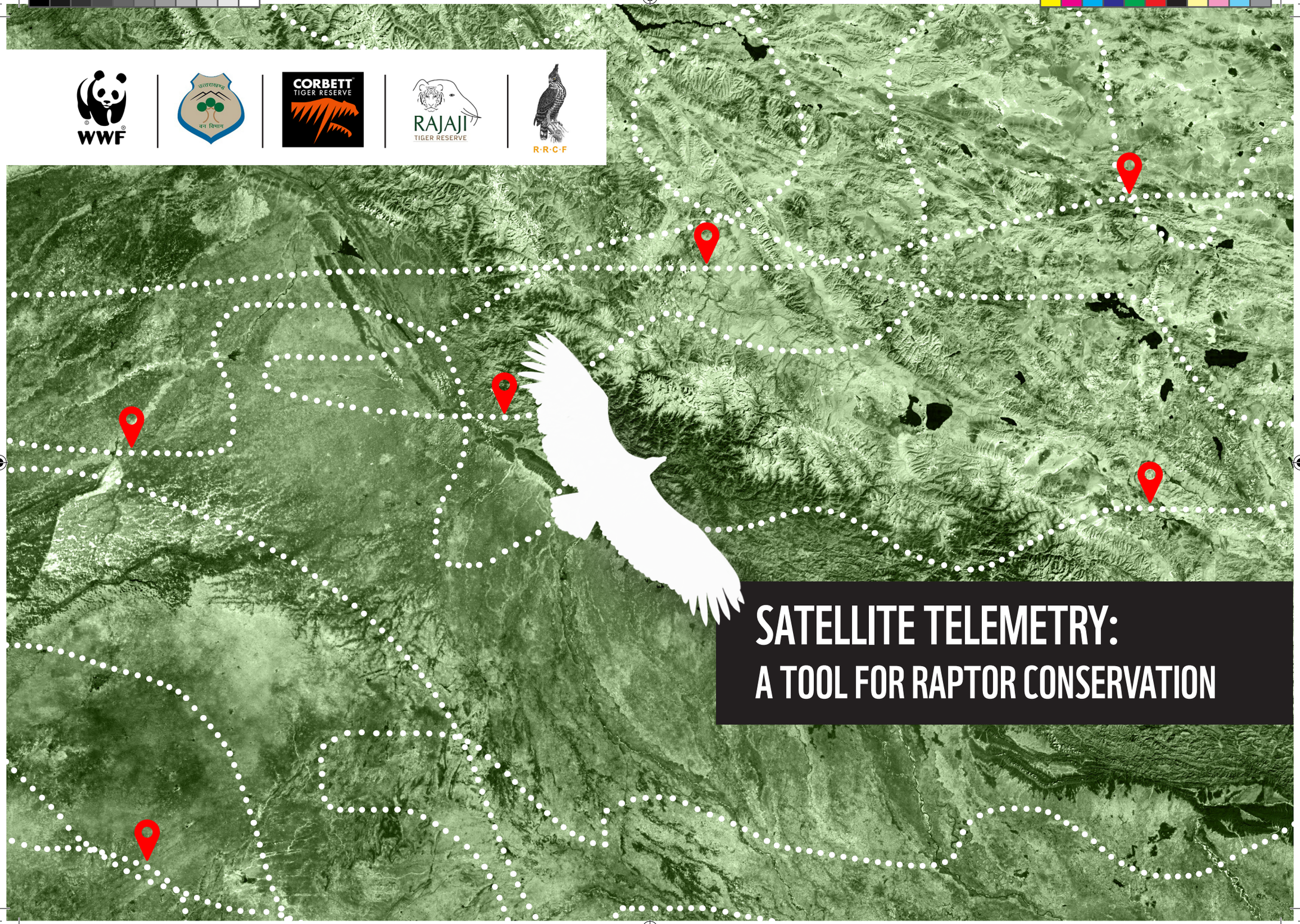

SATELLITE TELEMETRY:
A TOOL FOR RAPTOR CONSERVATION

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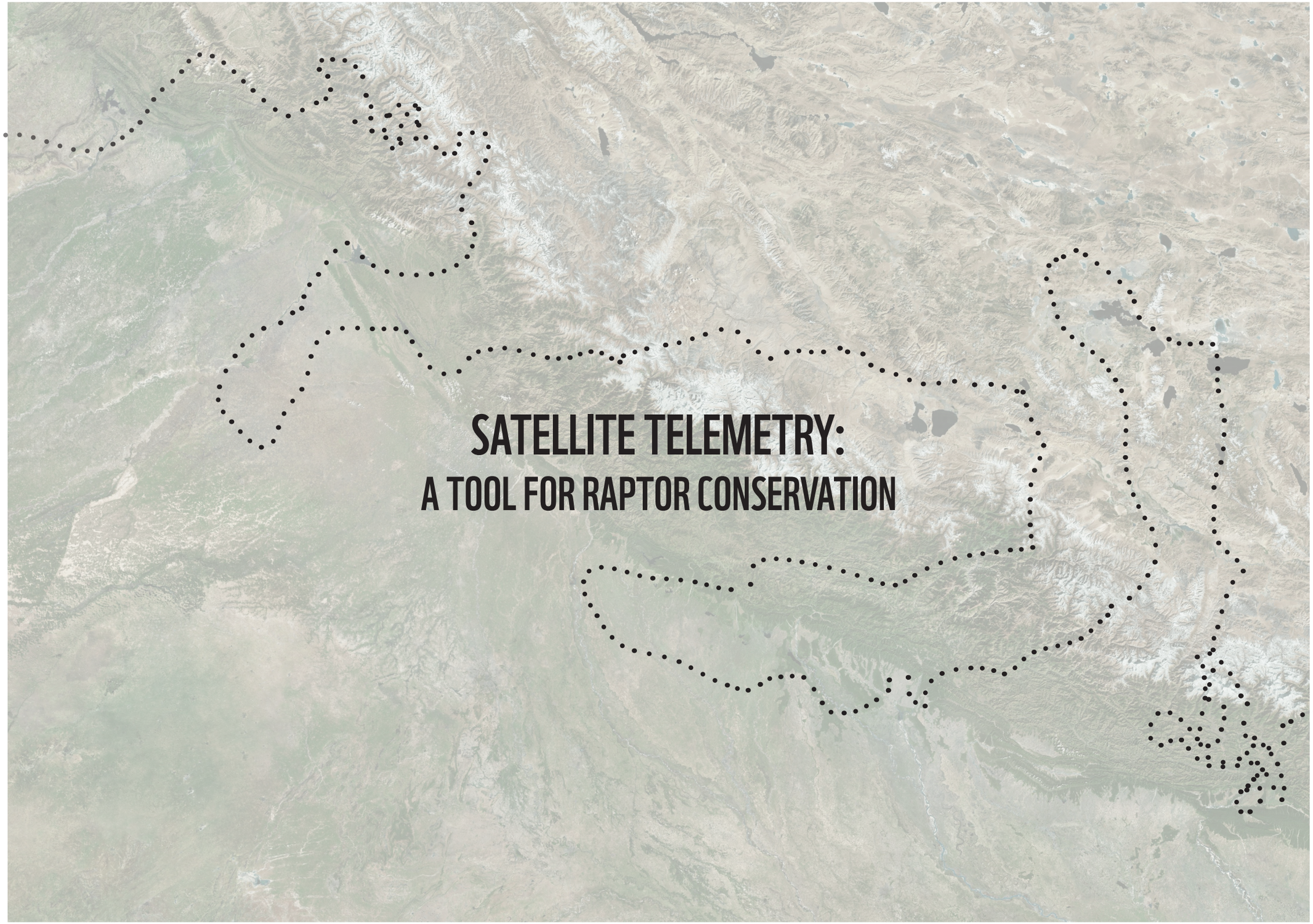

SATELLITE TELEMETRY:
A TOOL FOR RAPTOR CONSERVATION

PREFACE

रंजन कुमार मिश्र
RANJAN KUMAR MISHRA

Principal Chief Conservator of Forests (Wildlife) & Chief Wildlife Warden, Uttarakhand

I have always been deeply fascinated by the incredible creatures known as raptors and the wide range of ecosystem services they provide. These birds symbolize strength, perseverance, courage, and, in the case of vultures, remarkable collaboration. Vultures embody collaboration through their communal feeding habits, where multiple individuals work together to efficiently locate and scavenge carrion, playing a critical role in maintaining ecosystem health. Despite their significance, much remains to be learned about the movement ecology and key stopover sites of many raptor species in India. This knowledge gap limits our understanding of crucial conflicts at important raptor habitats and hinders effective decision-making to safeguard these vital ecosystems.

