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中国科学院昆明动物研究所
KUNMING INSTITUTE OF ZOOLOGY
CHINESE ACADEMY OF SCIENCES

Application of space—ground—eDNA integrated technology for wildlife monitoring and research in the Gaoligong Mountain Region

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24th September 2025, Hangzhou

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Key topics

- What makes GLG Mountains so special?
- How to capture full spectrum of biodiversity information?
- What we have done in GLG mountains?
- Research highlights

What makes GLG Mountains so special?

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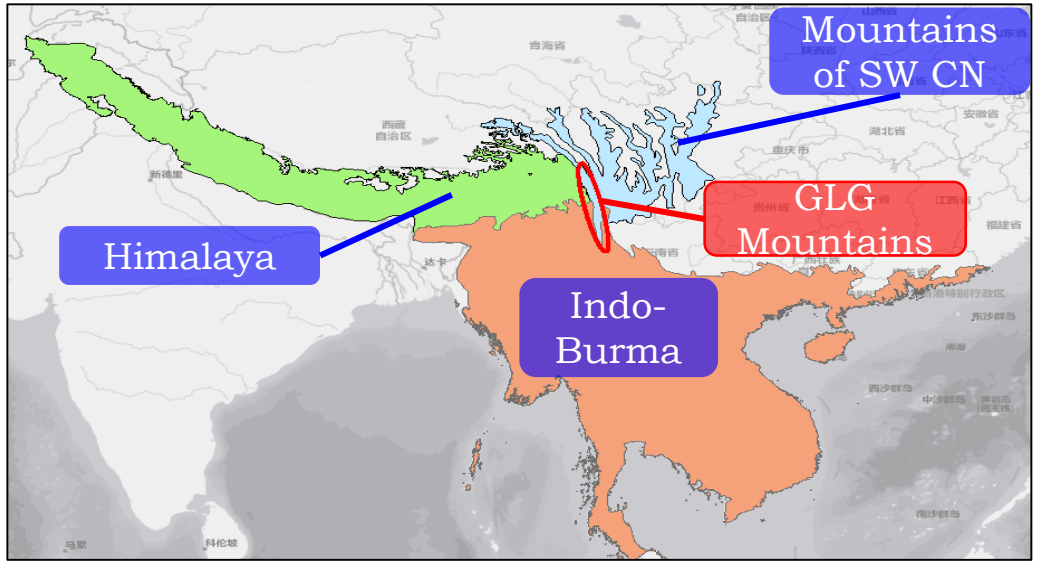
Ecological significance

- spans three globally significant **biodiversity hotspots:** the Himalayas, Indo-Burma, and the Mountains of Southwest China
- acting as a critical **front-line for ecological security** in southwestern China
- Extraordinary biodiversity: **home to about 37% of China's vertebrates**



高黎贡山
国家级自然保护区
GAOLIGONGSHAN NATIONAL NATURE RESERVE

Unique position contributes immensely to its extraordinary biodiversity

How to capture full spectrum of biodiversity?

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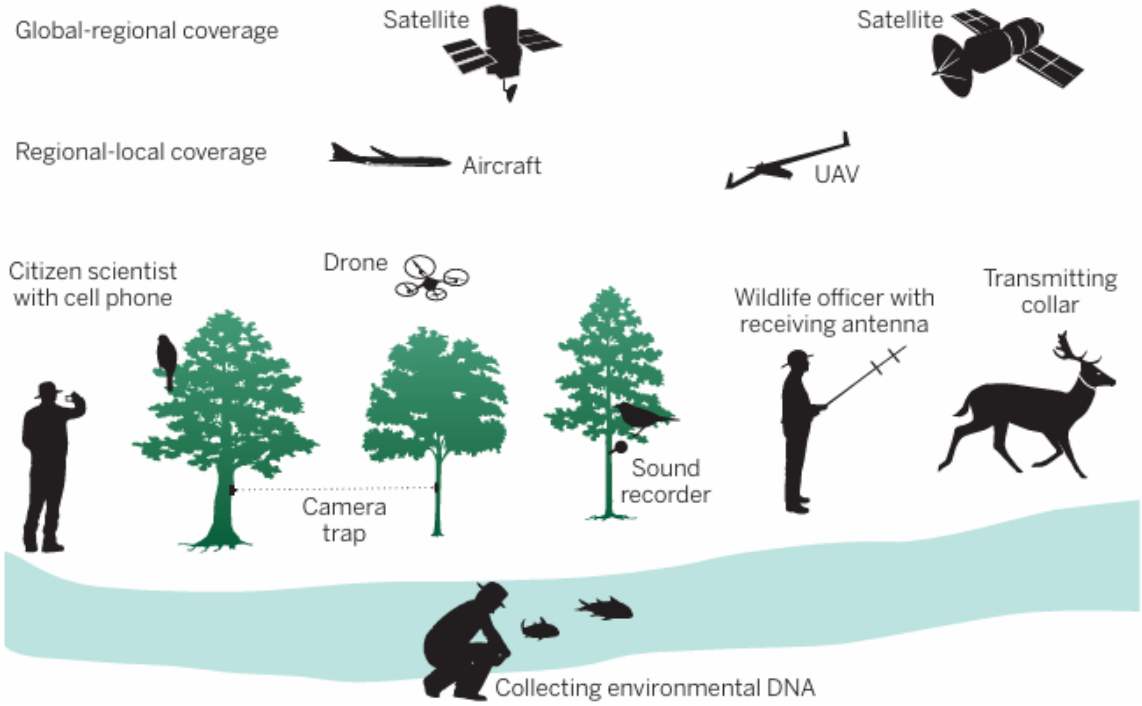
- **Tools**
  - field observation: plot (point) sampling, line transect, live trap……
  - remote sensing: satellite, drone, camera-trap survey, passive acoustic monitoring……
  - eDNA
- **Limitations**
  - false positive/negative
  - efficiency

Woody et al., 2014 Science



- We need to integrate multiple technologies to capture full spectrum of biodiversity information

