SPATIAL NEEDS OF OECMs IN CHINA — Based on Conservation Gaps of Terrestrial Vertebrates

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Executive Summary

Against the dual backdrop of accelerating global biodiversity loss and intensifying climate change, the strictly protected area model alone is insufficient to reconcile biodiversity conservation with land use in some areas of China, making other effective area-based conservation measures (OECMs) a valuable complement. OECMs refer to geographically defined areas, other than legally protected areas, that achieve long-term in situ biodiversity conservation through sustained, effective governance and management. They complement protected areas and contribute to achieving the 30×30 target (Target 3) of the Kunming-Montreal Global Biodiversity Framework (KM-GBF). By accommodating moderate human activities, fostering multi-stakeholder governance, and enabling flexible, inclusive conservation in human-dominated landscapes, OECMs have drawn growing international attention in recent years. This report systematically identifies biodiversity conservation priority areas and conservation gaps in China, focusing on the habitat needs of terrestrial vertebrate species. It further analyzes the causes, spatial characteristics, and governance challenges underlying such gaps, and outlines the practical necessity, local adaptability, and implementation pathways of OECMs in China. The findings provide scientific support for enhancing China's biodiversity conservation network and advancing the transformation of conservation models.

This report uses terrestrial vertebrates (1,765 species, including 519 mammalian species and 1,246 bird species) as the core indicator group. Based on Area of Habitat (AOH) data and utilizing the conservation spatial planning tool Zonation, it identifies the top 30% of conservation priority areas nationwide. Through overlay analysis with existing protected areas, the report identifies conservation gaps not covered by protected areas. Furthermore, by integrating spatial environmental variables such as land cover, human footprint, and ecosystem service value, the report analyzes the distribution patterns, characteristics, and conservation constraints of these gap areas.

The results indicate that among the top 30% of terrestrial vertebrate conservation priority areas nationwide, only 21.5% are located within the existing protected area system. The identified conservation gaps exhibit strong heterogeneity and spatial clustering, closely coupled with geographical gradients, geological evolution, and the intensity of socioeconomic development. Key gaps include the insufficient conservation of forests in the mountains of southwest China and the mid-and low-elevation zones in southeast Xizang; habitat fragmentation in the middle and lower reaches of the Yangtze River and the hilly regions of East China; disruption of migratory bird corridors along coastal mudflats; inadequate protection of island-specific habitats; and insufficient conservation of water sources in the arid regions of northwest China and the northern Qinghai-Xizang Plateau.

The land cover composition of conservation gaps is complex, with forests accounting for 42.0%, farmland for 15.6%, shrublands and grasslands for 23.3%, bare land for 15.8%, urban areas for 2.5%, and water bodies for 0.8%. Forest-related conservation gaps constitute the largest share, reflecting insufficient coverage of forest ecosystem conservation across China. Conservation planning for these gap areas is constrained by a preference for establishing protected areas in high-altitude sites, as well as restrictions associated with collective forest tenure. As a high-value and productive landscape, farmland has long been neglected by protected area systems, even

though it provides key habitat for many bird and mammal species. Semi-natural habitats such as urban peripheries and wetland patches, despite their limited area, serve as critical ecological stepping-stones supporting landscape connectivity.

The coupling analysis between conservation gaps, human footprint, and ecosystem service value reveals that high-biodiversity-value areas, such as the eastern plains and costal regions of southern China, face prominent conflicts between conservation and development, making traditional exclusion-based conservation models difficult to implement; thus, flexible conservation measures that balance production and livelihoods are needed. Areas such as southeastern Xizang and northern Xinjiang have favorable conservation conditions and low conservation costs, making them suitable for inclusion in the protected area system. Regions such as western Yunnan and western Zhejiang, characterized by heterogeneous mosaic distribution of human activities, require differentiated source-sink landscape governance strategies to coordinate conservation and development. Forest regions across southern and southwestern China show strong synergy between biodiversity and ecosystem services, generating substantial ecological spillover and offering ample potential to translate ecological values into tangible benefits.

Three core constraints hinder efforts to address existing conservation gaps: (i) land tenure complexities, characterized by the predominance of collectively owned forests and farmland, together with high coordination and compensation costs; (ii) socioeconomic pressures arising from intensive development in densely-populated areas of central and eastern China, resulting in high conservation opportunity costs; and (iii) significant challenges in corridor conservation, where fragmented habitats fail to meet the minimum area criteria for the establishment of PAs, making ecological connectivity difficult to sustain. Overall, the scope for further PAs expansion is severely constrained by the above factors, creating a growing need for flexible and inclusive conservation approaches such as OECMs.