Satellite telemetry is a powerful method used to track the movement ecology of animals, particularly wildlife, across vast distances. Acknowledging the recent advancements in satellite telemetry studies on birds globally, and the significant management decisions facilitated by the insights from such studies, the Uttarakhand Forest Department, in collaboration with WWF-India, has initiated a satellite telemetry study on globally threatened species of raptors including White-rumped vulture, Egyptian vulture and Red-headed vulture in the Rajaji Tiger Reserve (RTR) and Corbett Tiger Reserve (CTR).

This report presents the initial findings and insights from the data obtained from five raptors of three species. A key highlight of this study is the identification of five preferred sites for roosting, nesting, or foraging by the tagged birds. Among these sites, critical conflicts have been identified at two locations, for which targeted management interventions would be implemented soon.

I extend my gratitude to WWF-India for leading the implementation of this study and convey my best wishes to all involved in their future efforts to conserve the species and their habitats.

(Ranjan Kumar Mishra)

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KEY MESSAGE

रवि सिंह
Ravi Singh

Secretary General & CEO
WWF-India

Raptors, also known as birds of prey, are essential for maintaining the balance of ecosystems. Vultures, for example, play a crucial role in preventing the spread of infectious diseases by feeding on decaying carcasses. Similarly, other raptor species like eagles, kites, buzzards, kestrels, harriers, falcons and owls help control the populations of rodents, insects and reptiles, thus helping maintain an ecological balance.

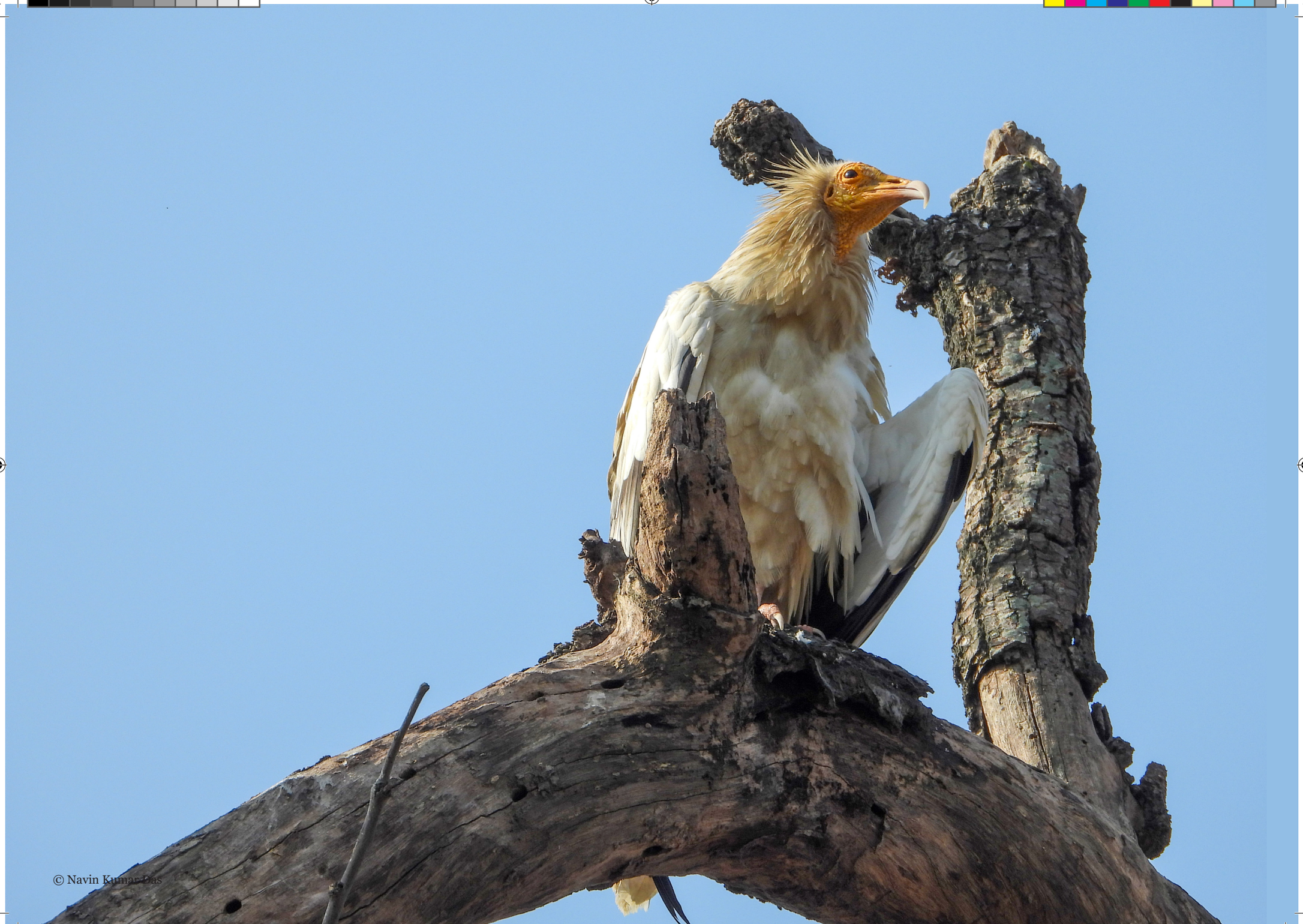
In India, there are 105 species of raptors, with 15 of them being globally threatened and some facing the risk of extinction. However, the lack of data on various raptor species, including population, range, migration routes, stopover sites and critical conflicts, hinders planning for their conservation.

To address this issue, a study has been initiated to understand the movement patterns and identify key stopover sites of three threatened raptor species - the white-rumped vulture, red-headed vulture, and Egyptian vulture - at Corbett Tiger Reserve and Rajaji Tiger Reserve in Uttarakhand. The study has already yielded valuable data from five tagged birds, which will contribute to the conservation and management of these majestic species and their habitats.

Moving forward, this study aims to document the socio-ecological aspects of the areas frequently used by raptors to identify critical conservation issues and assist the Uttarakhand Forest Department in making effective management decisions.

I express my gratitude and appreciation to the officers of the Uttarakhand Forest Department, as well as all field units and frontline staff of the Corbett Tiger Reserve and the Rajaji Tiger Reserve. I would also like to sincerely thank the Ministry of Environment, Forests, and Climate Change, Govt. of India, for approving this work. I congratulate my team for their dedicated efforts in conducting this important study. I am hopeful that the findings will pave the way for meaningful conservation measures and urge the state government to take necessary steps to safeguard these iconic species and their habitats.