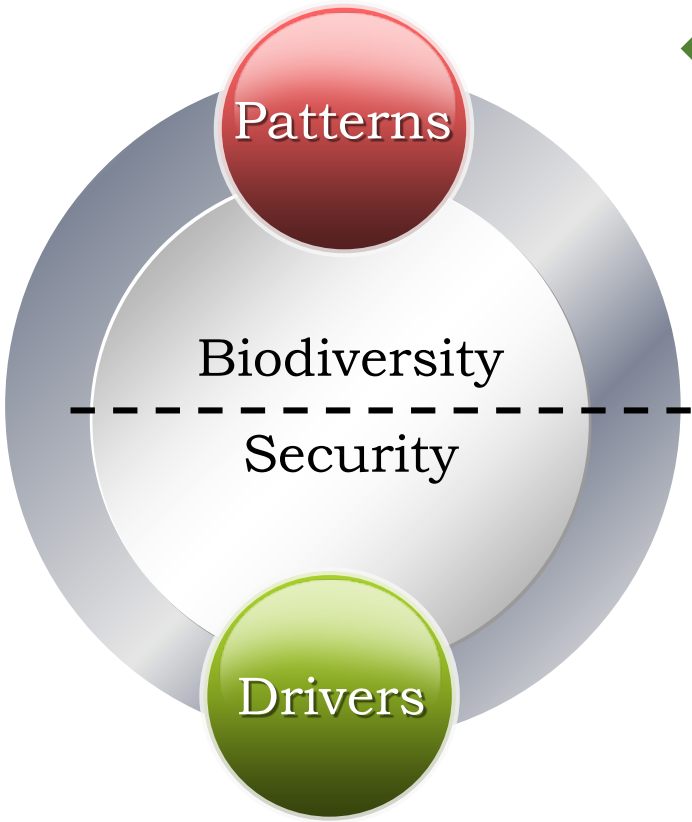
What we have done in GLG Mountains?

- **Targets groups**
  - wildlife: mammals, birds, reptiles, amphibians, fishes and insects
  - human activities: land use, human presence
- **Objectives**
  - establish GLG research centre: concentrate resources and efforts for biodiversity research in the critical region
  - construct systematic monitoring network: accumulating long-term in situ observational dataset to **support data intensive research**
  - understand diversity and distribution patterns of animals to inform effective conservation strategies

Effort 1: Establishment of GLG Lab

Yunnan Key Laboratory of Biodiversity and Ecological Conservation of Gaoligong Mountain

- **Mission:** to inform ecological conservation based on insights into biodiversity patterns



- **Patterns and changes**
  - species inventory, distribution and dynamics
  - response to environmental changes and humans

- **Conservation and management**
  - biodiversity hotspots
  - drivers of biodiversity loss

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Organizational framework:

KIZ Lab

- Established since 2021
- Affiliated institutes:

Kunming Institute of Zoology (KIZ), CAS

Yunnan Academy of Forestry and Grassland

Lab Director:

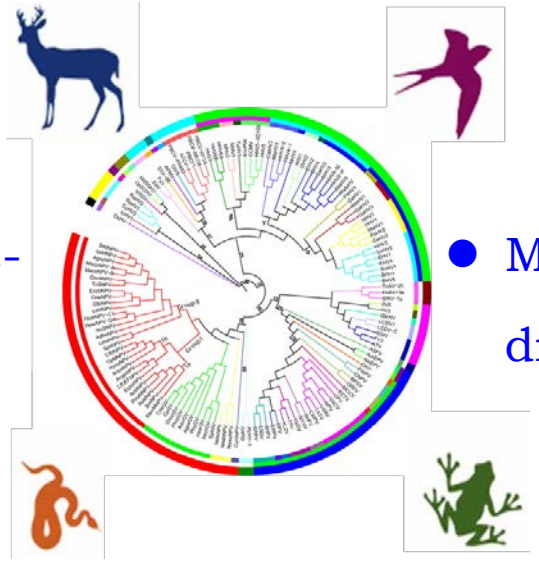
Prof. Che, Jing

KIZ, CAS

Academic Director:

Prof. Wei, Fuwen

IOZ, CAS



- Cross-taxon
- Multi-dimensional

- comprises 41 permanent staff members

Effort 2: Construction of monitoring network

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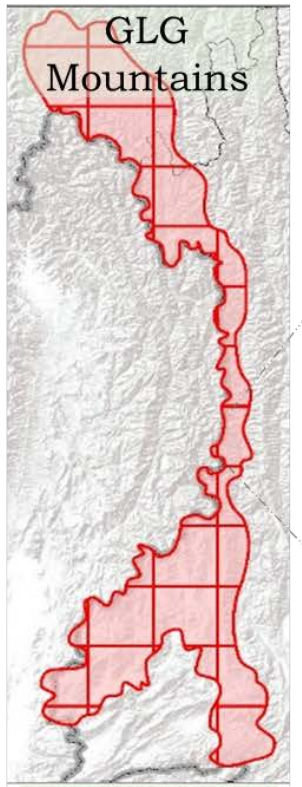
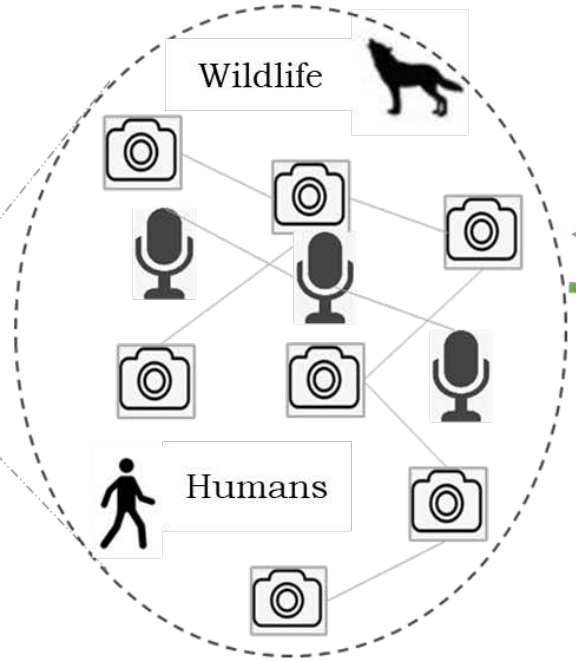
In situ observational systems



