

Journal of
**Threatened
Taxa**

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10.11609/jott.2021.13.13.19887-20142

www.threatenedtaxa.org

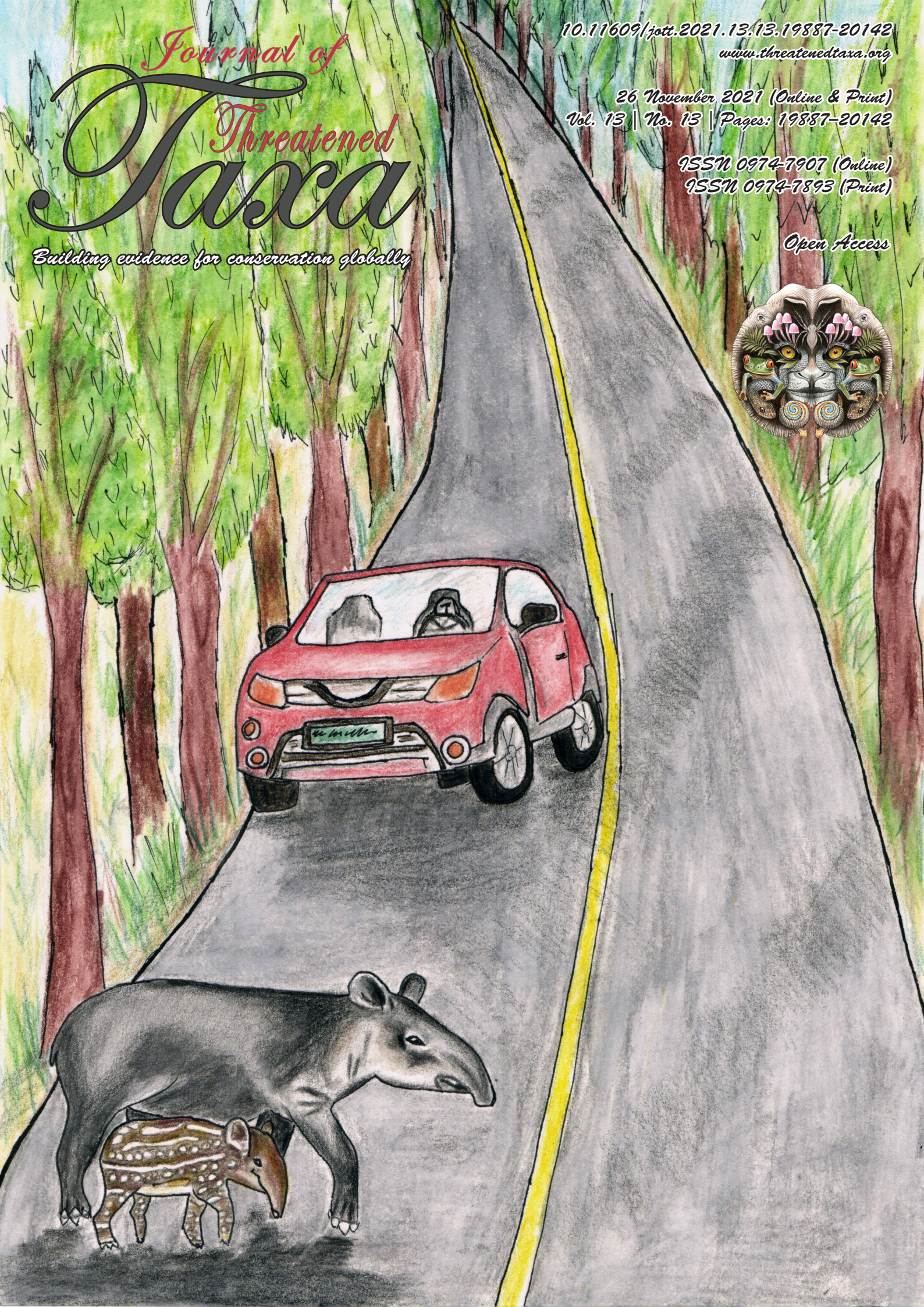
26 November 2021 (Online & Print)

Vol. 13 | No. 13 | Pages: 19887-20142

ISSN 0974-7907 (Online)

ISSN 0974-7893 (Print)

Open Access





ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

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Caption: Lowland Tapir *Tapirus terrestris* (Medium—watercolours on watercolour paper) © Aakanksha Komanduri.