Ravi Singh
Secretary General & CEO
WWF-India



CONTENTS

ACKNOWLEDGEMENTS

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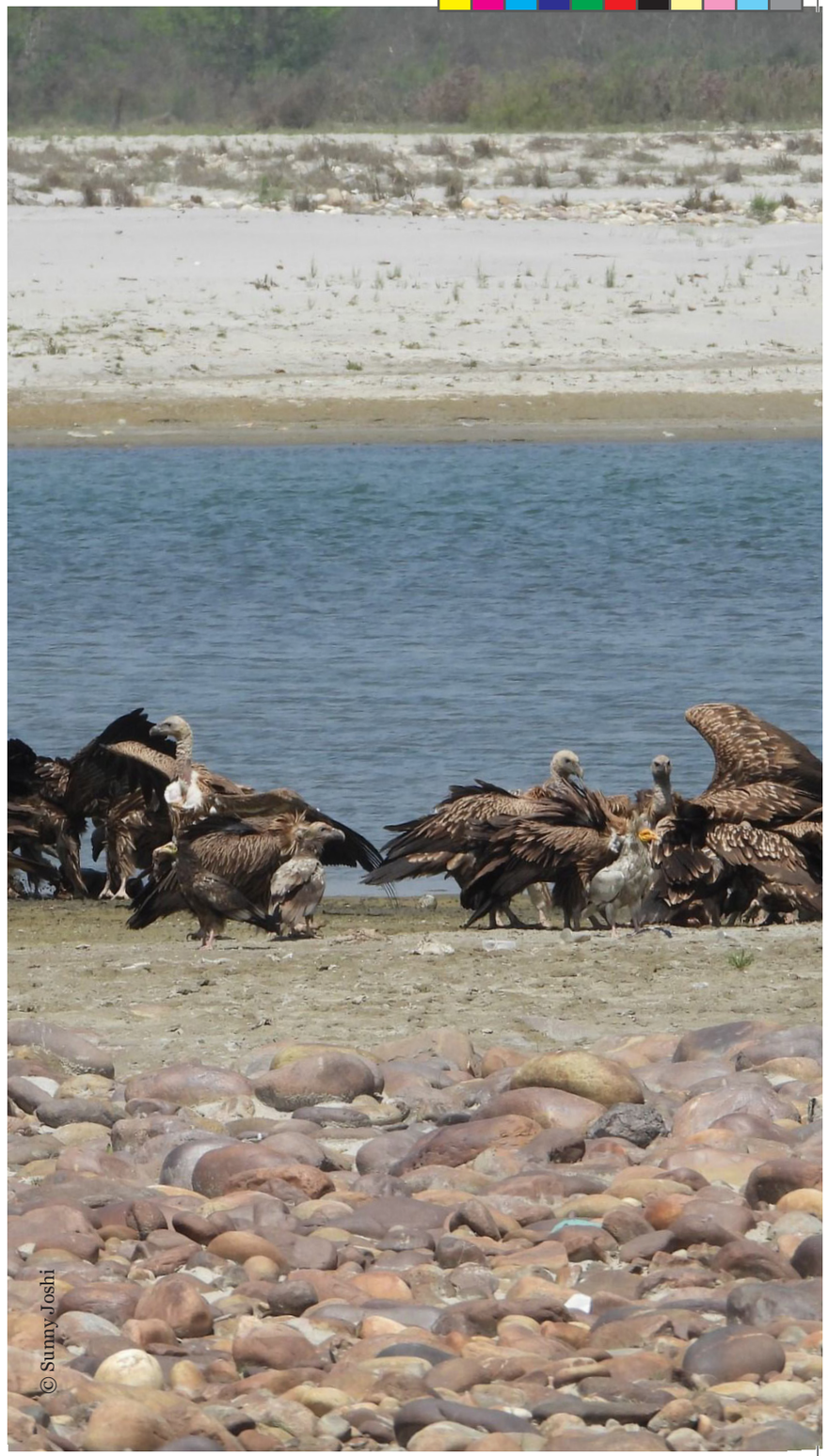
We are also grateful for the support from the Range Officers and Deputy Range Officers of Dhikala, Dhela, and Sarpduli ranges of Corbett Tiger Reserve, as well as Beribada, Chilla, Chillawali, and Dholkhand ranges of Rajaji Tiger Reserve. Their collaboration ensured the efficient conduct of our exercise.

We would also like to thank all Beat Officers, Forest Guards, and Casual Daily Labourers at these forest ranges who accompanied us during our fieldwork.

This exercise is supported by the Raptor Research and Conservation Foundation.

We extend our gratitude to Mr Ravi Singh, SG & CEO, WWF-India; Dr Sejal Worah, Programme Director, WWF-India, for their guidance and oversight. Last, but not the least, we thank the efforts of our erstwhile colleague from Raptor Conservation Programme, Ms Aishwarya Laghate, Dr Nilutpal Mahanta, and Dr Diwakar Sharma, for their contribution in the initial planning, and field activities for the exercise.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SUMMARY

Raptors, also known as birds of prey, are renowned for flying long distances in search of food and suitable habitats for nesting and roosting. Some raptor species stay close to their nest sites, travel locally within a few hundred kilometers, while others have a much larger range, covering several thousand kilometers from their nest site and back before the next breeding season. During their journeys, migratory raptors make stopovers to rest and replenish their energy reserves. In India, the movement patterns of several raptor species, including threatened vultures, remain poorly studied, making it difficult to understand the socio-economic aspects of their habitats and plan conservation interventions.

To address this gap, a study was conducted in Corbett Tiger Reserve and Rajaji Tiger Reserve in Uttarakhand to understand the movement patterns and identify key stopover sites of three resident raptor species: the white-rumped vulture, red-headed vulture, and Egyptian vulture. A total of five individuals from these species were captured and fitted with satellite tags during October–November 2023 and March–April 2024. The birds were captured using traps and fitted with 50 g GSM PTT (platform transmitter terminal) tags from Ornitela, programmed to receive data every 4 hours and transmit data every 12 hours.

The tagged birds were tracked using the online tool Ornitrack, and on-ground tracking was also conducted to verify the data and understand the factors influencing the birds' affinity to certain sites. The study identified that two of the frequently visited sites were near Dehradun, at carcass disposal sites, revealing the main foraging sites of the birds. However, these sites posed a threat to the raptors due to a dense network of high-tension powerlines, requiring mitigation measures such as bird flight diverters and powerline insulators to prevent bird mortality.

The study's findings aim to help the Forest Department identify critical habitats and movement corridors. This would facilitate protection of biodiversity and habitats through strategic interventions. Additionally, the study recommends for user-friendly decision-support systems to visualize the data across multiple socio-ecological layers, which could be utilized by various agencies, including forest department officials, line departments of the Uttarakhand Government, conservation NGOs, and research institutions, to effectively manage wildlife and their habitats.

1

SATELLITE TELEMETRY

Satellite telemetry is a method used to track the movement ecology of animals, particularly wildlife, across large distances.[1] This technique involves attaching a small transmitter to an animal, which sends signals to satellites orbiting the Earth.[2] These satellites then relay the data back to ground stations, allowing researchers to monitor the animal's location, movement patterns, and, in some cases, physiological data in near real-time.[3]

This technology has become an indispensable tool in wildlife biology and conservation, providing insights into animal behaviour, habitat use, migration patterns, and survival rates that would be challenging to obtain otherwise. Satellite telemetry is especially valuable for studying species with wide ranges or those that inhabit inaccessible areas.[4]

A. Importance of satellite telemetry in raptor research and conservation

Birds, particularly raptors, are ideal candidates for satellite telemetry due to their wide-ranging movement, migratory behaviour, and the ecological roles they play.[5] Satellite telemetry studies of birds help in:

Understanding migration patterns: Some raptor species migrate over several hundred kilometres, crossing continents and oceans. Satellite telemetry allows conservation practitioners to track these movements with high precision, revealing the timing, routes, and stopover sites critical for conservation efforts.[6]

Identifying critical habitats: Tracking tagged birds allows scientists to pinpoint important habitats for breeding, roosting, and feeding. This knowledge is crucial for conserving these areas, especially in regions where habitat loss or degradation is a concern.[7]

Studying behaviour and ecology: Satellite telemetry provides insights into the daily movements, hunting behaviours, and territorial ranges of raptors.[8] Understanding these aspects helps in assess the impact of environmental changes and

[1]Kingsbury, B.A. and Robinson, N.J. 2016. Movement patterns and telemetry. *Reptile ecology and conservation: a handbook of techniques*, 110pp.
[2]Hussey, N.E., Kessel, S.T., Aarestrup, K., Cooke, S.J., Cowley, P.D., Fisk, A.T., Harcourt, R.G., Holland, K.N., Iverson, S.J., Kocik, J.F., Mills Flemming, J.E., and F.G. Whoriskey. 2015. Aquatic animal telemetry: a panoramic window into the underwater world. *Science*, 348(6240), 1255642.
[3]Tomkiewicz, S.M., Fuller, M.R., Kie, J.G., and K.K. Bates. 2010. Global positioning system and associated technologies in animal behaviour and ecological research. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 365(1550), 2163-2176.
[4]Cooke, S.J. 2008. Biotelemetry and biologging in endangered species research and animal conservation: relevance to regional, national, and IUCN Red List threat assessments. *Endangered Species Research*, 4(1-2), 165-185.
[5]Serrano, D. 2018. *Dispersal in raptors. Birds of Prey: Biology and Conservation in the XXI century*, 522pp.
[6]Mellone, U. 2013. *Movement ecology of long-distance migrants: insights from the Eleonora's falcon and other raptors*. 128pp.
[7]Batbayar, N., Yi, K., Zhang, J., Natsagdorj, T., Damba, I., Cao, L., and A.D. Fox. 2021. Combining tracking and remote sensing to identify critical year-round site, habitat use and migratory connectivity of a threatened waterbird species. *Remote Sensing*, 13(20), 4049.
[8]Moliner, V.U., Gil, M.R., and U. Mellone. 2015. *The use of satellite telemetry for the study of the movement ecology of raptors*. University of Alicante. 178pp.

and human activities on their populations.