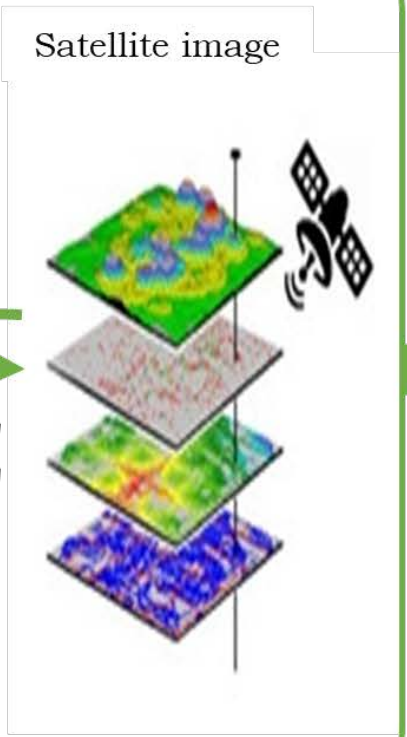
0.5° lat/lon grids



Monitoring network

格局

人为压力



Habitat analysis

Scientific dataset

Patterns and changes

Understand data

Goal: Generate datasets, understand biodiversity patterns, inform conservation efforts

Effort 2: Construction of monitoring network

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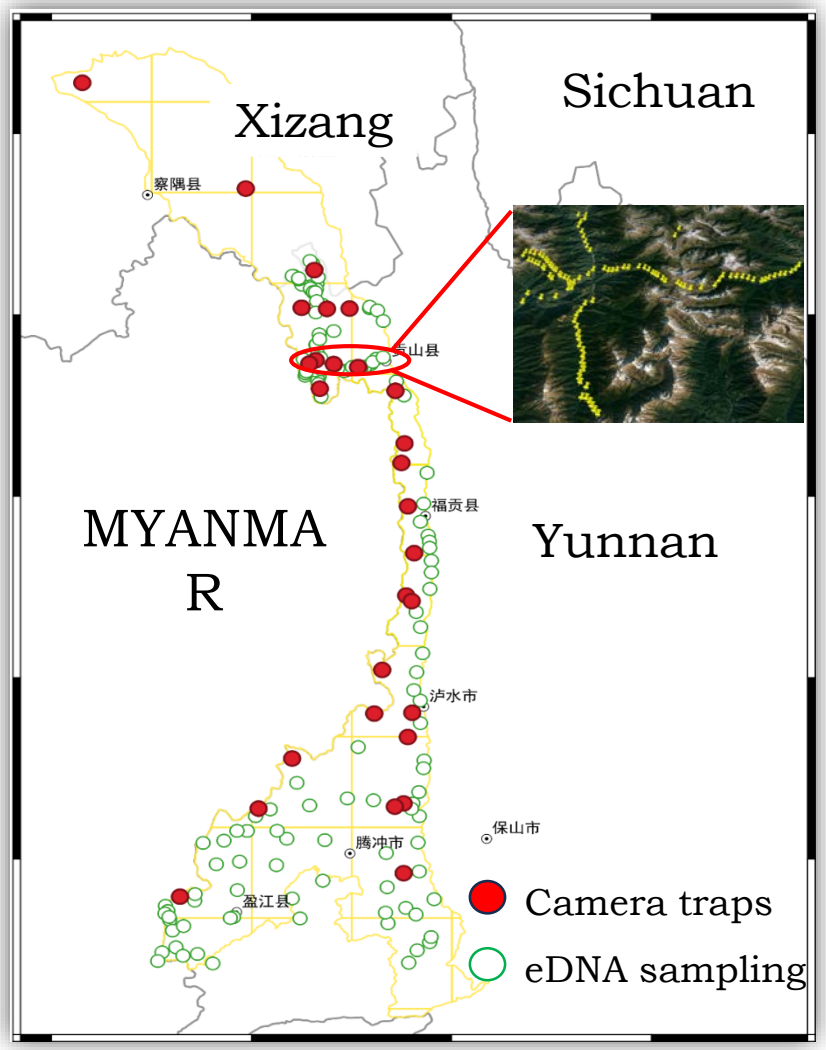

Since 2016:

- Camera trapping stations: 695
- Wildlife images: 1 million+
- Human presence: 100 thousands
- Large animals: 84 species
- At-risk species: 52 (62 %)

- Water samples: 689
- Vertebrate species: 397
- At-risk species: 55 (16 %)

Integrated network to complement different monitoring methods and improve efficiency

Biodiversity monitoring data management and Visualization Platform

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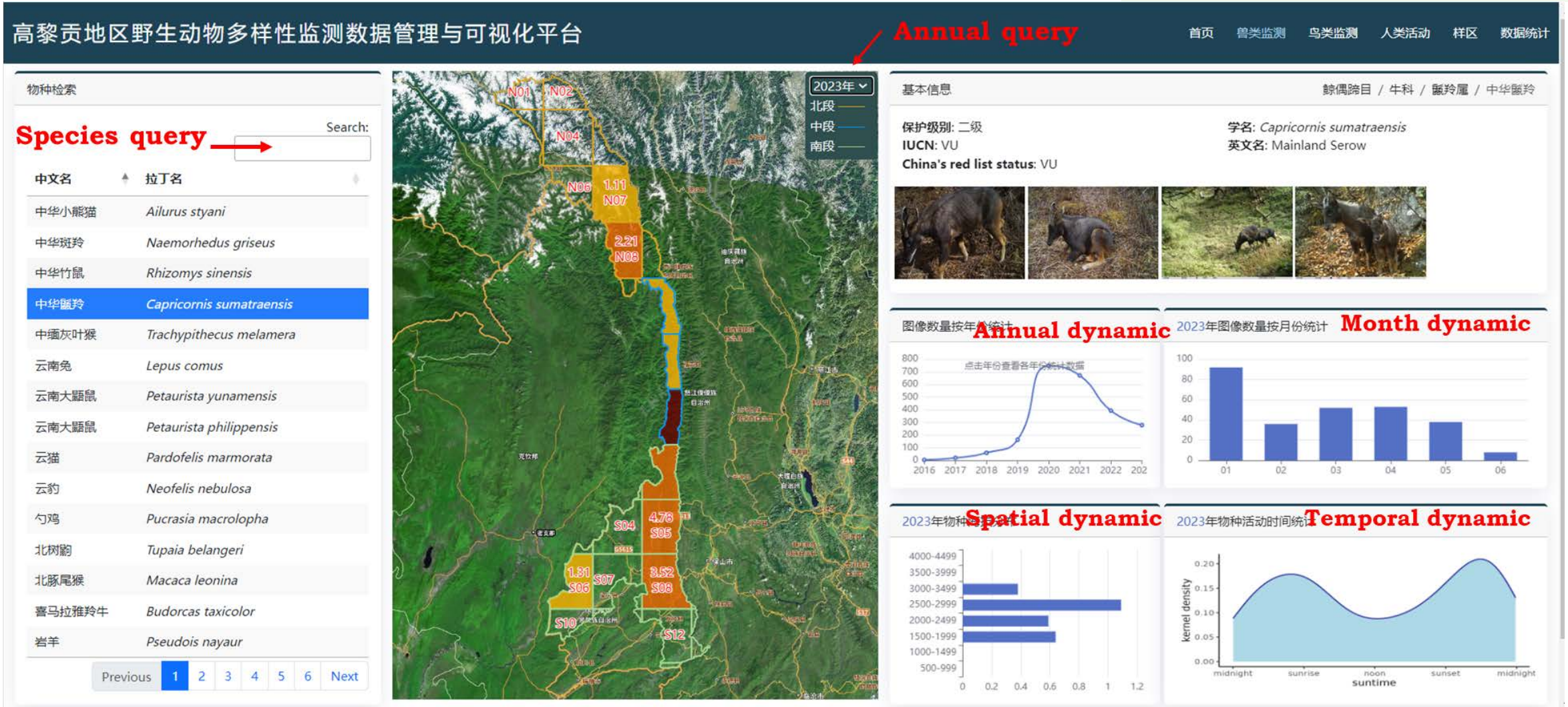
Current version only in Chinese