OECMs align with China's vision for harmony between humans and nature, and their core characteristics—diversified governance, compatible objectives, and outcome-oriented approach—offer a viable solution to addressing prevailing conservation challenges. Currently, China is exploring innovative and localized approaches to OECM implementation, with abundant strategic opportunities and solid local practical foundations. Notably, *China National Biodiversity Conservation Strategy and Action Plan (NBSAP) (2023–2030)* has formally integrated OECMs into its priority actions of *in situ* conservation, offering explicit policy guidance for related work. China possesses rich local ecological culture and knowledge, with a wide range of community-managed landscapes such as feng shui forests, sacred mountains and lakes, and community pastures, that are closely aligned with the OECM criteria. Moreover, farmlands and urban green spaces managed with biodiversity-friendly practices that support key wildlife species also have the potential to qualify as OECMs. Policy-supported ecological areas, such as Ecological Conservation Red Lines, key wildlife habitats, ecological public welfare forests, and important and general wetlands, provide a robust spatial foundation for OECMs. Active social engagement from multiple stakeholders, together with a series of academic studies, has laid a solid practical foundation and offered scientific evidence to support OECM implementation in China. In particular, efforts to collect potential OECM cases in China reveal broad participation from local communities, enterprises, and social organizations. These potential OECM cases span a wide range of ecosystems including forests, farmlands and

wetlands. Over 90% of them fall within the conservation gaps identified in this report, thereby helping to fill these gaps and enhance the connectivity of conservation networks.

Overall, based on the conservation needs of terrestrial vertebrates, China continues to face extensive conservation gaps to be addressed, particularly in areas where high conservation value overlaps with intense human activity and the conventional PA framework faces notable constraints. OECMs complement PAs by addressing differentiated regional conservation needs, leveraging existing ecological resources such as public welfare forests, farmland, and urban green spaces, and balancing ecological conservation, livelihood advancement, and the realization of ecological values. However, the development of OECMs in China is confronted with several challenges including inadequate top-level institutional frameworks, insufficient cross-departmental coordination, insufficient biodiversity baseline information and monitoring data, funding shortages, and low public awareness.

This report proposes the following policy recommendations:

- Strengthen the top-level institutional framework and cross-departmental coordination mechanisms for OECMs, and support local pilot initiatives;
- Delineate priority areas for OECMs based on conservation gaps, so as to build a complementary "PAs + OECMs" conservation network;
- Align OECM development with existing policy-based spatial frameworks, expand the inventory of potential OECMs, and improve monitoring, assessment and evaluation systems;
- Explore localized tiered and classified management approaches, raise public awareness, and encourage broad stakeholder participation;
- Support the conservation of production landscapes and improve agricultural biodiversity-related systems;
- Innovate diversified funding mechanisms and explore models for ecological value realization and compensation.

These actions can promote standardized and well-organized development of OECMs in China, facilitate the synergistic advancement of biodiversity conservation and socioeconomic growth, and build an efficient, well-connected and inclusive nationwide biodiversity conservation network.

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Chapter 1 Evolution of In-Situ Conservation Systems and Emergence of OECMs

1.1. Global In-situ Conservation System and Limitations of the Protected Areas

Against the backdrop of climate change, drastic land-use changes, and expanding human footprints, biodiversity loss poses a major threat to global ecosystem stability and sustainable human development. Since the start of the Anthropocene, human activities have transformed terrestrial landscapes to an unprecedented extent. Agricultural expansion, urbanization and intensive resource extraction have led to massive loss and spatial fragmentation of natural habitats (Haddad et al., 2015). Assessments by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) show that nearly one million plant and animal species worldwide face extinction risks, and current extinction rates are tens to hundreds of times the average over the past ten million years (IPBES, 2019). Particularly under the synergistic effects of land-use change and climate change, habitat carrying capacity and connectivity are experiencing systematic decline (Mantyka-Pringle et al., 2012).

In response to the increasingly severe trends of biodiversity loss and habitat degradation, biodiversity conservation has become a global consensus. Early conservation efforts were primarily rescue-oriented, with strategies focusing on ex-situ conservation of certain rare species or captive breeding in enclosed artificial environments. As theories of macroecology, conservation genetics, and community ecology advanced, the international scientific community has reached a clear consensus: in-situ conservation—protecting species within their native habitats—is more effective in preserving ecosystem integrity, safeguarding species' evolutionary potential, and securing the continuity of genetic resources (Zegeye, 2017).

While conventional protected areas play an indispensable role in conserving species and ecosystems, the increasingly intertwined relationship between human activities and natural environments has made the demarcation-and-isolation model obsolete. Finding a balance between conservation and development has thus become a pivotal challenge.

1.2. Emergence and Global Practices of OECMs as a Complementary Conservation Tool

1.2.1. Concept Definition and Development of OECMs

The limitations of the protected area system have prompted international biodiversity conservation policies to reassess alternative conservation approaches beyond conventional protected areas. The "Aichi Biodiversity Targets," adopted at the tenth Conference of the Parties (COP10) to the Convention on Biological Diversity (CBD) in 2010 set out global conservation targets of protecting 17% terrestrial and 10% marine areas through "the establishment of ecologically representative, well-connected protected area systems and other effective area-based conservation measures (OECMs)." This marked the first time under an international multilateral environmental agreement, OECMs were elevated to the same strategic standing as conventional protected areas. As an innovative in-situ conservation mechanism, OECMs offers more flexible and inclusive pathways toward achieving global biodiversity objectives. However, due to the absence of clear scientific definitions, operational standards, and identification guidelines, OECMs remained conceptually ambiguous and marginalized in international conservation policy implementation during the initial years following the adoption of the Aichi Targets.