Monitoring threats: Raptors face numerous threats, including habitat destruction, poisoning, and illegal hunting.[9] By tracking their movements, conservation practitioners can identify high-risk areas and take targeted actions to mitigate these threats.[10]

Enhancing species recovery programs: Satellite telemetry plays a vital role in safeguarding endangered species by enabling the monitoring of reintroduction efforts, evaluating the survival rates of released individuals, and informing strategic decisions to improve recovery efforts.[11]

[9]McClure, C.J., Westrip, J.R., Johnson, J.A., Schulwitz, S.E., Virani, M.Z., Davies, R., Symes, A., Wheatley, H., Thorstrom, R., Amar, A., Buij, R., Jones, V.R., Williams, N.P., Buechley, E.R., and S.H.M. Butchart. 2018. State of the world's raptors: Distributions, threats, and conservation recommendations. *Biological Conservation*, 227, 390-402

[10]Runge, C. and Tulloch, A.I. 2018. Solving problems of conservation inadequacy for nomadic birds. *Australian Zoologist*, 39(2), 280-295.

[11]Monti, F., Serroni, P., Rotondaro, F., Sangiuliano, A., Sforzi, A., Opramolla, G., Pascazi, A., Spacca, S., Civita, F.L., and M. Posillico. 2023. Survival of a small reintroduced griffon vulture population in the Apennines: insights from Global Positioning System tracking. *Avian Biology Research*, 16(1), 3-13.

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B. Outcomes of satellite telemetry studies

Revealing migration routes and stopover sites

Telemetry data have uncovered previously unknown migration routes and critical stopover sites that are essential for the survival of migratory raptors. Tracking studies have pinpointed key areas in Central Asia, the Middle East, and Africa where targeted conservation efforts have been concentrated for maximum impact.[12]

Discovering wintering and feeding grounds

The understanding of wintering grounds for many raptor species significantly improved with the introduction of satellite telemetry.[13] Understanding where these birds spend the non-breeding season allows for the protection of these areas from threats, such as habitat destruction and hunting.

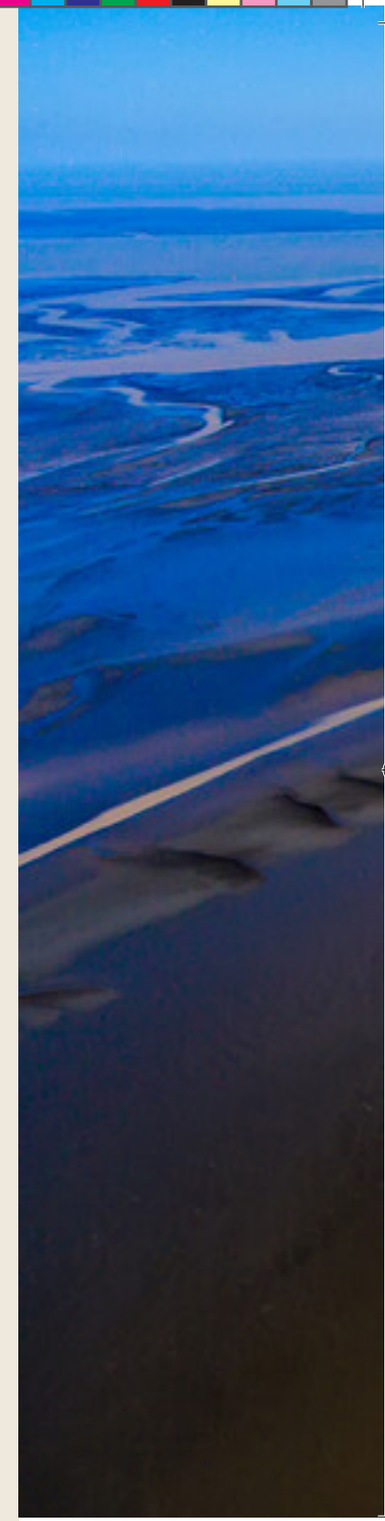
Assessing the impact of climate change on raptors

Telemetry data have provided evidence of how climate change is affecting raptor migration patterns, breeding timings, and habitat use.[14] This information is crucial for developing adaptive conservation strategies to mitigate these impacts.

Contributing to international conservation efforts

Satellite telemetry data have been instrumental in international conservation initiatives, such as the Convention on Migratory Species (CMS).[15] These data help coordinate conservation actions across countries and ensure the protection of migratory species along their entire flyways.

[12]Ram, M., Sahu, A., Tikadar, S., Gadhavi, D., Rather, T.A., Jhala, L., and Y. Zala. 2022. Home ranges and migration routes of four threatened raptors in Central Asia: Preliminary Results. *Birds*, 3(3), 293-305.
[13]Moliner, V.U., Gil, M.R., and U. Mellone. 2015. *The use of satellite telemetry for the study of the movement ecology of raptors*. University of Alicante. 178pp.
[14]Sullivan, A.R., Flaspohler, D.J., Froese, R.E., and D., Ford. 2016. Climate variability and the timing of spring raptor migration in eastern North America. *Journal of Avian Biology*, 47(2), 208-218.
[15]Hykle, D. 2002. The Convention on Migratory Species and other international instruments relevant to marine turtle conservation: pros and cons. *Journal of International Wildlife Law and Policy*, 5(1-2), 105-119.



About stopover sites

Stopover sites are locations where birds stop, rest, and replenish their energy reserves during their movement within their habitat. These sites depend on resource availability and landscape related factors. The ecological variability, along with weather and a bird's condition, determines how a particular stopover site will contribute to its habitat utilization or its ability to perform long-distance flights over barriers or to a final destination. Following terminologies have been used to denote the function of each type of stopover site[16]:

1. **Fire escapes:** These sites are not frequently used, but are extremely important in emergency situations, similar to fire escapes in human habitats. Fire escape sites are usually located near significant barriers, such as large bodies of water, deserts, or heavily altered landscapes. They are typically small and isolated habitat patches surrounded by unusable habitat. The resources available at these sites may be too low to allow birds to replenish fat stores or recover muscle mass, but the stop allows them to survive and continue migrating from the site.
2. **Convenience stores:** These sites are relatively small and isolated, allowing birds to briefly rest (i.e., stopover of two days or less) and easily replenish fat, muscle, or both. The ideal convenience store is structurally heterogeneous, contains fresh water, and offers a variety of food resources. Protection, restoration, and habitat management efforts are being implemented to encourage compatible use and establish networks of convenience store sites that fill gaps between large protected sites.
3. **Full-service hotels:** These sites are large areas mostly covered with forests, providing abundant resources such as food, water, and shelter for many species. Birds can stay at these sites for several days as they can easily find all resources that they need and the risks are low. This allows them to be in their best physical condition before moving on. Full-service hotels may not experience significant changes in resource availability due to their size and diversity, which reduces competition.