https://glg.ewildlife.kiz.ac.cn/



Support for data management, analysis, and dissemination efforts, making our findings accessible

Effort 3: Biodiversity inventory

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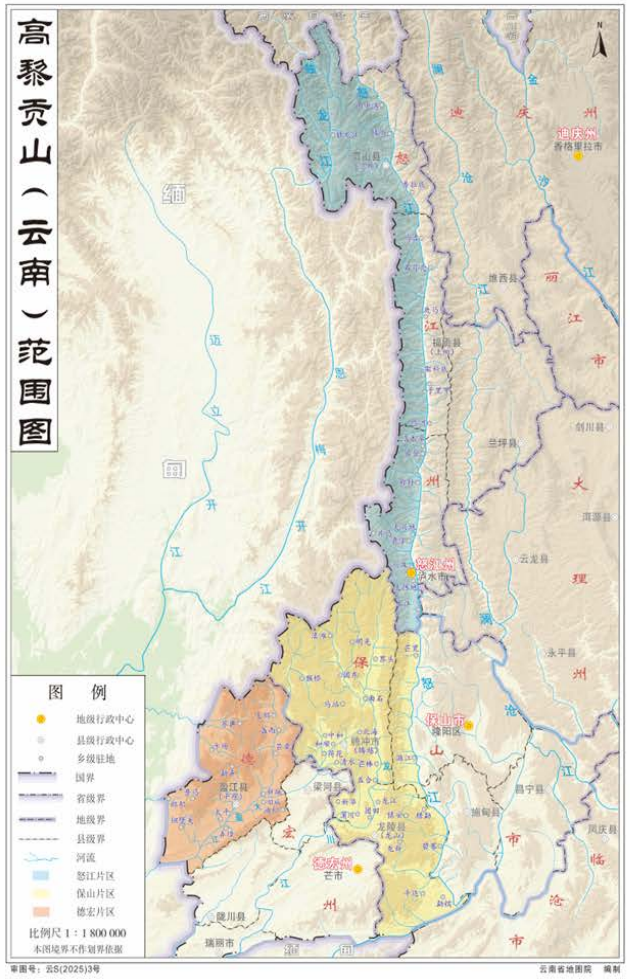
1959-1960
First survey

Second survey
1981-1985

Third survey
2009-2012

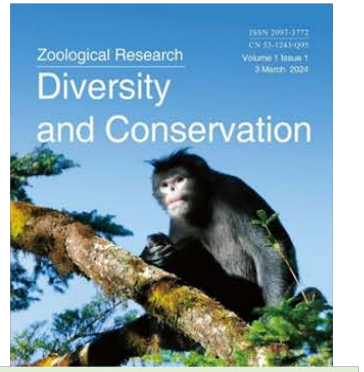
Fourth survey
2015-2021

Ongoing
2022-2025



GLG Integrated Scientific Investigation and Research (2023)

- Indigenous vertebrate: **1065**
  - Mammals: 204
  - Birds: 753
  - Reptiles: 53
  - Amphibians: 52



Special Issue on GLG Biodiversity (2024)

- Indigenous vertebrate: **1199**
  (37 % of China's vertebrates)
  - Mammals: 212
  - Birds: 796
  - Reptiles: 107
  - Amphibians: 84