It was not until 2018 at the 14th Conference of the Parties (COP14) to the CBD, OECM was officially defined as "a geographically defined area other than a protected area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio-economic, and other locally relevant values." (CBD Decision 14/8, 2018). In 2019, IUCN WCPA published guidelines on *Recognising and reporting other effective area-based conservation measures*, providing technical standards and an operational framework for identifying, reporting, and incorporating OECMs into global conservation databases. The clarification of definition and accompanying technical guidelines have driven OECM from conceptual advocacy to institutionalized practice, establishing its core identification criteria as below:

1. not designated as a protected area, with clearly defined geographical boundaries;

2. effectively governed and managed, with relevant authorities and free, prior, informed consent from landowners;

3. achieves long-term, sustained conservation monitoring, reporting, and verifiable effectiveness;

4. supports the realization of ecosystem services, cultural, spiritual, socio-economic and other locally relevant values (IUCN-WCPA, 2019).

Depending on site management objectives, OECMs can achieve effective conservation in three main ways:

Primary conservation: Areas where biodiversity conservation is the main management objective, such as well-managed permanent forest reserves or conservation areas managed by

social organizations, but which are not included in the formal protected area system due to land tenure, willingness of management entity, or other constraints.

Secondary conservation: Areas with other primary management objectives, where biodiversity conservation is incorporated as a secondary objective and supported through active management. Examples include watershed conservation areas primarily managed for drinking water security, permanent fishing moratorium areas established to maintain fishery resources, and large urban parks managed mainly for public recreation.

Ancillary conservation: Areas whose management objectives are not biodiversity conservation, but whose management practices nevertheless deliver in-situ conservation outcomes. Examples include natural sacred sites, historic shipwrecks, military lands, where strict exclusion of human activities or distinctive traditional use patterns can effectively contribute to biodiversity conservation.

In practice, the management objectives of many areas may not center on biodiversity conservation—for instance, military restricted zones established for national security, water source protection areas designated to ensure drinking water safety, traditional sacred forests sustainably managed by local communities, or low-intensity agroforestry systems managed under sustainable use principles. As long as these areas effectively maintain healthy ecosystems, secure long-term stable habitats for endangered species, and demonstrate resilience against external overexploitation pressures, they have the potential to be recognized as OECMs (Donald et al., 2019).

Following the establishment of the World Database on Other Effective Area-based Conservation Measures (WD-OECM) in 2019, early submissions were primarily concentrated in countries such as Canada, Colombia, and Algeria. The slow progress in recognition resulted from the need for each country to develop domestic recognition systems, coupled with divergent national interpretations of OECM identification criteria and their relationship with existing protected area systems.

Adopted in 2022, the Kunming-Montreal Global Biodiversity Framework (KM-GBF) raised the in-situ conservation target (Target 3) to cover 30% of global terrestrial, inland waters, coastal, and marine areas through protected areas and OECMs, namely the 30×30 target. Given the numerous constraints on expanding protected areas, OECMs, as a complementary conservation tool, have attracted growing attention across countries.

Global identification and reporting of OECMs accelerated markedly following the adoption of the KM-GBF. As of July 2026, the WD-OECM database recorded 7,488 OECMs reported by 17 countries, covering 1.1% of global land areas and 0.21% of marine areas (UNEP-WCMC & IUCN, 2025). Despite notable shortcomings in data quality and transparency of identification criteria (Cook, 2024), these OECMs not only fill critical conservation gaps inaccessible to

protected areas due to high economic opportunity costs, delivering meaningful gains in protected spatial extent and ecological connectivity for the 30×30 target (Jonas et al., 2024; UNEP-WCMC & IUCN, 2024).

Within the implementation framework of the KM-GBF, it is important to clearly distinguish OECM, as one of the core instruments for supporting Target 3 on in-situ conservation, from other targets related to sustainable use and spatial improvement, such as Target 10 on agriculture, forestry, and fisheries, and Target 12 on urban blue and green spaces. This distinction is essential for ensuring the conservation effectiveness of the 30×30 target, preventing conceptual misuse, and avoiding double counting. Because OECMs can accommodate human production and living spaces, they may easily be confused with general biodiversity-friendly management or landscape improvement measures.

Targets 10 and 12 focus on broad reduction of environmental pressures and improvement of the matrix landscape. Examples include reducing fertilizer and pesticide use across farmland, increasing urban street greenery, or mitigating urban heat island effects. Their core logic is to reduce negative ecological footprints, but they do not necessarily support the long-term persistence of specific rare or threatened species.

