|
| 32 | Black Kite | *Milvus migrans* | sfnf] rLn | LC, M(f), Ex(r, br?) |
| 33 | Himalayan Vulture | *Gyps himalayensis* | lxdfnL lu4 | LC, M(f), Ex(r, br?) |
| 34 | Eurasian Marsh-harrier | *Circus aeruginosus* | k"jL{o l;d e'O{rLn | LC, M(f), Ex(v) |
| 35 | Bearded Vulture | *Gypaetus barbatus* | xf8kmf]/ | NT, Ex(r,br?) |
| 36 | Himalayan Buzzard | *Bueto b. burmanicus* | Zo]gafh | LC, Ex(r) |
| 37 | White-tailed Sea-Eagle * | *Haliaeetus albicilla* | s°d rLn | LC, M(f), Ex(nbr) |
| **CORACIIFORMES** | | | | |
| **Alcedinidae** | | | | |
| 38 | Crested Kingfisher | *Megaceryle lugubris* | ुठुलोसिरसबरेमाटी्ोरे | LC, M(a), Ex(br) |
| **PICIFORMES** | | | | |
| **Picidae** | | | | |
| 39 | Himalayan Woodpecker | *Dendrocopos himalayensis* | lxdfnL sfi7s"6 | LC, Ex(r) |
| 40 | Scaly-bellied Woodpecker | *Picus squamatus* | 7"nf]sTn] sf7kmf]/ | LC, Ex(br) |
| **CARIAMIFORMES** | | | | |
| **Falconidae** | | | | |
| 41 | Common Kestrel | *Falco tinnunculus* | af}8f0 | LC, M(f), Ex(br) |
| 42 | Peregrine Falcon* | *Falco peregrinus* | zfxL afh | LC, M(f), Ex(br) |
| **PASSERIFORMES** | | | | |
| **Vireonidae** | | | | |
| 43 | Green Shrike-babbler* | *Pteruthius xanthochlorus* | xl/t eb\|fO{Eofs'/ | LC, M(a), Ex(r) |
| **Laniidae** | | | | |
| 44 | Grey-backed Shrike | *Lanius tephronotus* | lxdfnL eb\|fO{ | LC, M(f), Ex(r) |
| **Corvidae** | | | | |
| 45 | Yellow-billed Blue Magpie | *Urocissa flavirostris* | ;'g7"8] nfdk'R5] | LC, M(a), Ex(r) |
| 46 | Southern Nutcracker | *Nucifraga hemispila* | jg;/ | LC, Ex(br) |