Ongoing discovery highlights the richness of the region

Publish a series of books on GLG biodiversity

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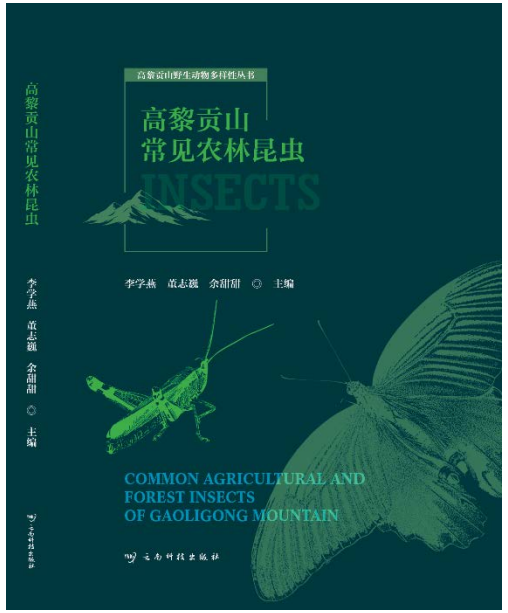
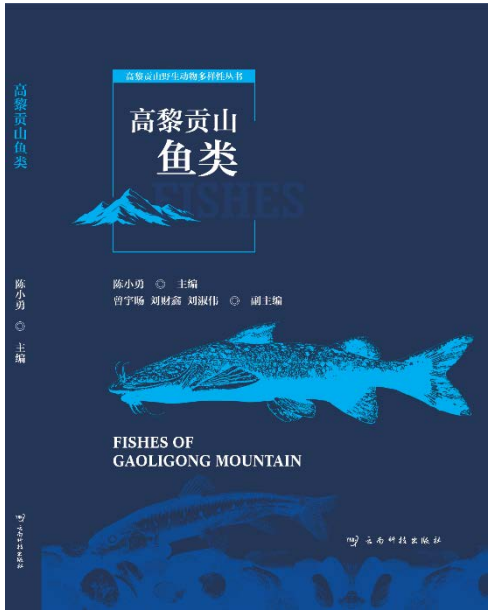
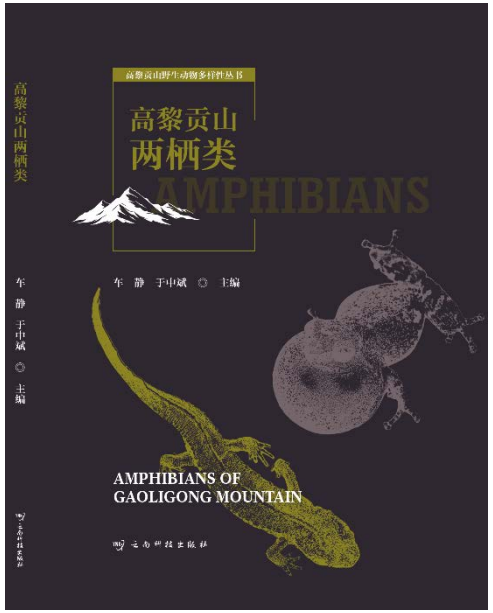
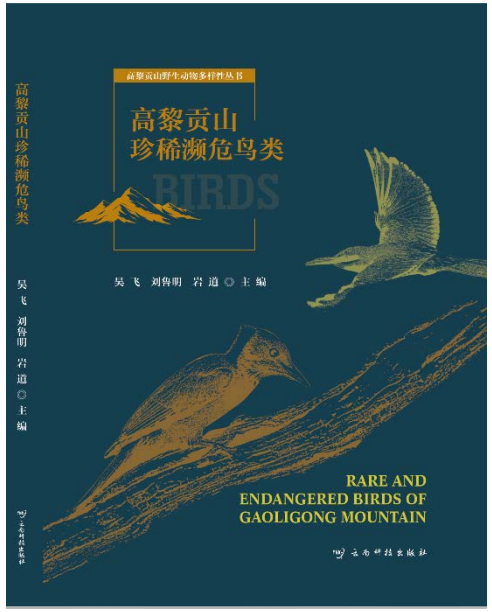
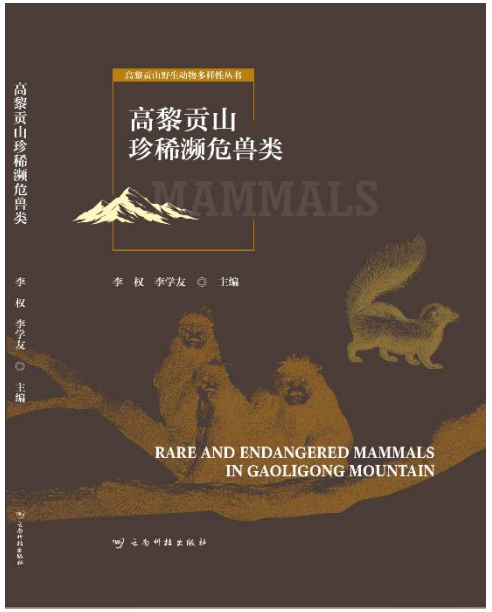
Field guide to GLG animals comprising 999 species











474 Vertebrate species: 146 fishes, 78 amphibians, 180 threatened birds and 70 threatened mammals; 525 common agricultural and forest insects

These publications are crucial for researchers, conservation practitioners, and the public