A rare photographic record of Eurasian Otter *Lutra lutra* with a note on its habitat from the Bhagirathi Basin, western Himalaya, India

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Abstract: The Eurasian Otter *Lutra lutra* is an elusive, solitary animal that has one of the widest distributions of all palearctic mammals. Once widely distributed in Asia, the Eurasian Otter population is now vulnerable to urbanization, pollution, poaching, and dam construction. Eurasian Otter distribution in the Indian Himalayan rivers is little explored, and information from this high-altitude riverine ecosystem is sparse. This publication reports a rare photographic record of the Eurasian Otter which confirms its presence in the high-altitude temperate forest of the Upper Bhagirathi Basin, western Himalayan region. The otter was recorded during investigations of terrestrial and aquatic fauna in the Bhagirathi Basin (7,586 km², 500–5,000 m) of Uttarakhand State, India from October 2015 to May 2019. Among aquatic fauna, Brown Trout were found to be abundant in high altitude river stretches, with a catch per unit effort of 1.02 kg h⁻¹. Additionally, 26 families of freshwater macroinvertebrates underscored a rich diet available for the Brown Trout, which in turn is a potential food source for the otters. The riverine ecosystem is undergoing dramatic changes because of the increasing demand for hydropower plants in the Bhagirathi Basin. Although mitigation measures are currently in place for fish, the presence of otters further necessitates the need for targeted management for high-altitude Himalayan rivers. There

is an imperative need for intensive otter surveys using methods such as camera traps in riparian habitats along the Bhagirathi River and its tributaries.

Keywords: Anthropogenic pressures, camera trapping, hydropower projects, otter, riverine ecosystem.

Information on otters of the high-altitude riverine ecosystems in the Indian Himalayan region is lacking. Eurasian Otter *Lutra lutra* (Linnaeus, 1758), is the only otter found in high altitude (>2,000 m) mountain streams and rivers (Prater 1971). The species has the widest distributions of all palearctic mammals (Corbet 1966); however, due to human pressures, they have disappeared from most of their range (Yoxon & Yoxon 2019). There is lack of information about its population status in Asia,

Editor: Nicole Duplax, Fisheries & Wildlife, Corvallis, USA.

Date of publication: 26 November 2021 (online & print)

Citation: Pal, R., A. Sharma, V.K. Dubey, T. Bhattacharya, J.A. Johnson, K. Sivakumar & S Sathyakumar (2021). A rare photographic record of Eurasian Otter *Lutra lutra* with a note on its habitat from the Bhagirathi Basin, western Himalaya, India. *Journal of Threatened Taxa* 13(13): 20072–20077. <https://doi.org/10.11609/jott.6937.13.13.20072-20077>

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Funding: Department of Science and Technology (DST), Government of India, National Mission for Sustaining Himalayan Ecosystem (NMSHE), Grant No. DST/SPLICE/CCP/NMSHE/TF-2/WII/2014/[G].

Competing interests: The authors declare no competing interests.

Acknowledgements: This work is part of project initiated under the National Mission for Sustaining the Himalayan Ecosystem Programme funded by the Department of Science and Technology, Government of India under grant no. DST/SPLICE/CCP/ NMSHE/TF-2/WII/2014[G]. We are thankful to the director and dean, Wildlife Institute of India, for their guidance and support. We are grateful to Mr. D.V.S. Khati, principal chief conservator of forests and chief wildlife warden, Uttarakhand, for granting us the research permission and Mr. Shrawan Kumar, Mr. N.B. Sharma, deputy director, Gangotri National Park, and Mr. Sandeep Kumar, divisional forest officer, Uttarkashi, for providing necessary support and cooperation. We thank Dr. S.A. Hussain and Ms. Sayanti Basak for their help in identification of the species.





where it is believed to be under tremendous pressure because of poaching (Roos et al. 2015). The species is classified as 'Near Threatened' on the IUCN Red List, and is vulnerable to the pelt trade (Roos et al. 2015), climate change (Gupta et al. 2020), and habitat destruction & pollution (Roos et al. 2015). It is listed in Appendix I of CITES, and in India, is listed in Schedule II (Part 2) of the Wildlife (Protection) Act, 1972.