[16]Mehlman, D.W., Mabey, S.E., Ewert, D.N., Duncan, C., Abel, B., Cimprich, D., Sutter, R.D., and M. Woodrey. 2005. Conserving stopover sites for forest-dwelling migratory landbirds. *The Auk*, 122(4):1281–1290, Available at: https://doi.org/10.1642/0004-8038(2005)122[1281:CSSFFM]2.0.CO;2 [Accessed 30 September 2024].

2

SATELLITE TELEMETRY STUDY IN UTTARAKHAND

WWF-India and the Uttarakhand Forest Department (UKFD) conducted a pilot exercise to trap a total of five individuals of three species of raptors and tag them with Platform Transmitter Terminals (PTTs or satellite tags). The study aimed to track the movement patterns of the raptors, locate their nesting, roosting, and feeding sites, and assess the safety of these sites for the raptors.

The selection of the raptor species was based on their distribution in the study area, breeding grounds, available scientific literature, and the current conservation needs, as identified by the latest IUCN status and trends from The State of India's Birds (SoIB) report.

PLANNING

The initial capture and tagging exercise was planned to be conducted at Rajaji Tiger Reserve and Corbett Tiger Reserve of Uttarakhand

Survey was conducted in

Rajaji Tiger Reserve (RTR)
Corbett Tiger Reserve (CTR)
in
March-April 2023

to ascertain the presence of our target species in the study area and identify potential trapping locations.

After finalizing the locations, tagging exercise was conducted

1st site

2023
26th October to 17th November
in
Corbett Tiger Reserve (CTR)

2nd site

2024
5th March to 16th April
in
Rajaji Tiger Reserve (RTR)

Target Species

White-rumped vulture
Gyps bengalensis

CR

Red-headed vulture
Sarcogyps calvus

CR

SoIB STATUS
Rapid Decline

EN

Egyptian vulture
Neophron percnopterus

Approach: usage of traps

Expert trappers were responsible for both, the selection of the traps and execution of the task, drawing upon their expertise using the following capture techniques

TRAPS

Noose Trap

Snake Trap

Deccan Trap

Balchhatri Trap

Clap Trap

STEP BY STEP PROCESS OF CAPTURING AND TAGGING

1. Scanning for the target raptor species

2. Placing traps to capture the birds

3. Restraining the captured bird

4. Clinical and morphological examination & deploying the satellite tag

5. Release of the tagged bird

WHERE ARE THEY

NOW

Regular tracking of the tagged vultures remotely and on-ground monitoring indicated that they frequently visited certain locations, forming location clusters.

CLUSTERS

When a satellite-tagged bird creates cluster patterns where the bird remains in a confined area for an extended period, several vital pieces of information can be revealed by doing ground truth surveys. In this study, most of the tagged birds formed clusters or close affinity with some areas, which were identified using satellite data.

White-rumped vulture

Satellite tag no. 233774

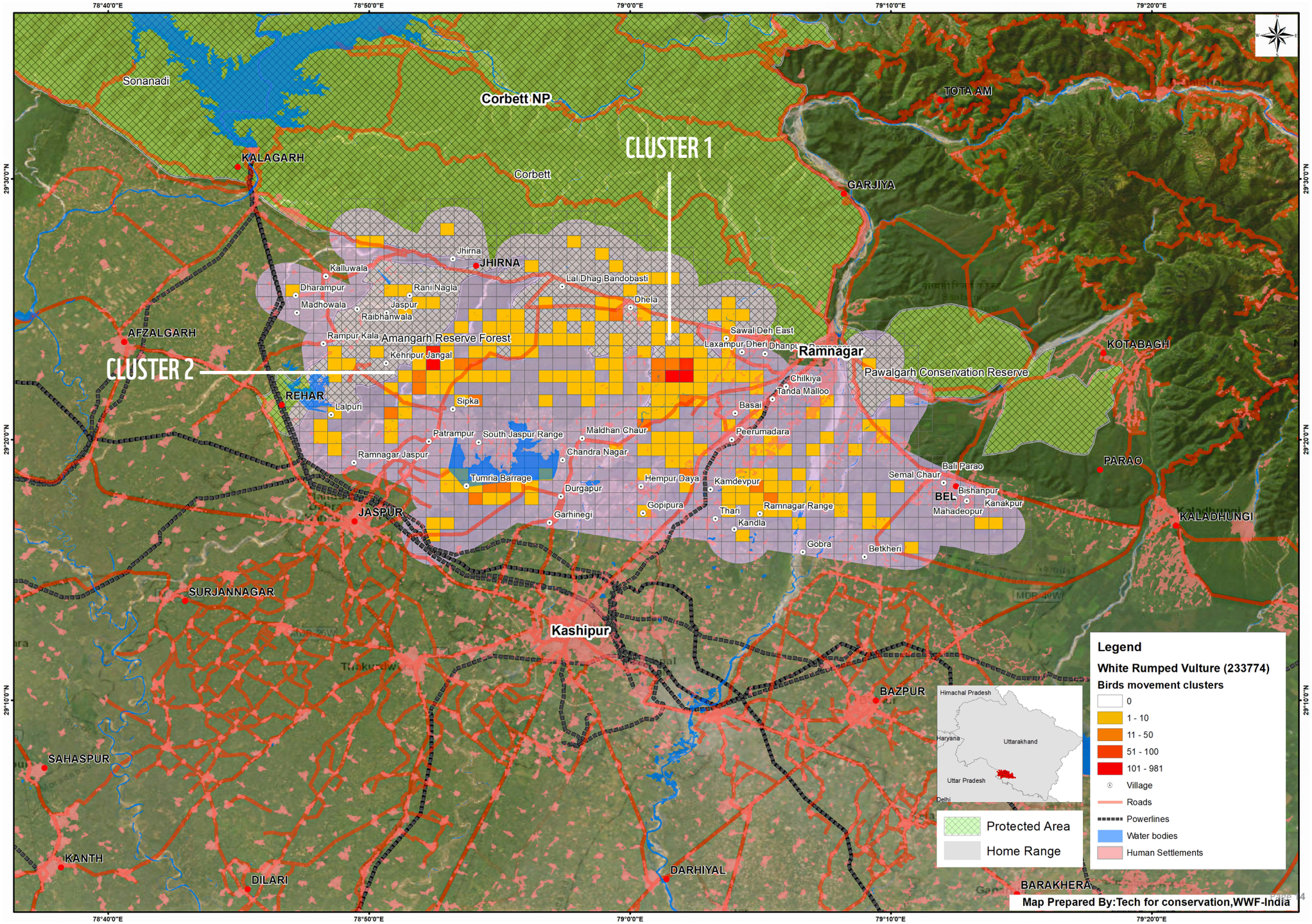
Cluster 1

Location	Dhela Range, Corbett Tiger Reserve, located at 29°24’56.18”N and 78°59’37.90”E, with an elevation of 345 m above sea level, covering an area of approximately 11.73 sq.km
Habitat	Mixed forest type; mainly covered with *Sal* forest along with some large *Semal* and teak plantations.
Nearby water bodies	*Dhela* and *Sawaldeh* rivers, *Tumaria* Dam
Socio-economic aspects	Communities practicing agriculture live within 20 km of the location. Outside the protected area, there are around eight *Gujjar khattas*, each holding 800-1000 cattle. The major income source of the *Gujjar* community is from farming and dairy.
Significance of the site for the tagged bird	The site is home to a nesting colony of white-rumped vultures, with approximately 15 active nests and 50-60 individuals. The vultures are sustained by deceased livestock from nearby *Gujjar* settlements.

Cluster 2

Location	Amangarh Tiger Reserve, located at 29°34'00"N and 78°37'00"E, covering an area of approximately 95 sq.km
Habitat	Mixed forest type, mainly covered with *Sal* forest and teak plantations.
Nearby water bodies	Perennial streams and the *Pili* Dam reservoir.
Socio-economic aspects	Outside the protected area, there are approximately 4 to 5 *Gujjar* settlements, each housing 300 to 500 cattle.
Significance of the site for the tagged bird	Approximately 40-50 white-rumped vultures, 20 Egyptian vultures, and 3-4 red-headed vultures reside at this site.* Dead livestock from nearby *Gujjar* settlements consistently provide food for the vultures.