By contrast, OECMs under Target 3 require long-term mechanisms within clearly defined geographic boundaries to maintain important biodiversity values, such as core habitats of threatened species or key migratory stepping stones. If managers of production or living spaces identify important biodiversity values within a site and maintain or adjust management measures to deliver secondary or ancillary conservation outcomes, such areas move beyond general landscape improvement, substantively perform in-situ conservation functions, and thereby qualify for recognition as OECMs.

1.2.2. Comparison and Complementarity Between OECMs and Protected Areas

Both OECMs and protected areas aim to curb species extinction and achieve long-term, effective in-situ biodiversity conservation at the landscape scale. They differ in management objectives, governance structures, and evaluation frameworks. Instead of competing functionally, OECMs and protected areas jointly build a complementary network that sustains regional ecosystem stability.

Protected areas prioritize biodiversity conservation as their primary objective, imposing strict restrictions on human activities; in contrast, OECMs encompass diverse management goals, whose primary objectives may be unrelated to biodiversity — as long as conservation outcomes are

achieved. Although both conservation frameworks adopt diverse governance structures, protected areas are predominantly state-led, where local communities may have limited participation in core decision-making; OECMs, however, apply a multi-centric governance model that fully incorporates local communities, businesses, social organizations, and other stakeholders. This approach not only reduces the management burden of national conservation authorities but also enhances the resilience and equity of the overall conservation governance system. Empirical studies have demonstrated that territories managed by IPLCs experience significantly lower deforestation and species loss than unprotected landscapes (Dawson et al., 2021; Garnett et al., 2018).

Spatially, protected areas typically enforce stringent controls on human activity, and are often situated in remote areas. On one hand, such sites tend to overlook ecologically significant areas with moderate human presence that underpin biodiversity persistence. On the other hand, they can create tensions for local communities within and adjacent to protected areas since it is difficult to reconcile conservation and development needs. In comparison, OECMs accommodate moderate human activities that are compatible with biodiversity conservation. Through sustainable and biodiversity-friendly natural resource management practices, they foster synergies between conservation and socioeconomic development. Meanwhile, they incorporate conservation efforts covering small and medium-sized critical habitats into the overall conservation system to build an interconnected ecological network.

In terms of evaluation, protected areas mainly focus on the management process, namely assessments of management effectiveness, whereas OECMs emphasize outcome-oriented assessments of conservation effectiveness alongside management practices, ensuring tangible and verifiable conservation outcomes.

Therefore, OECMs are not merely an alternative pathway for increasing conservation coverage. They can also complement protected areas in improving conservation effectiveness, ecological representativeness, conservation network connectivity, and governance equity under the 30×30 target.

Against the backdrop of intensifying climate change, many species are forced to shift their geographic ranges in search of suitable climatic niches. A highly interconnected network combining PAs and OECMs may provide vital spatial buffers and migratory corridors for range-shifting species, helping to strengthen the long-term resilience of global ecosystems against climate change (Maxwell et al., 2020).

1.2.3. Global Progress of OECMs Implementation

Currently, OECM practices worldwide follow diverse trajectories. Their conservation

performance and governance models are significantly influenced by each country's socio-economic context, land tenure systems, existing conservation policies, and native ecological conditions, demonstrating notable regional variations.

Regional cases reveal distinct priorities. North America and Latin America prioritize spatial optimization and institutional integration: Canada designates marine refugia as OECMs under marine governance frameworks to curb destructive fisheries, and also recognizes community-conserved territories as OECMs. Colombia integrates private forests, water conservation forests, and community-managed forestlands within biodiversity hotspots into the OECMs framework, demonstrating how developing countries can leverage civil society efforts to alleviate conservation pressures. Africa, exemplified by South Africa, deeply integrates OECMs into national spatial planning, promoting contractual protection of private lands through biodiversity stewardship schemes, filling conservation gaps and enhancing species migration corridors via fiscal incentives and ecological restoration policies. The Asia-Pacific region features complex human-nature interactions and emphasizes balancing ecological preservation with livelihoods: Japan establishes nature coexistence site certification frameworks based on traditional Satoyama-Satoumi landscapes managed by local actors to sustain native biodiversity; Australia leverages local ecological knowledge to improve arid zone management; India incorporates sacred village groves and other customary conservation spaces into OECMs framework, alleviating human-land tensions in densely populated areas.

The widespread application of OECMs is driving a global transformation in conservation governance structures—from government-dominated models to collaborative multi-stakeholder governance. Statistics show that OECMs adopting the shared governance model account for 40.9%, significantly higher than the 2.5% for protected areas (Jonas et al., 2024). This shift mobilizes broader societal participation in biodiversity conservation, engaging communities, enterprises, and non-profit organizations to participate in stewardship. It cuts public administrative costs while reconciling conservation and development demands, delivering ecological, socio-economic and cultural co-benefits through flexible, inclusive institutional arrangements.