Scattered records across Asia are indicative of otter distribution along all the major river systems, ranging to the southernmost parts of Sumatra, Indonesia (Corbet & Hill 1992). However, its distributional range in the Indian Himalayan region is still unclear, with research suggesting that it is mostly confined to river plains and foothills (Atkinson 1882; Hussain 2002) with the exception of a few high-altitude records from the Trans-Himalayan regions of Ladakh and Himachal Pradesh (Conroy et al. 1998). The earliest records of otter from the state of Uttarakhand (Atkinson 1882) date to the 19th century, when they were recorded from the Ramganga River and Dehradun. According to Atkinson (1882), the Eurasian Otter was found throughout the Terai and in all the larger streams along the Himalayan foothill. Apart from its distribution in the Indian Himalayan region, this species has been recorded from the northern mountainous region of Pakistan and Punatshangchu basin of Bhutan (Yoxon & Yoxon 2019). There are no recent confirmed records of the Eurasian Otter from Nepal (Yoxon & Yoxon 2019). Based on their distribution records from mountainous habitats in neighbouring regions (Image 1), their presence was long anticipated in the high-altitude river systems of Uttarakhand state. However, studies in low elevation areas have indicated that otters have declined drastically from most stretches of the rivers in Uttarakhand due to habitat loss/degradation caused by hydropower projects, anthropogenic pressures, and poaching (Nawab 2008; Chopra et al. 2014). Recent attempts to confirm otter presence in lower part of Bhagirathi and adjacent Alaknanda basin using sign surveys yielded no sightings or any indirect evidence of their presence, although suitable habitats were found in both the basins (Hussain 2002; Rajvanshi et al. 2012).

Here, we report a photographic record of Eurasian Otter from the high-altitude temperate forest of the Upper Bhagirathi River Basin, Uttarakhand state. The study is the part of a long-term monitoring of wild flora and fauna under the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) project (Task force IV). Surveys were carried out in different areas of Bhagirathi Basin (7,586.71 km²), to develop baseline information on faunal species of terrestrial and aquatic

components. Based on their records specifically from the high-elevations in other basins of Himalaya, we also aimed to understand the habitat availability in our study area, as well as the potential faunal composition which supports the dietary needs of the Eurasian Otter in such landscapes. As such the camera trapping surveys were paralleled with the aquatic habitat, fish and macroinvertebrate faunal surveys to investigate the reasons dictating their rare preference for the high-elevation streams and rivers of Himalaya.

MATERIALS AND METHODS

The Bhagirathi is a large glacial fed and turbulent Himalayan river that emerges from Gangotri glacier (Gaumukh), 30.925°N & 79.082°E at an elevation of 3,812m. The valley has a broad U-shape at higher elevations characteristic of glacial origin, but at lower elevations the river has cut a narrow V-shaped fluvial valley. Along the 217km long river the elevation ranges from 480m to 3,200m with an average gradient of 1.25% (Rajvanshi et al. 2012). The basin encompasses diverse habitats: tropical and sub-tropical forests (500–1,200 m), temperate forests (1,200–2,800 m), sub-alpine forests (2,900–3,200 m), alpine scrub and meadows above 3,200 m (Rajwar 1993). Human habitations in the study area are confined below the elevation of 3,000 m (Image 1).

Data on the seasonal distribution of mammal species were collected using camera traps (Cuddeback C1, WI, USA) from October 2015 to March 2019 broadly covering two seasons: summer and winter. Camera trapping was carried out in two stages. In the first stage (October 2015–September 2017), preliminary survey for all the mammals was carried out along the elevation gradient of 500 m to 5,200 m. At each site, camera traps were deployed in locations likely to be used by animals inside the forest, alpine meadows, along the river beds and other such microhabitats (Sathyakumar et al. 2013). In the second stage (October 2017 to March 2019), camera traps exercise was carried out only in the high elevation habitats (2500 m to 5200 m) targeting Snow Leopard *Panthera uncia*, Leopard *Panthera pardus*, and their prey species. To survey evenly across the various habitats, we divided the basin into 16 x 16 km grids, which corresponds to the average home range of the largest mammal in the area, the Himalayan Brown Bear *Ursus arctos isabellinus*. We subdivided these cells into 4 x 4 km (first stage) and 3 x 3 km cells (second stage) deployed camera traps in 3–6 of these smaller cells within each 16 x 16 cell. A total of 318 locations were sampled during this period (Image 1).