| | | | | |
|---|---|---|---|---|
| 47 | Yellow-billed Chough | *Pyrrhocorax graulus* | 6]d' | LC, Ex(r) |
| 48 | Large-billed Crow | *Corvus macrortynchos* | sfnf] sfu | LC, Ex(r) |
| **Stenostiridae** | | | | |
| 49 | Yellow-bellied Fairy-fantail | *Chelidorhynx hypoxanthus* | kx]nf] df?gLr/L | LC, M(a), Ex(r) |
| **Paridae** | | | | |
| 50 | Great Tit | *Parus major* | lrlrNsf]6 | LC, Ex(r) |
| 51 | Green-backed Tit | *Parus monticolus* | xl/of] lrlrNsf]6] | LC, M(a), Ex(r) |
| 52 | Coal Tit | *Periparus ater* | ;fgf] km';\|] lrlrNsf]6] | LC, Ex(r) |
| 53 | Grey-crested Tit | *Lophophanes dichrous* | km';\|f]h'/] lrlrNsf]6] | LC, Ex(r) |
| **Alaudidae** | | | | |
| 54 | Oriental Skylark | *Alauda gulgula* | a\|fXdLr6L | LC, M(f), Ex(r) |
| **Hirundinidae** | | | | |
| 55 | Barn Swallow* | *Hirundo rustica* | 3/ uf}ynL | LC, M(f), Ex(br) |
| 56 | Eurasian Crag Martin | *Ptyonoprogne rupestris* | glxs'6L uf}ynL | LC, M(f), Ex(br) |
| **Pycnonotidae** | | | | |
| 57 | Himalayan Bulbul | *Pycnonotus leucogenys* | h'Nkm] h'/]nL | LC, M(f), Ex(r) |
| 58 | Black Bulbul | *Hypsipetes leucocephalus* | afv\|] h'/]nL | LC, M(f), Ex(r) |
| **Phylloscopidae** | | | | |
| 59 | Lemon-rumped Leaf-warbler | *Phylloscopus chloronotus* | kLts6L lkm:6f] | LC, M(a), Ex(r) |
| **Aegithalidae** | | | | |
| 60 | White-throated Tit | *Aegithalos niveogularis* | ;]tf]s07] /fhlrlrNsf]6] | LC, Ex(br) |
| 61 | Red-headed Tit | *Aegithalos iredalei* | sfnLs07] /fhlrlrNsf]6 | LC, Ex(r) |
| **Sylviidae** | | | | |
| 62 | White-browed Fulvetta | *Fulvetta vinipectus* | kLtgog km"na'§f | LC, M(a), Ex(r) |
| **Zosteropidae** | | | | |
| 63 | Oriental White-eye | *Zosterops palpebrosus* | sf+sL/ | LC, Ex(r) |
| 64 | Stripe-throated Yuhina | *Yuhina gularis* | y'knsNsL h'/]r/f | LC, M(a), Ex(r) |

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| **Leiotrichidae** | | | | |
| 65 | Variegated Laughingthrush | *Trochalopteron variegatum* | l6sLo'/ tf]/LufFF8f | LC, Ex(r) |
| 66 | Spotted Laughingthrush | *Garrulax ocellatus* | d'Fbfn] tf]/LufFF8f | LC, Ex(r) |
| 67 | Streaked Laughingthrush | *Trochalopteron lineatum* | l5s]{/ tf]/LufF8f | LC, Ex(r) |
| 68 | Chestnut-crowned Laughingthrush | *Trochalopteron erythrocephalum* | s6';6fps] tf]/LufFF8f | LC, Ex(r) |
| 69 | Rufous Sibia | *Heterophasia capistrata* | l;laof | LC, Ex(r) |
| **Certhiidae** | | | | |
| 70 | Hodgson's Treecreeper | *Certhia hodgsoni* | ;]tf]k]6] 5]kf/ɮ/l | LC, Ex(r) |
| **Sittidae** | | | | |
| 71 | Kashmir Nuthatch | *Sitta cashmirensis* | sfZdL/L d§f | LC, Ex(r) |
| 72 | White-cheeked Nuthatch | *Sitta leucopsis* | sfnf]6fps] d§f | LC, Ex(r) |
| 73 | Wallcreeper | *Tichodroma muraria* | d'/f/L k'tnLr/f | LC, Ex(r) |
| **Troglodytidae** | | | | |
| 74 | Northern Wren | *Troglodytes troglodytes* | lrqL | LC, M(f), Ex(br) |
| **Cinclidae** | | | | |
| 75 | Brown Dipper | *Cinclus pallasii* | v}/f] j~h"n | LC, Ex(r) |
| **Turdidae** | | | | |
| 76 | Alpine Thrush | *Zoothera mollissima* | ;fbf9f8] rfFr/ | LC, M(a), Ex(r) |
| 77 | White-collared Blackbird | *Turdus albocinctus* | s07] rfFr/ | LC, M(a), Ex(r) |
| 78 | Black-throated Thrush | *Turdus atrogularis* | sfnf]s07] rfFr/ | LC, M(f), Ex(nbr) |
| **Muscicapidae** | | | | |
| 79 | Himalayan Bush-robin | *Tarsiger rufilatus* | ;'Gtnfsf]v] /lag | LC, M(f), Ex(r) |
| 80 | Rufous-bellied Niltava | *Niltava sundara* | ;'Gb/ gLntef | LC, Ex(r) |
| 81 | Blue-fronted Redstart | *Phoenicurus frontails* | gLn6fps] v~h/L | LC, M(a), Ex(r) |
| 82 | Blue-capped Redstart | *Phoenicurus coeruleocephala* | wf]lagL v~h/L | LC, M(a), Ex(r) |