Efforts 4: Understanding biodiversity patterns

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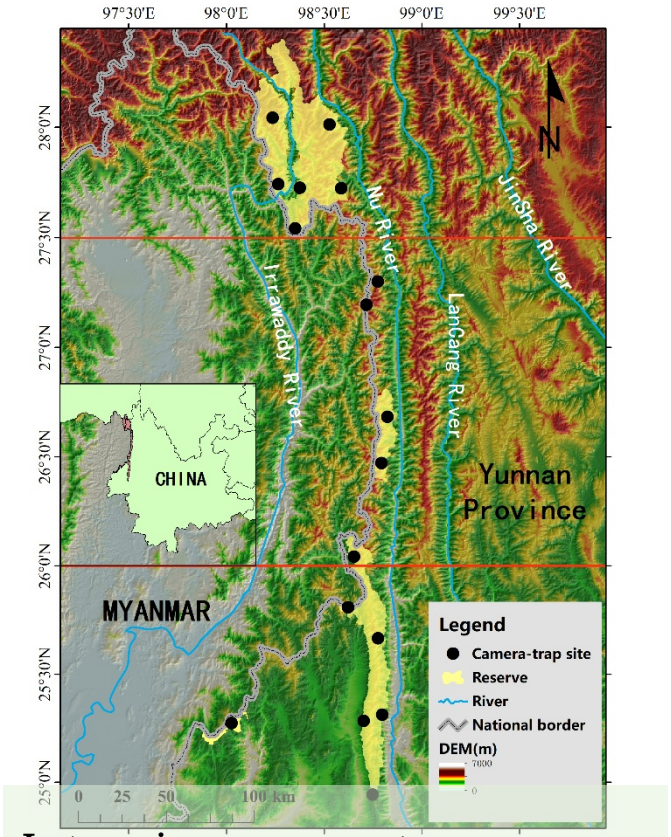
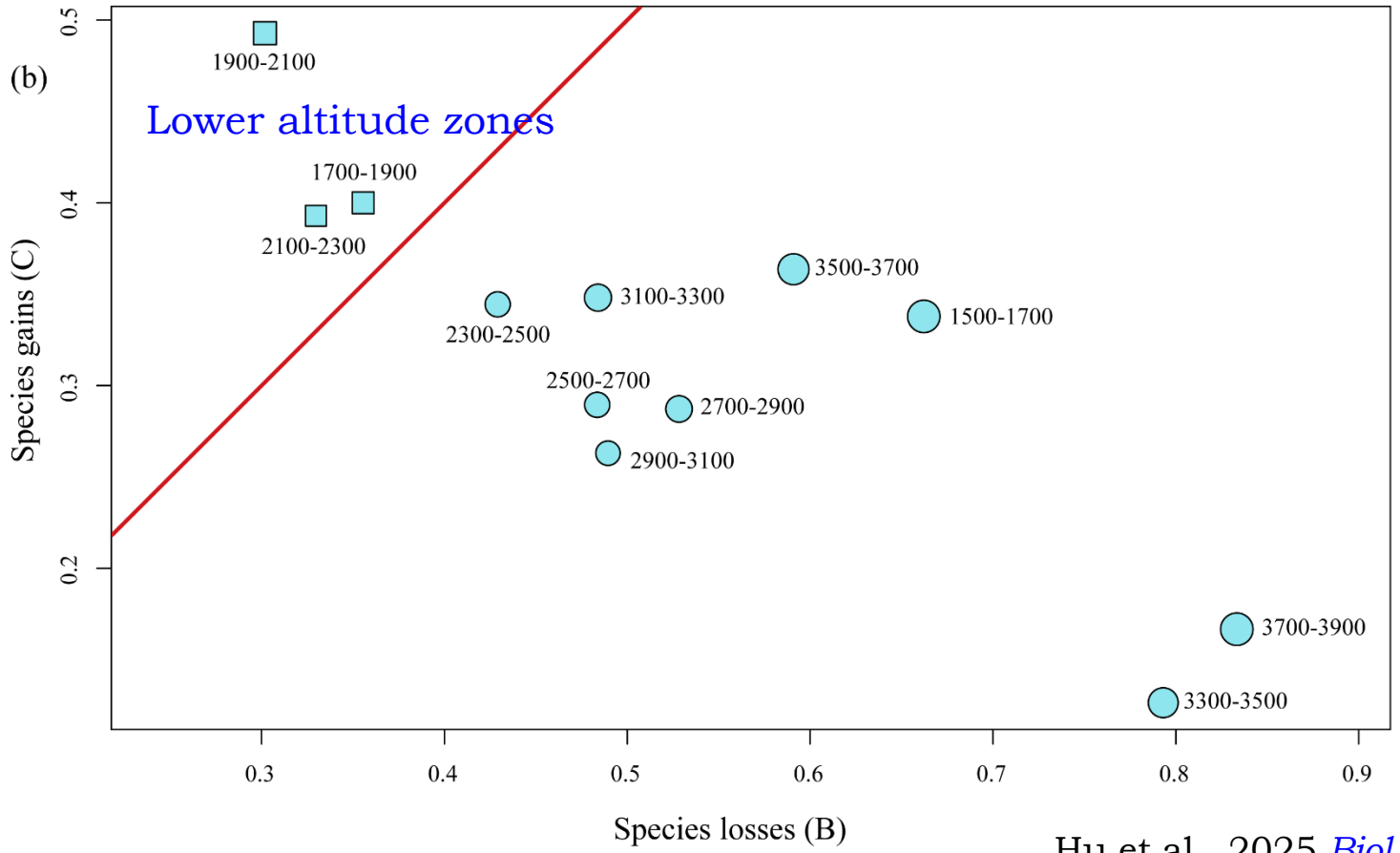
Temporal beta diversity analysis identify **lower elevation gained more species in the cold season**



Intensive camera-trap survey



Hu et al., 2025 *Biol. Conserv.*

Conservation should consider the varying habitat requirements across different seasons

Activity 4: Understanding biodiversity patterns

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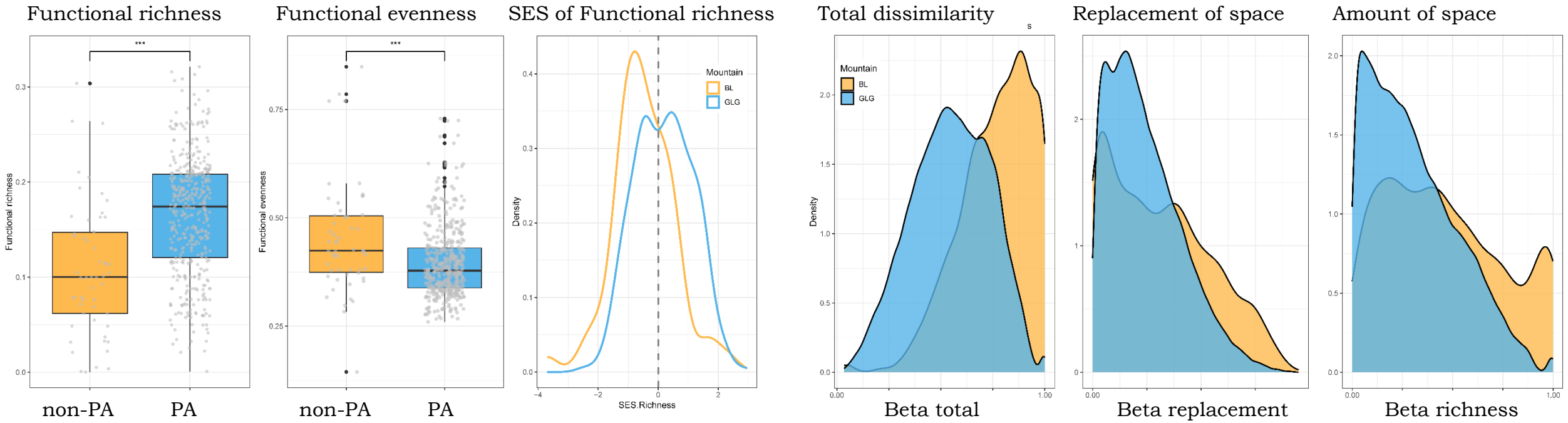
Functional diversity patterns within and outside protected areas (PAs)

- PAs maintained higher functional richness and turnover
- Functional richness outside PAs was markedly lower than in PAs, and β-diversity was dominated by nestedness