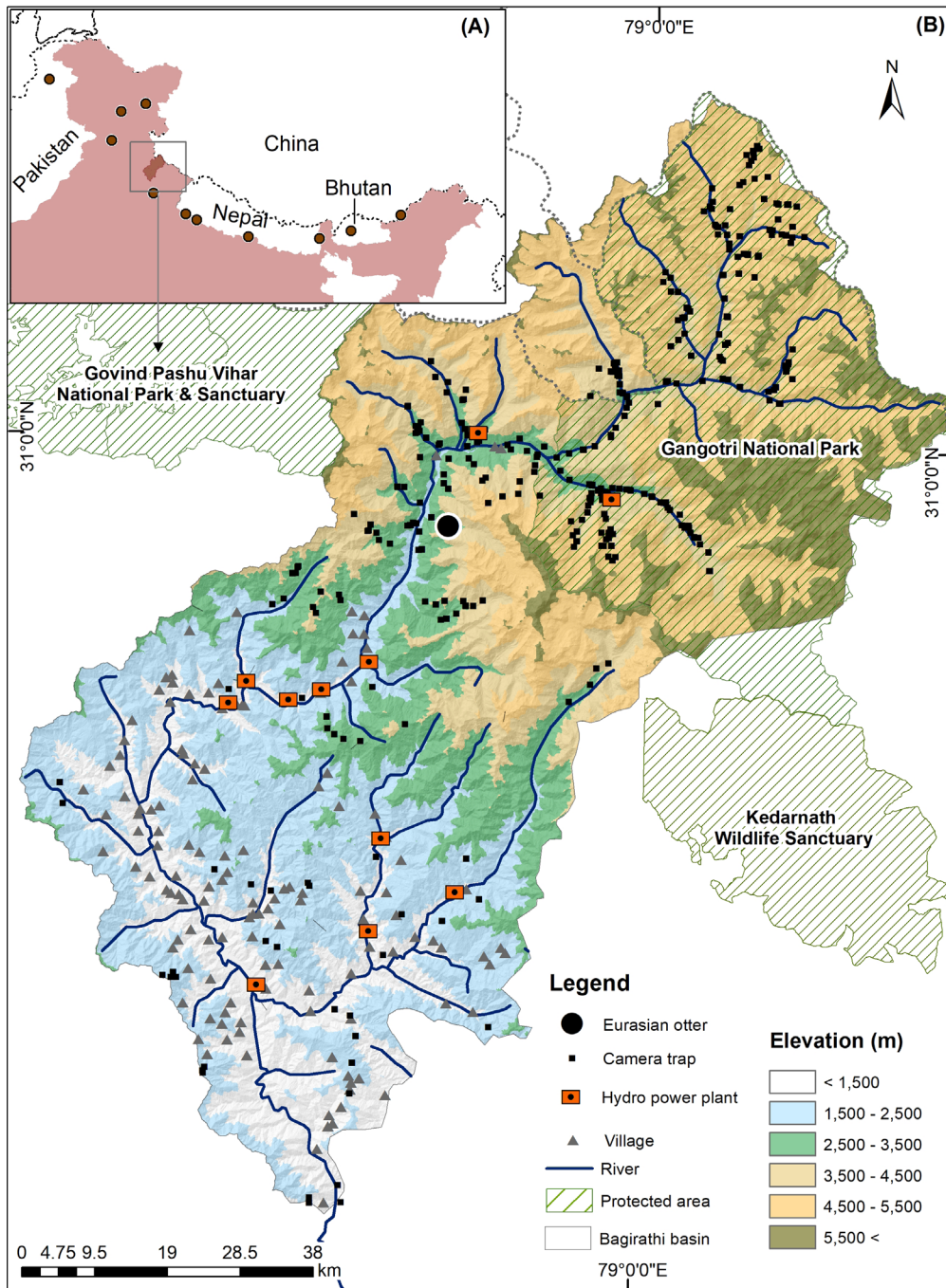


Image 1. A—Map showing location of the Bhagirathi Basin. The red points show the recent confirmed records from different Himalayan regions | **B—**Map showing distribution of camera trapping locations along the Bhagirathi Basin and Eurasian Otter captured location.