*Based on a survey by WWF-India of the site conducted during on-ground tracking of the tagged vulture in April 2024.


CLUSTER 1
CLUSTER 2
Corbett NP
Corbett
Amangarh Reserve Forest
Pawalgarh Conservation Reserve
Sonanadi
KALAGARH
AFZALGARH
REHAR
JHIRNA
Jhirna
Kalluwala
Dharampur
Rani Nagla
Madhowala
Jaspur
Raibhanwala
Rampur Kala
Kehripur Jangal
Lal Dhag Bandobasti
Dhela
Sawal Deh East
Laxampur Dheri
Dhanpur
Ramnagar
Chilkiya
Tanda Malloo
Basai
Lalpuri
Sipka
Patrampur
South Jaspur Range
Maldhan Chaur
Peerumadara
Ramnagar Jaspur
Chandra Nagar
Tumria Barrage
Hempur Daya
Kamdevpur
Durgapur
Gopipura
Thari
Ramnagar Range
Garhinegi
Kandla
Gobra
Betkheri
Semal Chaur
Bali Parao
Bishanpur
Kanakpur
Mahadeopur
BEL
JASPUR
SURJANNAGAR
Kashipur
BAZPUR
SAHASPUR
KANTH
DILARI
DARHIYAL
BARAKHERA
TOTA AM
GARJIYA
KOTABAGH
PARAO
KALADHUNGI
78°40'0"E
78°50'0"E
79°0'0"E
79°10'0"E
79°20'0"E
29°30'0"N
29°20'0"N
29°10'0"N
Legend
White Rumped Vulture (233774)
Birds movement clusters
0
1 - 10
11 - 50
51 - 100
101 - 981
Village
Roads
Powerlines
Water bodies
Human Settlements
Himachal Pradesh
Haryana
Uttarakhand
Uttar Pradesh
Delhi
Protected Area
Home Range
Map Prepared By:Tech for conservation,WWF-India

Egyptian vulture

Satellite tag no. 233775

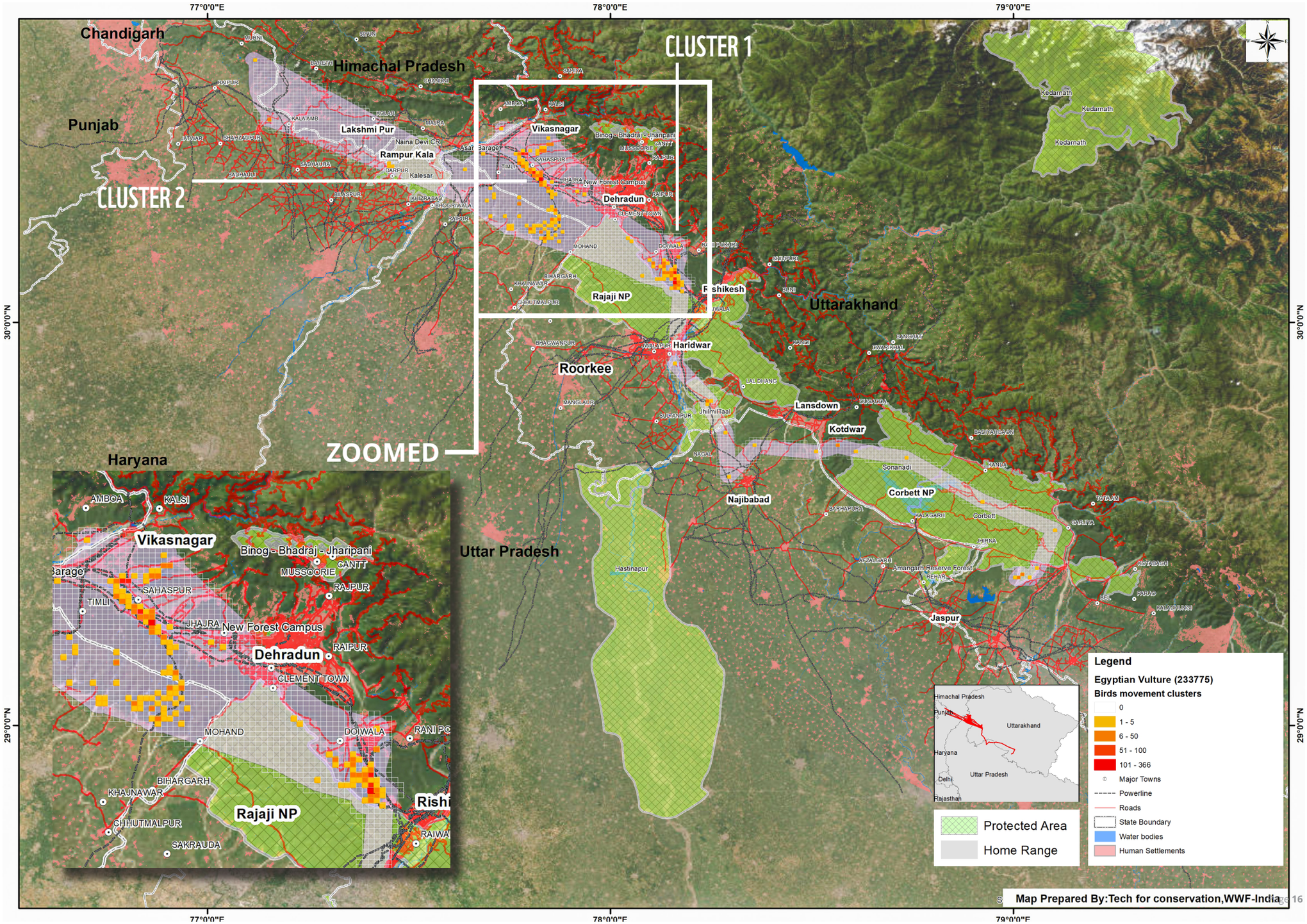
Cluster 1

Location	Langha road carcass disposal site located at 30°25’14.38”N and 77°47’15.59”E, with an elevation of 492 m above sea level, covering an area of approximately 3.5 sq.km
Habitat	The area primarily comprises tropical dry deciduous vegetation, scrubland, and rivers, surrounded by roads, national highways, villages, and agricultural fields. High-voltage electricity transmission lines and power pylons traverse the area.
Nearby water bodies	The seasonal river *Sheetla* flows alongside the carcass disposal site, covering 65% of the total area of the site.
Socio-economic aspects	The site is located 31 km from Dehradun and is adjacent to the suburban regions of Vikas Nagar, Herbertpur, and Sahaspur in Dehradun. The local community primarily depends on agriculture, including cattle rearing for dairy production, and there are a few industries manufacturing shoes, plastic, and medicine, nearby.
Significance of the site for the tagged bird	Every day, about 4-5 livestock carcasses from the Pachwa Doon area and surrounding suburban regions are disposed of at this site. This provides a regular food supply for 24 raptor species, including over 100 Egyptian vultures.* These raptors are known to perch on the power transmission lines, which poses a threat of electrocution.

Cluster 2

Location	Majri Grant carcass disposal site, located at 30°06’49.18”N and 78°09’32.58”E, with an elevation of 484 m above sea level, covering an area of approximately 4.0 sq.km
Habitat	The area primarily consists of scrubland and rivers, surrounded by roads, national highways, villages, and agricultural fields. High-voltage electricity transmission lines and power pylons traverse the area.
Nearby water bodies	The seasonal river known as *Jakhan Rao* flows alongside the animal carcass disposal site.
Socio-economic aspects	The site is surrounded by the suburban areas of Doiwala, Ranipokhari, and Chhiderwala in Dehradun. The area is fairly well-developed with several industries, tourist hotels, and a large housing colony nearby. The local population mainly depends on the industry and tourism.
Significance of the site for the tagged bird	Every day, approximately 3-4 livestock carcasses from nearby suburban areas are disposed of at this site. These carcasses serve as the food source for 120-130 Egyptian vultures that roost in this area.* Since there is limited vegetation and no large trees, the vultures use high-tension powerline pylons for roosting, which significantly increases the risk of electrocution and collision.

*Based on a survey by WWF-India of the site conducted during on-ground tracking of the tagged vulture in January 2024.