1.3. Current Status of China's In-Situ Biodiversity Conservation

China is one of the world's most biodiverse countries.With 6.4% of the global land area, it supports about 10% of the world's higher plant species, 13.7% of vertebrate species, and 14% of fungal species (Yang et al., 2022; Ministry of Ecology and Environment of China, 2024). Its vast geographic extent and high habitat heterogeneity provide diverse ecological niches for species evolution. At the same time, biodiversity conservation in China continues to face pressures from ecosystem fragility and localized degradation, overuse of natural resources, environmental

pollution, invasive alien species, and climate change. According to China's biodiversity red lists, 10.4% of assessed higher plant species and 22.0% of assessed vertebrate species (excluding marine fishes) are threatened (Ministry of Ecology and Environment of China, 2024). In response to these pressures, China has continued to improve its multi-level in-situ conservation system, with protected areas forming the institutional backbone, safeguarding domestic biodiversity while contributing practical experience to the global implementation of KM-GBF. This section reviews China's in-situ conservation system, including its protected area network, conservation outcomes, and links with the ecological redline (ERL) and other policy-based conservation spaces, and identifies key gaps and foundations to inform the localization of OECMs.

1.3.1. Overview of the Development History of China's Protected Area System

China's modern in-situ conservation system began with the establishment of Dinghushan Nature Reserve in 1956. Since then, it has gone through four stages: an initial rescue-oriented phase, rapid expansion after reform and opening-up, diversified development aligned with international conventions, and system restructuring centered on national parks since 2019. In the early stages, protected area development was slow due to limited economic and technical capacity. Subsequently the number and area of protected areas increased rapidly under a multi-agency management system, but development-oriented use sometimes outweighed conservation. From the mid-to-late 1990s, protected area types diversified and coverage expanded, while problems such as overlapping spatial boundaries, divided authority and inadequate local management capacity remained.

Leveraging the overarching framework for ecological civilization agenda, the "Guiding Opinions on Establishing a Protected Area System Centered on National Parks," jointly issued by the General Office of the Communist Party of China Central Committee and the General Office of the State Council in 2019, formally established China's new classified system for protected areas. It promoted the integration and optimization of protected areas, clarified spatial boundaries and management responsibilities, and resolved various land-use conflicts, thereby laying the foundation for more effective protected area management (General Office of the CPC Central Committee & General Office of the State Council, 2019). Meanwhile, protected area governance has increasingly incorporated modern conservation concepts, aligned itself with global biodiversity conservation goals, formulated innovative spatial conservation frameworks such as the ecological redline, and linked conservation with national strategies such as rural revitalization.

1.3.2. Categories and Current Pattern of Protected Areas in China

China has established a three-tier protected area system, with national parks as the main body, nature reserves as the foundation, and various types of nature parks as supplements. This system define clear ecological function in spatial use management. National parks bear the core mission of representing national significance and ecological integrity; nature reserves serve as the cornerstone of in-situ conservation network for typical ecosystems and species-rich areas; nature parks protect ecosystems, natural relics, and landscapes while also supporting ecological, cultural, scientific, educational, recreational, and sustainable-use values, and deliver buffering and ecological connectivity functions.

By the end of 2019, China had established 11,800 protected areas of various types and levels, covering 18% of its land area and 4.1% of its jurisdictional maritime area (MEE, 2019).

1) National Parks

China's national parks encompass the most representative, extensive, and ecologically intact natural ecosystems across the country. They often span provincial boundaries and integrate natural geographic units that had previously been divided by administrative borders. Land tenure in national parks is predominantly state-owned, with some collectively owned land included. In terms of governance, the competent department for national parks under the State Council, namely the National Forestry and Grassland Administration, is responsible for the nationwide supervision and administration of national parks. National park management institutions undertake site-specific conservation and management duties, while local governments are responsible for related public services, social administration, and coordination of local development.

National park selection emphasizes ecosystem authenticity and integrity. It prioritizes large natural landscapes that can maintain apex predators, long-distance migratory species, and natural disturbance regimes such as fire and hydrological cycles. Spatially, national parks apply strict and unified land-use control, simplifying the previous core, buffer, and experimental zones into core protection zones and general control zones. Human activities are generally prohibited in core protection zones, while limited traditional sustainable use and nature education activities are allowed in general control zones.

This spatial framework aligns with IUCN Category II of protected areas, while it also serves multiple functions such as community livelihood support and human-wildlife conflict mitigation within China's unique socio-economic context. In comparison with nature reserves, it should be noted that national parks and nature reserves adopt equally stringent control over their core protection zones, with strict restrictions imposed on all human activities within both categories. Institutionally, national parks are managed through central vertical management or central-local coordination, with a higher administrative status than locally managed nature reserves. This differs from the IUCN protected area classification system, where nature reserves under Category Ia are

more strictly protected than national parks in Category II.