Simultaneously, fish and macroinvertebrate sampling was also conducted in the river stretches of Bhagirathi Basin. Rivers were sampled from March 2016 to December 2018 at every 500 m for the higher-order streams (4th and higher) and 200 m interval for the lower order streams (3rd and lower). This method was followed to target equivalent representation of all streams, as

the lower order streams often did not extend more than 500 m in length (Sharma et al. 2021). In total, 38.92 km of river stretch was sampled with a total of 51 sampling points spanning across the Bhagirathi River and three of its major tributaries *Kakori*, *Jalandhari*, and *Sian* using cast nets for fishes and D-frame dip net for macroinvertebrates. The catch per unit effort (CPUE) of



the cast net was calculated by dividing the catch of each sampling site by the number of hours fished (Morgan & Burgess 2005). The fishes were caught and released post-sampling. The water quality parameters were recorded using a multi-parameter water monitoring kit, while the microhabitat characterization was done based on Bain & Stevenson (1999).

RESULTS

Camera trapping effort (78,828 trap nights) across the basin resulted in 28,257 captures of different mammal species. Excluding Eurasian Otter, a total of 39 species of mammals were recorded during the survey belonging to 13 families in five orders (Pal et al. 2020). A solitary otter was likely first photo-captured on 25 September 2018 at 1352 h, although the species could not be definitively identified as the capture was too close to the camera. Another photo of an individual was captured on 14 February 2019 at 0546 h (Image 2). Based on the characteristic features such as the conical tail, lighter underside, the bare and black rhinarium with a W-shaped upper margin, the otter species was confirmed as the Eurasian Otter (Hussain 2013; Menon 2014). Along with photographic capture we also captured a 30-sec video recording, where the otter was observed moving on snow. The species is known to survive in extreme cold conditions and has previously been reported at an elevation of 3,700 m in the Himalaya (Prater 1971) and up to 4,120 m in Tibet (Mason & Macdonald 1986).

An image of the Eurasian Otter was captured near the Dabrani region, which is the confluence point of Jaulighad, and Songhad tributaries with Bhagirathi River. It was captured at an elevation of 2,700 m near the bank of Jaulighad approximately two km away from its confluence with the main river. The area is characterized by highly rugged mountainous terrain (Image 2). The river forms a deep constricted V-shaped valley in Dabrani together with a high runoff and steep gradient. The area where the otter was captured is characterized by big rocks, boulder fields, and deep crevices. Such habitats are considered as ideal denning and breeding sites for the Eurasian Otters (Hussain 2013). Dense bankside vegetation is also an important determinant of otter's presence as crucial resting sites (Kruuk 2006). The vegetation in the area where otter was photocaptured is a dense temperate riverine habitat with steep slopes covered with conifer- broadleaved mixed forests characterized by the presence of tree species such as *Alnus nepalensis*, *Betula alnoides*, and *Cedrus deodara*. The habitat in the upstream river changes to sub-alpine where species such as *Rhododendron*

sp. and *Pinus wallichiana* are found. Other mammals recorded from the same location are common leopard, Himalayan Goral *Nemorhaedus goral*, Himalayan Tahr *Hemitragus jemlahicus*, Himalayan Serow *Capricornis thar*, Himalayan Langur *Semnopithecus schistaceus*, and Yellow-throated Marten *Martes flavigula*.