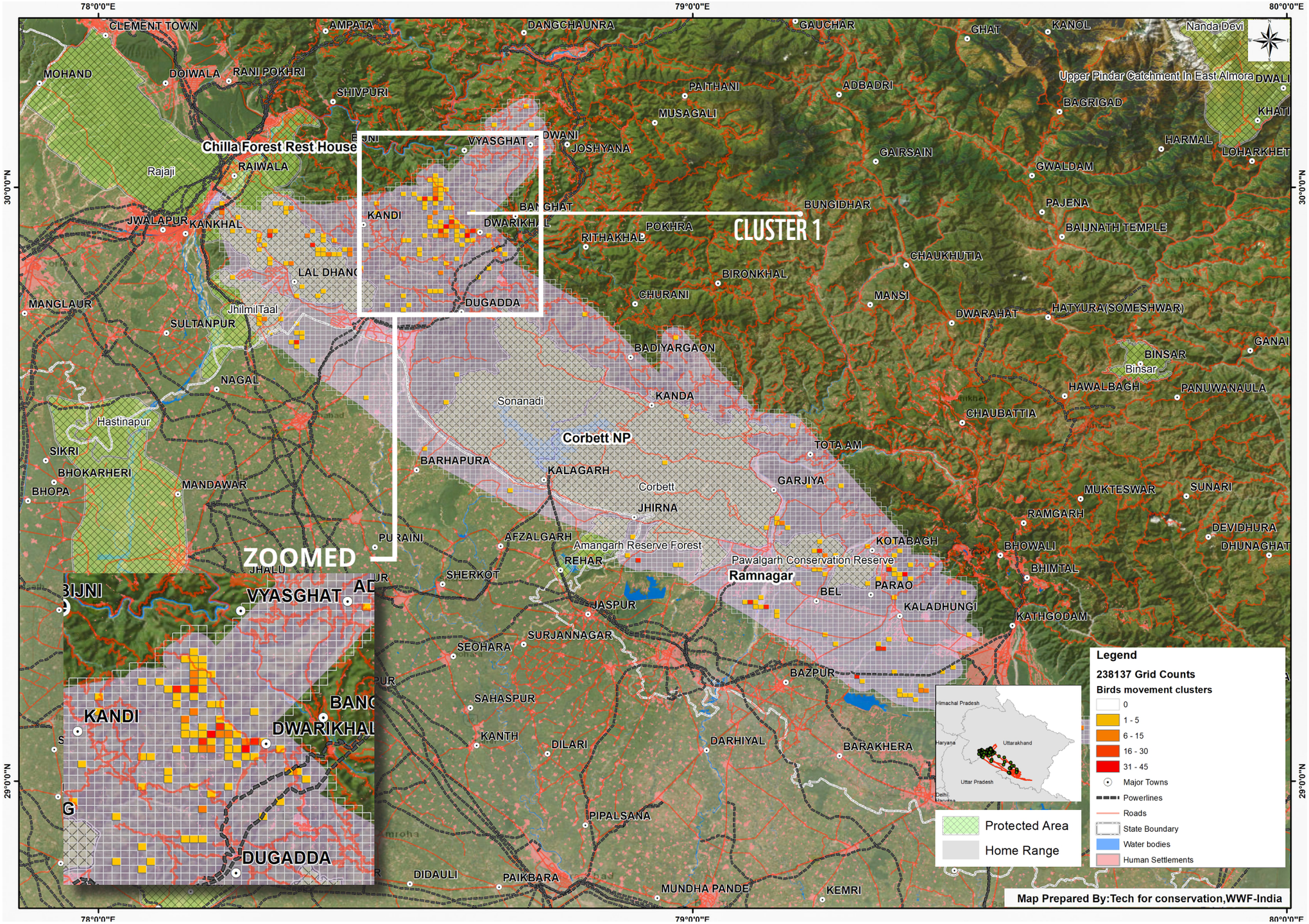


Red-headed vulture

Satellite tag no. 238137

Cluster 1

Location	Silogi range, located at 29°59’14.52”N and 78°32’49.11”E, with an elevation of 1800 m above sea level, covering an area of approximately 1.36 sq.km
Habitat	The area consists mainly of forested areas in the Lansdowne Forest Division, characterized by temperate forest. Key vegetation includes *Chir* pine, *Sal,* and *Banj* oak trees.
Nearby water bodies	Seasonal and perennial streams from the Himalayan mountain range traverse the area.
Socio-economic aspects	The area is sparsely populated with only a few scattered villages such as *Pujaldi, Koti Bali, Dhungali, and Kakhwari*. The local people mainly depend on cattle rearing and small-scale farming.
Significance of the site for the tagged bird	Due to the shy nature of the red-headed vulture, it prefers sparsely populated areas for roosting and nesting. The tagged bird covered an area of approx. 10 sq. km. per day to find food and roosting sites.


78°0'0"E
79°0'0"E
80°0'0"E
30°0'0"N
29°0'0"N
CLEMENT TOWN
AMPATA
DANGCHAUNRA
GAUCHAR
GHAT
KANOL
Nanda Devi
MOHAND
DOIWALA
RANI POKHRI
SHIVPURI
PAITHANI
ADBADRI
Upper Pindar Catchment In East Almora
DWALI
BAGRIGAD
KHATI
MUSAGALI
Chilla Forest Rest House
VYASGHAT
JOSHYANA
HARMAL
LOHARKHET
GAIRSAIN
Rajaji
RAIWALA
GWALDAM
KANDI
BUNGIDHAR
PAJENA
JWALAPUR
KANKHAL
DWARIKHAL
POKHRA
CLUSTER 1
BAIJNATH TEMPLE
RITHAKHAL
CHAUKHUTIA
LAL DHANG
BIRONKHAL
CHURANI
MANSI
MANGLAUR
DUGADDA
DWARAHAT
HATYURA(SOMESHWAR)
JhilmilTaal
SULTANPUR
BADIYARGAON
GANAI
BINSAR
Binsar
NAGAL
HAWALBAGH
PANUWANAULA
Sonanadi
KANDA
CHAUBATTIA
Hastinapur
Corbett NP
SIKRI
TOTA AM
BARHAPURA
KALAGARH
BHOKARHERI
GARJIYA
Corbett
MUKTESWAR
SUNARI
BHOPA
MANDAWAR
JHIRNA
RAMGARH
DEVIDHURA
PURAINI
AFZALGARH
Amangarh Reserve Forest
KOTABAGH
DHUNAGHAT
ZOOMED
REHAR
Pawalgarh Conservation Reserve
BHOWALI
JHALU
SHERKOT
Ramnagar
BHIMTAL
BIJNI
VYASGHAT
PARAO
BEL
JASPUR
KALADHUNGI
KATHGODAM
SURJANNAGAR
SEOHARA
BAZPUR
SAHASPUR
KANDI
DWARIKHAL
KANTH
DILARI
DARHIYAL
BARAKHERA
PIPALSANA
DUGADDA
DIDAULI
PAIKBARA
MUNDHA PANDE
KEMRI
Himachal Pradesh
Haryana
Uttarakhand
Uttar Pradesh
Delhi
Protected Area
Home Range
Legend
238137 Grid Counts
Birds movement clusters
0
1 - 5
6 - 15
16 - 30
31 - 45
Major Towns
Powerlines
Roads
State Boundary
Water bodies
Human Settlements
Map Prepared By:Tech for conservation,WWF-India

DISCUSSION

The state of Uttarakhand is committed to conducting additional satellite telemetry of raptors to identify key stopover sites. This would enable the implementation of strategic management interventions to minimise threats at the identified stopover sites located outside protected areas (Case Study). Conservation efforts are complicated by the involvement of various stakeholders, multiple jurisdictions, complex ecological processes, and diverse bird habitats outside protected areas. While high-quality data may be available for several resource management areas, the decision-making process often struggles to effectively analyse, integrate, query, and synthesise this data to support management and restoration efforts.