By the end of 2025, China has officially established five national parks (Sanjiangyuan, Giant Panda, Northeast China Tiger and Leopard, Hainan Tropical Rainforest, and Wuyishan), primarily located in regions with the most prominent ecosystem representation and richest biodiversity, such as the Qinghai-Xizang Plateau, southwestern mountainous areas, northeastern temperate forest zones, and the tropical rainforest area of Hainan Island. The total area of these five national parks is approximately 23 million hectares, accounting for about 2.4% of the country's terrestrial territory and encompassing nearly 30% of nationally protected wild animal and plant species. Each national park typically spans between 0.1 to 19 million hectares, significantly larger than nature reserves and nature parks (National Forestry and Grassland Administration, 2021). Additionally, China has selected 49 candidate areas for national parks, covering ecosystems such as forests, grasslands, wetlands, and deserts. These areas protect over 5,000 species of wild vertebrates and more than 29,000 species of higher plants, covering over 80% of nationally protected species and their habitats, while also safeguarding ecological corridors and cross-border migration routes. National park development also involve participation of local communities and the general public through concession programs, volunteer services, and ecological ranger positions.

2) Nature Reserves

Nature reserves represent the oldest, largest in number, and most widely distributed type of protected area in China, implementing stringent conservation measures in representative ecosystems and habitats of rare or endangered wildlife species. The core objectives of nature reserves are to maintain phylogenetic diversity and physical isolation of microhabitats at the regional scale, while preventing invasive species incursions and habitat degradation caused by human disturbance.

According to China's current *Nature Reserve Regulations* and the integration and optimization plan, nature reserve management has been streamlined from a fragmented system involving multiple departments—including forestry, environmental protection, urban construction, and natural resources — to unified administration by forestry and grassland authorities under supervision by ecology and environment authorities. Approval levels have been simplified from national, provincial, municipal, and county levels to national and provincial levels. Nature reserves also adopt the core protection zone/general control zone system, but their overall protection intensity is higher than that of nature parks. Core protection zones strictly prohibit commercial development, resource extraction, and new permanent human settlements, while permitting limited, low-intensity subsistence activities for resident local communities.

Nature reserves are cornerstone for in-situ biodiversity conservation in China, primarily corresponding to Category Ia (Strict Nature Reserves) and Category IV (Habitat/Species

Management Areas) in the IUCN classification (Tseng et al., 2025). They provide key refugia for endemic, narrow-range species, as well as amphibians, reptiles, and endangered plants (Mi et al., 2023a; Xu & Zang, 2023). After integration and optimization in 2024, China has a total of 1,527 nature reserves, covering a total area of approximately 120.3 million hectares, accounting for 64.9% of the total area within the protected area system.

3) Nature Parks

Nature parks represent the most diverse and multifunctional tier within China's protected area system, integrating various types of protected areas that were previously administered by different government departments and currently under unified management by the forestry and grassland authorities. Their core mission is to safeguard the fundamental functions and ecological integrity of natural ecosystems while also preserving the aesthetic value of landscapes, recreational experiences, nature education, science outreach, and the preservation of cultural and historical heritage. They serve as buffer and transition areas around national parks and nature reserves, mitigating edge effects from rigid protection boundaries and providing ecological stepping stones for wildlife migration between different strictly protected areas. Nature parks correspond primarily to Category V (Protected Landscape / Seascape) and Category VI (Protected Area with Sustainable Use of Natural Resources) in the IUCN classification (National Forestry and Grassland Administration, 2017; Bennett & Mulongoy, 2006).

As of the integration and optimization in 2024, China had a total of 5,159 nature parks, covering an area of approximately 36.4 million hectares, accounting for 19.6% of the total area within the protected area system. These parks encompass diverse ecosystem types including forests, wetlands, geological sites, marine areas, and deserts. Spatially, they are generally small, widely distributed patches, often located in hilly areas, suburban zones, and agricultural-forestry transition zones in central and eastern China. The number and main functions of each subcategory are detailed in Table 1.1.

Table 1.1 Types and Main Functions of Nature Parks

Type	Number	Area (million hectares)	Main conservation Target	Major function
Forest Park	2,395	14.09	Forest ecosystems	Protect forest succession processes, provide carbon sinks and habitats for forest-dependent species, and carry out orderly recreational activities within ecological carrying capacity. (Li et al., 2025c; Lu & Chen, 2024).

Wetland Park	1,443	4.81	Wetland ecosystems and riparian areas	Maintain hydrological connectivity, provide resting and wintering sites for waterbirds, particularly long-distance migratory species (Teng et al., 2025).
Scenic Area	883	13.74	A comprehensive landscape that integrates natural aesthetics with humanistic and historical elements	Protect visual integrity of cultural landscapes, restrict incongruous architectural developments, and reflect the coupled system of long-term interaction between humans and nature.
Geopark	312	2.61	Special geological relics and landforms	Protect stratigraphic sections, fossil assemblages, karst formations, and glacial relics, and provide the foundation for both abiotic diversity and endemic biological communities.
Marine Park/ Marine Special Protected Area	60	0.76	Marine and Coastal Ecosystems	Protect and restore benthic ecosystems, enhance blue carbon capacity, and protect coral reefs, mangroves, seagrass beds, and spawning grounds (Li et al., 2025a).
Desert (Rocky Desert) Park	106	0.36	Desert Ecosystems and Sandland Vegetation	Control desertification and protect xerophytic plants and drought-tolerant vertebrates

Overall, China's current protected area system has formed a multi-level network in which national parks protect large-scale ecological processes, nature reserves secure key phylogenetic diversity, and nature parks support ecological buffering and habitat connectivity.