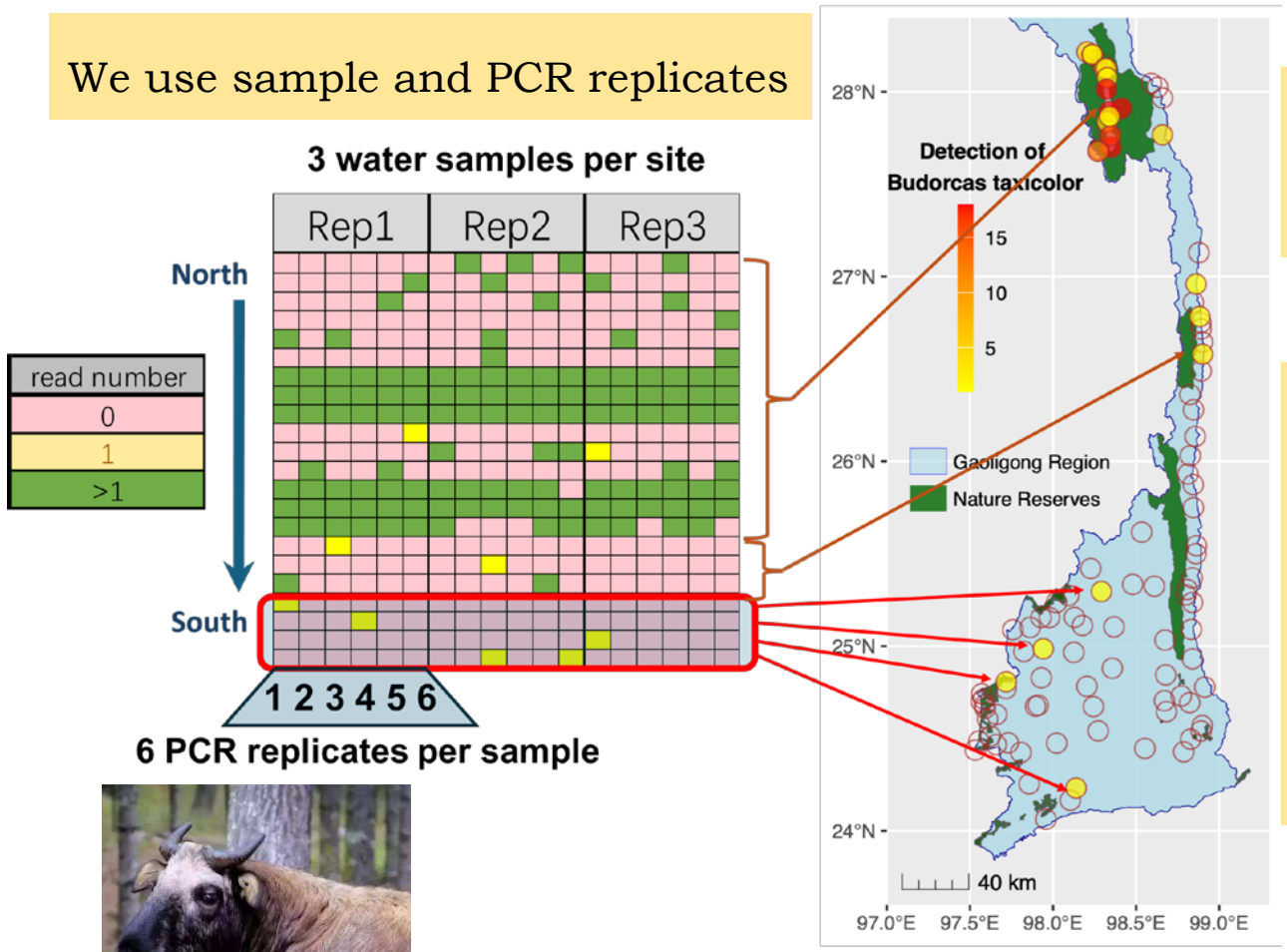
Li et al., 2025 *Conserv. Biol.*

Emphasize the critical role of PAs in safeguarding biodiversity functions

Research highlight

Key question: How do we know which detections are real (not false positives)?

We use sample and PCR replicates

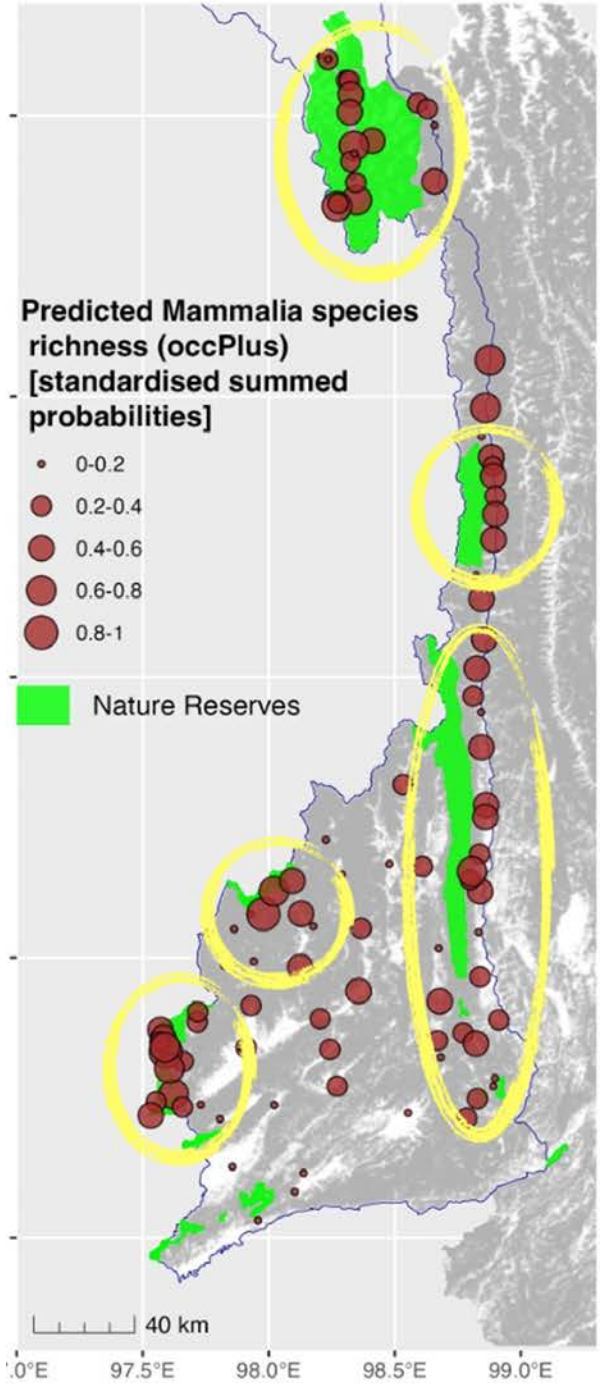


The 4 detections in the south look like contamination.