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| 83 | Grey Bushchat | *Saxicola ferreus* | lxdfnL ‰ofK;L | LC, Ex(r) |
| 84 | Common Stonechat | *Saxicola torquatus* | ´]s´]s ‰ofK;L | LC, M(f), Ex(br) |
| 85 | Blue Whistling Thrush | *Myoponus caeruleus* | sNrf}8] | LC, M(a), Ex(br) |

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| 85 | White-capped Water-redstart | *Chaimarrornis leucocephalus* | ;]tf]6fps] hnv~h/L | LC, M(a), Ex(r) |
| 87 | Plumbeous Water Redstart | *Rhyacornis fuliginosus* | gLnfDa/ hnv~h/L | LC, Ex(r) |
| 88 | Spotted Forktail | *Enicurus scouleri* | yf]Kn] vf]n]wf]lagL | LC, Ex(r) |
| **Regulidae** | | | | |
| 89 | Goldcrest | *Regulus regulus* | :j0f{r"n lkm:6 | LC, M(f), Ex(r) |
| **Prunellidae** | | | | |
| 90 | Rufous-breasted Accentor | *Prunella strophiata* | d';] n]sr/L | LC, Ex(r) |
| **Passeridae** | | | | |
| 91 | Russet Sparrow | *Passer rutilans* | s}nf] eFu]/f | LC, M(a), Ex(r) |
| 92 | Eurasian Tree Sparrow | *Passer montanus* | ?v eFu]/f | LC, Ex(br) |
| **Motacillidae** | | | | |
| 92 | Upland Pipit | *Anthus sylvanus* | kxf8L r'OofF | LC, Ex(r) |
| 94 | Tree Pipit* | *Anthus trivialis* | aufn] r'OofF | LC, M(f), Ex(r) |
| 95 | White Wagtail | *Motacilla alba* | km';|f] l6sl6s] | LC, Ex(br) |
| **Fringillidae** | | | | |
| 96 | Common Chaffinch | *Fringilla coelebs* | lrqsr/L | LC, M(f), Ex(r) |
| 97 | White-winged Grosbeak | *Mycerobas carnipes* | w"kL dxfF7"F8 | LC, M(f), Ex(r) |
| 98 | Plain Mountain Finch | *Leucosticte nemoricola* | ltt'eFu]/f | LC, M(f), Ex(r) |
| 99 | Yellow-breasted Greenfinch | *Chloris spinoides* | ufhn] kLtr/L | LC, M(f), Ex(r) |
| 100 | Common Rosefinch | *Carpodacus erythrinus* | cdf]+uf ltt' | LC, M(f), Ex(br) |
| 101 | Pink-browed Rosefinch | *Carpodacus rodochroa* | /ftf] l´aL ltt' | LC, M(a), Ex(r) |
| 102 | Red-fronted Serin | *Serinus pusillus* | nfndfyf l;l/g | LC, M(a), Ex(br) |
| 103 | Eastern Goldfinch | *Carduelis carduelis* | /Qmd'xf/ kLtr/L | LC, M(f), Ex(r) |
| 104 | Red-headed Bullfinch | *Pyrrhula erythrocephala* | /ftf]6fps] l6pFl6p | LC, M(a), Ex(r) |

* New Species record for Rara National Park

LC-Least Concern; NT-Near Threatened; M(f)-Full Migrant; M(a)-Altitudinal Migrant; Ex(nbr)- Extent non-breeding; Ex(v)-Extent visitor; Ex(r)-Extent Resident; Ex(br)- ?-Information from Nepal not mentioned in IUCN Redlist of Threatened Species