1.3.3. Effectiveness of Protected Area System and its Main Challenges

China has made significant progress in restoring ecological foundation and strengthening spatial conservation through its protected area network. Monitoring by the National Forestry and Grassland Administration shows that the optimized protected area network has improved spatial layout and patch connectivity, while populations and habitat ranges of flagship species such as the giant panda, crested ibis, Hainan gibbon, and Tibetan antelope have steadily recovered (National

Forestry and Grassland Administration, 2024). Protected areas cover 90.5% of terrestrial ecosystem types, 85% of nationally protected terrestrial wildlife species, and 65% of higher plant communities (National Forestry and Grassland Administration, 2020). National-scale quantitative studies further confirm that the protected area system provides broad habitat coverage for rare and endangered terrestrial wildlife, with the core activity ranges of the majority of nationally protected species now under protected area management. Protected areas have played an important role in maintaining wild populations, conserving typical natural ecosystems, and reducing habitat fragmentation. Grassland coverage and grass yield in Sanjiangyuan have increased by over 11% and 30%; Tibetan antelope population has recovered from fewer than 20,000 individuals to approximately 70,000; Amur tiger and Amur leopard number exceeds 70 and 80 respectively; and Hainan gibbon population has increased to 7 groups totaling 42 individuals (People's Daily Online, 2023; National Forestry and Grassland Administration, 2024; National Park of Hainan Tropical Rainforest, 2022).

Beyond quantitative area coverage, China's protected area now faces challenges of improving conservation quality and social benefit-sharing. The main issues are as follows:

In terms of conservation effectiveness, China's protected area system exhibits structural shortcomings in key habitat coverage.

First, systematic planning is still insufficient. Most protected areas, such as nature reserves and nature parks, were established through "bottom-up" applications, lacking top-level design based on biodiversity priority zones, leading to both conservation gaps and spatial boundary overlap. Before the integration and optimization of protected areas, more than 58% of China's protected areas exhibited spatial overlap, with different types of protected areas exhibiting similar conservation functions and facing fragmented management by multiple authorities (Tang, 2024; Ma et al., 2019). Critical habitats in biodiversity hotspots such as the southwestern mountainous regions and the eastern edge of the Qinghai-Xizang Plateau remain uncovered (Jiang et al., 2025b).

Second, habitat fragmentation and weak connectivity remain major constraints. Protected areas are scattered in patches, lacking ecological corridors that facilitate species migration, gene exchange, and population dispersal (Tian et al., 2022). The northward migration and subsequent southward return of Asian elephants in Yunnan stands out as a typical example. Because existing nature reserves provided limited space for the existing elephant population, while surrounding landscapes lacked buffer areas and stepping-stone habitats, human land uses blocked corridors and forced elephant herds to move beyond protected area boundaries into human settlements and farmland (Liu et al., 2016; Liu et al., 2017). This exacerbated human-animal conflicts and revealed the systemic shortcomings of isolated protected area networks, fragmented corridors, and poor overall connectivity (Li et al., 2018). Remote sensing and habitat modelling studies further show that the suitable habitats for Asian elephants in Yunnan are severely fragmented, with protected

areas covering only portions of the core habitats. The connectivity between habitat patches is low, and local populations are isolated by human-dominated landscapes, which threatens long-term genetic diversity and natural population growth (Li et al., 2022; Chen et al., 2023).

Third, coverage remains insufficient for some key taxa. Protected area coverage is uneven across terrestrial vertebrates, invertebrates, plants, and genetic resources. Studies show that nature reserves cover 17.9% of threatened mammal habitats and 16.4% of threatened bird habitats, but only 13.1% of threatened plant habitats, 10.0% of amphibian habitats, and 8.5% of reptile habitats (Xu et al., 2017). Assessments based on effective conservation thresholds indicate that 71.67% of species have not yet met their conservation needs, meaning that only a low proportion of their core habitats is covered by protected areas (Mi et al., 2023b; Tseng, 2025).