Decision support system defined

Decision support system (DSS) have gained traction in natural resource management due to three important trends that are changing the way Protected Area managers address natural resource issues. Firstly, natural resource decisions are often at the center of intense economic, political, legal, and value conflicts. Secondly, the complexity of managing animals, plants, and other natural resources is increasing, and there is a massive volume of scientific information available regarding species-habitat relationships. They need efficient tools to summarize, analyze, and integrate the emanated information from different studies. Thirdly, technologies are now available to incorporate knowledge and expertise into ecological models. The primary role of DSS is to assist managers of protected areas in formulating relevant management questions and making decisions in situations where human judgment is a crucial factor in the problem-solving process (figure 1).

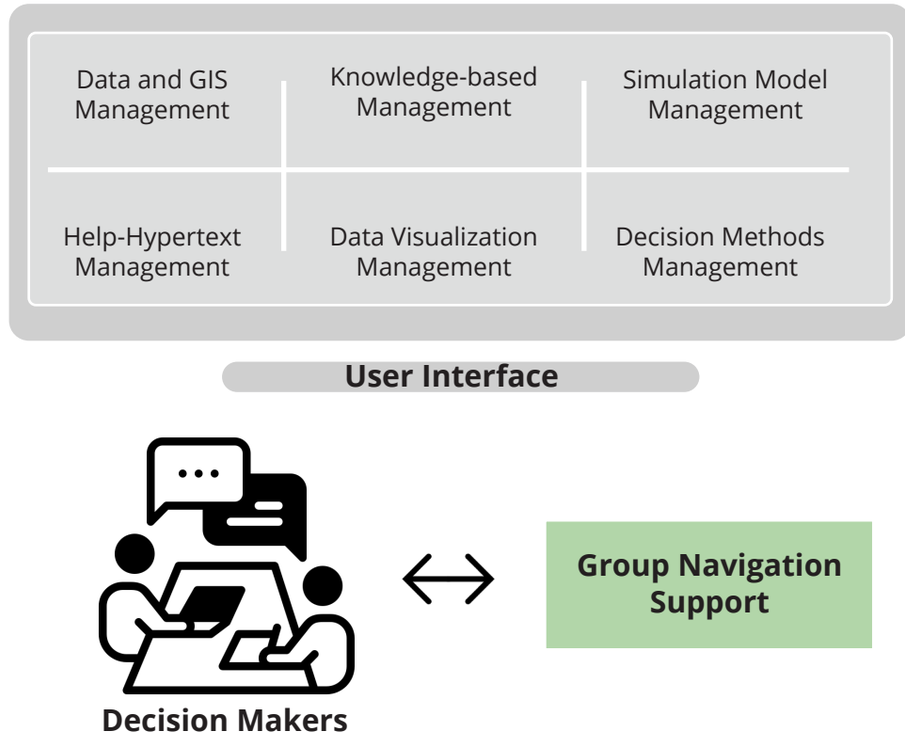


Figure 1: Major components of a generic decision support system

The DSS provide a process for organizing existing geographical, physical, and biological data for better management of natural resources. They are interactive, computer-based tools that use information and models to improve the process or outcome of decision-making through:

Analysis and visualization of management alternatives and their effects

Assimilation of available knowledge and data into the decision-making process

Assessment of the level of certainty of different predictions. Decision support tools organize disparate data by linking the data layers and the geographical context of the data.

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Raptor Conservation Planning

Figure 2 provides an outline for planning a DSS to support raptor and other wildlife conservation efforts in the state. It identifies five priority research areas: (1) life history, populations, and ecology; (2) habitat/environment; (3) integration of ecological information; (4) conservation planning; and (5) communication of ecological information.

A DSS that integrates research results, management activities, and monitoring can create a coherent system, enabling an adaptive management approach where lessons learned from past activities can improve future management. Implementing this operational framework could significantly advance avian conservation efforts in the State of Uttarakhand.

Thematic areas for decision-making to support management and restoration efforts

Informed habitat protection

- Habitat understanding and management
- Prioritise areas for protection
- Expand new Protected Areas based on the significance

Transboundary collaboration

- MoU between GOs/ NGOs for conservation, e.g., Raptors MoU, CMS
- Development & implementation of action plans

Adaptive management

- Identify and address critical conflicts, e.g., mitigation measures at power transmission lines
- Rapid response to ecological changes

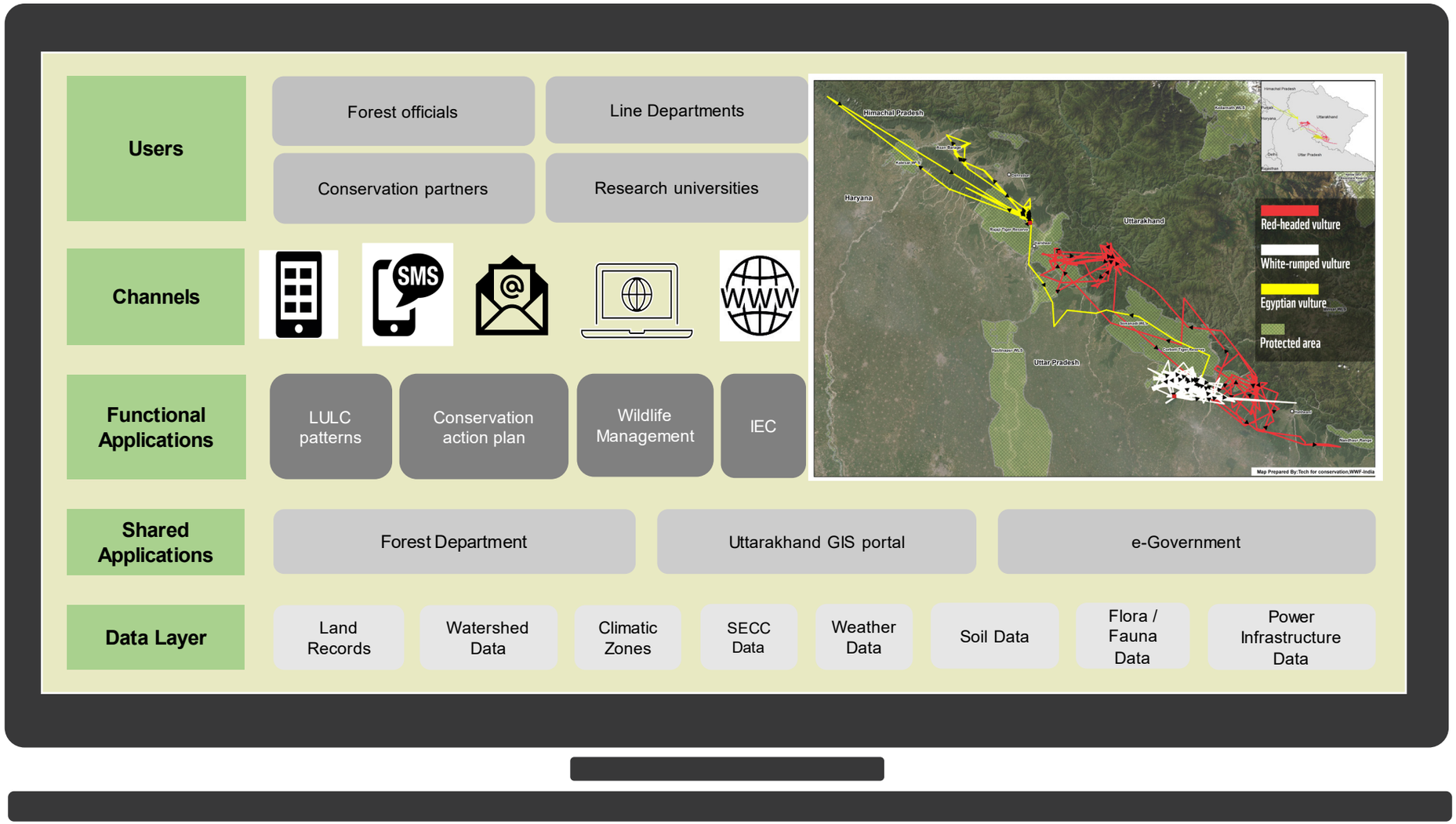

Figure 2: An illustrative architecture of technology-driven solutions to create decision support system

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