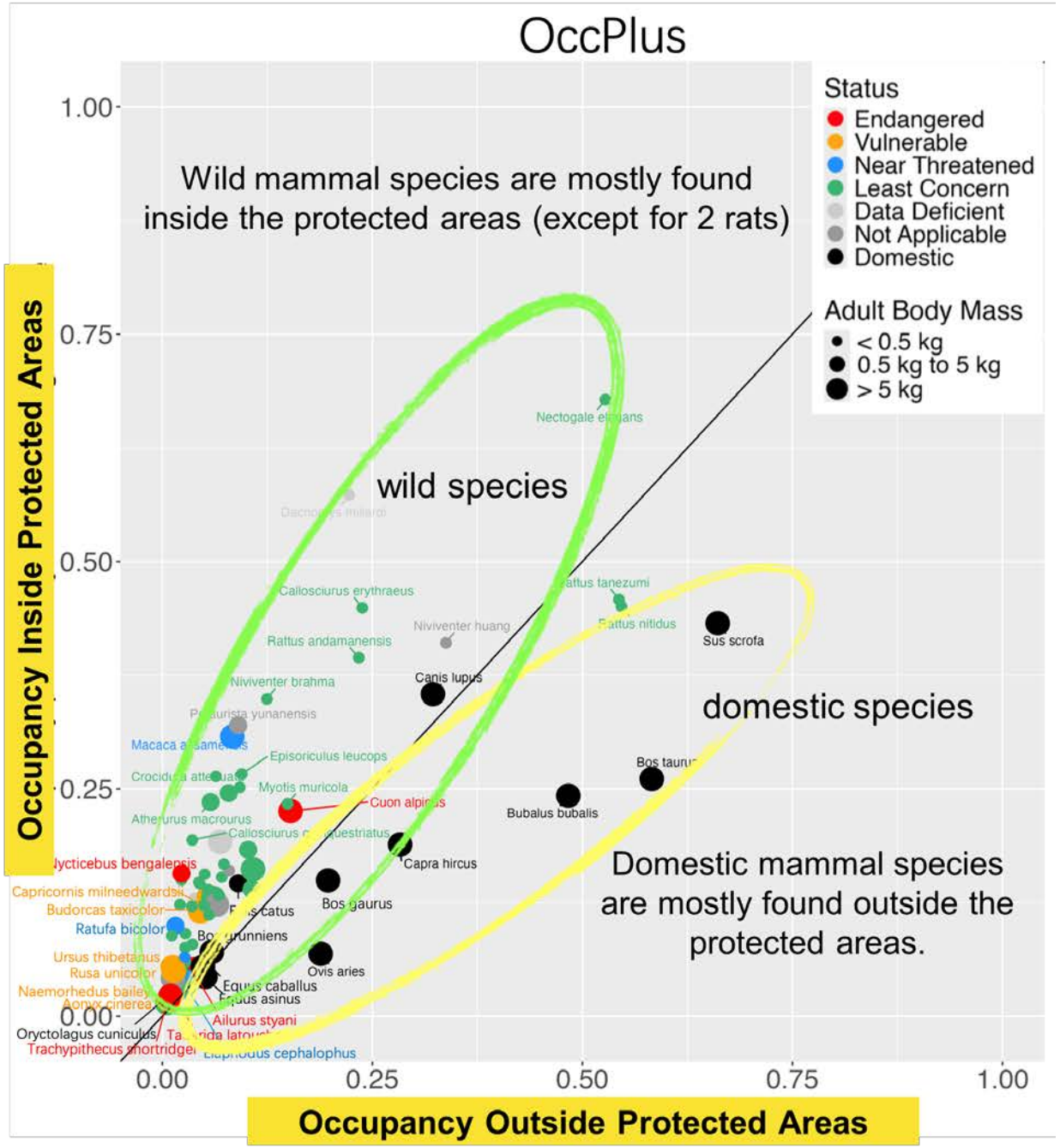
1 detection per 18 replicates per sampling point

OccPlus estimates probability of detection and false positive both in **field sampling and lab procedures**, allowing us to **statistically identify and distinguish likely false positives from true signals**

Budorcas taxicolor – the Takin (a species we expect to see only in the north)



Mammals: Let's subdivide the occupancy estimates by inside and outside protected areas



Conclusions

High quality, granular, timely, trustworthy, and efficient vertebrate species distribution data across a 30,000 km^2 protected area complex

Yinqiu Ji[1,*], Alex Diana[2,*], Xueyou Li[1,*], Eleni Matechou[3], Jim E. Griffin[4], Shuwei Liu[1], Mingjie Luo[1], Chunying Wu[1], Ru Bai[1,5], Chenyang Yao[1,5], Tingting Yin[1], Feng Dong[1], Fei Wu[1], Kai Wang[1,6], Zhongbin Yu[1,6], Xiaoyong Chen[1,6], Xuelong Jiang[1], Jing Che[1,6], Douglas W. Yu[1,7,**], and Viorel D. Popescu[8,9,**]

ECOLOGY LETTERS

In press

- With the right study design (replicates) and statistical analysis (OccPlus), we can account for both false-negative and false-positive error in eDNA surveys, leading to more reliable estimates of species occupancies and eDNA transport distances.
- Occupancy models are a powerful method for testing ecological hypotheses and for measuring management effectiveness.
- Different metabarcoding methods (e.g. different primers and collection methods) can be combined and analysed as one dataset, reducing need to standardise.

ACKNOWLEDGEMENT

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Yunnan Key Laboratory of Biodiversity and Ecological Conservation of Gaoligong Mountain

Gaoligongshan Nationtional Nature Reserve (**Biosphere Reserve**)

China Biodiversity Monitoring and Research Network (Sino Bon)

Animal Genetic Resources Bank, the Germplasm Bank of Wild Species

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谢　谢！