Adapted for a semi-aquatic life, Eurasian Otters are primarily piscivorous with fish contributing 80% of their diet (Webb 1975; Ruiz-Olmo & Palazon 1997). Throughout our surveys we found the exotic Brown Trout *Salmo trutta* to be the only fish species inhabiting elevations above 2,500 m, with a CPUE of 1.02 kg h⁻¹ ranging between 0.22 to 2.65 kg hr⁻¹ across all the sampling locations. As accounted for in our surveys, the high elevation streams (>2,500 m) of Bhagirathi Basin comprise 26 families of macroinvertebrates most of which belong to the Order Trichoptera, which is considered as a major diet of the Brown Trout (Fochetti et al. 2003). This underscores a habitat rich in diet for sustenance of the Brown Trout, which in turn could be a potential food source for the Eurasian Otter in the high elevation river stretches. The aquatic habitat in the high-elevation basin was characterized with dissolved oxygen (8.65±0.59 mg/l) and total dissolved solids (44.72±20.02 ppm) with a low water temperature (7.55±3.09 °C) across the sampling duration supporting the sustenance of Brown Trout. The water flow was recorded to be swift across the width of the river ranging between 1.5 to 4.4 ms⁻¹ with a microhabitat predominantly defined by fast flowing cascades, runs and rapids. Further, the Eurasian Otters are known to move large distances (adult male: 38.8±23.4; adult female: 18.7±3.5 km) (Durbin 1998; Green et al. 1984; Kruuk et al. 1993; Kruuk 1995) along the length of the river (which possibly include lower elevations). As such, other studies documenting the presence of fish species such as *Pseudecheneis sulcata*, *Tor tor*, *Schizothorax richardsonii*, *Opsarius bendelisis* and loaches of the genus *Schistura* possibly indicate a rich ichthyofaunal diet for the Eurasian Otter (Rajvanshi et al. 2012). It thus makes it evident that the potential food available for Eurasian Otter has been identified along the stretches of Bhagirathi River and necessitates the need for more surveys to document Eurasian Otters in the Himalayan region.

DISCUSSION

In a four year effort, Otters were recorded only twice. Although a large network of camera traps was used in the study, very few were deployed near rivers or streams. Of 318 cameras deployed in the basin, only five cameras placed within 1 km distance from the river



Image 2. A—A solitary Eurasian Otter was captured at an elevation of 2,700 m near the bank of Jualighad, a tributary of the Bhagirathi River. The area is characterized by highly rugged mountainous terrain (© WII_DST-NMSHE camera trap) | B—The vegetation in the area is a temperate riverine habitat with steep slopes covered with conifer- broadleaved mixed forests (© Ranjana Pal).

or stream. Otters may have been present in deep gorge areas, but as the sites were inaccessible they could not be sampled. Otter presence often goes unnoticed because of their elusive, solitary, and nocturnal habits. We recommend more dedicated surveys using camera traps to understand the status and distribution of Eurasian Otter in the region. A large chain of tributaries supports Bhagirathi; most of them are still in pristine conditions. Additionally, their presence should be explored in the similar habitat in other catchments of Uttarakhand. There is an urgent need to understand the scattered population of Eurasian Otter in order to effectively protect this species. Removal of bank side-vegetation, construction of dams, draining of wetlands,

aquaculture, and associated human-made impacts are some of the potential threats to Eurasian Otters (Roos et al. 2015). Dams have further been implicated in the decline of the Eurasian Otter (Foster-Turley et al. 1990; Macdonald & Mason 1994).

Currently the Bhagirathi River is dammed at 11 locations (Image 1), which has changed the hydro geomorphology of the river. The river has been altered drastically from a swiftly flowing stretch (due to steep gradient) into a vast stretch of semi stagnant water with a characteristic flat gradient and large volumes of water (Agarwal et al. 2018). Fish diversity in Bhagirathi River is also currently declining and is threatened by blockage of migration routes, disconnection of



the river and floodplain, changes in flow regime, change in physiochemical attributes (Agarwal et al. 2018). Destructive fishing practices in the lower order tributaries of the Bhagirathi, which are potential spawning grounds and nursery sites for many cold-water fish, are risking the viability of the fish populations imperative for the otter's diet. In addition to the existing pressures on the aquatic ecosystem, there are four more dams commissioned, one under construction and one proposed hydropower project in Bhagirathi River, which will potentially affect 70% of river length (Chopra et al. 2014). While mitigation strategies are currently being adapted to reduce impact on fish, otter presence further necessitates targeted management for the high-altitude Himalayan rivers. Mitigation strategies need to be revised to include a wider range of flora & fauna and consider the impact on the riparian ecosystem.

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NAAS rating (India) 5.64

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ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

November 2021 | Vol. 13 | No. 13 | Pages: 19887–20142

Date of Publication: 26 November 2021 (Online & Print)

DOI: 10.11609/jott.2021.13.13.19887-20142

www.threatenedtaxa.org

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