In terms of social ecological benefit-sharing, conflicts between protected area management and social development remain difficult to resolve. Strict controls over protected areas restrict traditional grazing, logging, hunting and gathering activities by local communities, while ecological compensation is often inadequate with insufficient coverage (Zhang et al., 2025a). Alternative livelihoods such as ecotourism remain small in scale and low in returns, and cannot fully offset livelihood losses (He et al., 2023). Moreover, cases exist where protected area demarcation fails to fully consult local communities concerning their collective lands, where unclear tenure and insufficient compensation became persistent issues. Economic benefits from ecological conservation (e.g., ecotourism) are often driven by governments or enterprises, while community participation and benefit-sharing remain limited (Zhang et al., 2025a; Liang et al., 2025b; Huang & Liang, 2024). Current community involvement is largely passive and limited, lacking institutionalized channels for decision-making, management, and benefit-sharing. As a result, communities are not fully recognized as conservation actors, and local motivation remains weak (IUCN, 2024; Tang et al., 2025). Participation by enterprises, social organizations, and research institutions in the establishment, management, and monitoring of protected areas is also constrained by limited channels, funding, and technical support, hindering the formation of coordinated conservation efforts (Ministry of Ecology and Environment, 2023; Huang et al., 2018).

Taken together, the China protected area network still faces multiple challenges in terms of protection coverage, spatial connectivity, and human-nature coordination. As a novel flexible conservation tool, OECM can revitalize various production, living, and ecological spaces not subject to strict regulation, enhance landscape connectivity, and alleviate human-nature conflicts, aligning with China's conservation needs.

1.3.4. Linkages between Ecological Redline, Other Spatial Conservation Policy System, and OECM in China

China has established a comprehensive spatial conservation policy framework that extends beyond protected areas, encompassing the ecological redline and various other policy-supported conservation spaces. These spatial policies collectively provide a substantial foundation for OECM development in China.

1) Ecological Redline

China's territorial spatial planning coordinates different spatial needs through the "three zones and three lines" framework. The "three zones" refer to ecological, agricultural, and urban spaces, corresponding respectively to ecological conservation, agricultural production, and urban development. The "three lines" refer to the ecological redline, the permanent basic farmland protection redline, and the urban development boundary. The ecological redline safeguards the bottom line of ecological security; the permanent basic farmland protection redline ensures national food security; and the urban development boundary regulates urban construction and prevents disorderly expansion.

In the process of implementing the KM-GBF, China has recently identified the ecological redline in its Seventh National Report to the CBD as a core spatial policy tool for achieving the 30x30 target. Currently, ecological redline covers more than 30% of China's terrestrial area (304 million hectares), and about 5% of its jurisdictional sea areas (15 million hactares). It includes not only most legally designated protected areas, but also extensive non-protected areas with very high ecological value, such as areas of critical ecological function and areas of high ecological sensitivity and fragility. From a macro-spatial perspective, the ecological redline forms China's largest and most solid spatial foundation and potential candidate pool for exploring and developing OECMs.

However, in the practical implementation of a whole-landscape biodiversity conservation network and international commitments, it is necessary to define, both scientifically and legally, the differences between the ecological redline and OECMs in terms of conceptual scope, governance scale, and evaluation logic.

As a macro-spatial governance innovation of China, the ecological redline is essentially a top-down macro-spatial land-use zoning instrument. Its core logic is based on bottom-line thinking and negative-list management. Through territorial spatial planning and regulation, it incorporates ecologically important, sensitive, and fragile areas into strict protection at the macro scale, and restricts or prohibits intensive industrial and urban development as well as large-scale resource extraction, in order to safeguard national and regional ecological security. Its conservation objectives are multiple and not limited to biodiversity conservation, but also include ecosystem services such as water conservation, soil retention, and windbreak and sand fixation. The redline is a policy control boundary, with a defensive focus on "what should not happen", namely preventing the physical reduction and disorderly degradation of ecological space.

By contrast, OECMs are site-level conservation areas with specific governance and management arrangements. They require not only clearly defined geographic boundaries, but also clear, substantive, and locally operating governance authorities. As outcome-oriented conservation instruments, OECMs are not only about preventing external threats, but also about what is happening at the site: whether local actors are implementing targeted adaptive management, and whether such management delivers long-term and effective biodiversity outcomes.

In short, the ecological redline addresses the bottom-line question of "where development should be limited" within the national territorial space, while OECMs address the site-level governance question of "who manages a specific area, how it is managed, and whether it delivers measurable biodiversity outcomes." The spatial control requirements of the ecological redline are broadly consistent with OECM recognition criteria. However, regular monitoring, conservation effectiveness assessment, and adaptive management systems are still needed to translate macro-level spatial controls into verifiable biodiversity conservation outcomes at the local scale.

2) Biodiversity Conservation Priority Areas

In 2010, China's Ministry of Environmental Protection, together with more than 20 departments, issued the China *National* Biodiversity Conservation Strategy and Action Plan (2011-2030). The NBSAP identified 35 biodiversity conservation priority areas, including 32 inland terrestrial and freshwater areas and three marine and coastal areas. Terrestrial areas include key ecological regions such as the Greater Khingan Mountains, Changbai Mountains, Qinling-Daba Mountains, southern Hengduan Mountains, southeastern Xizang, Wuling Mountains, Nanling Mountains, and central-southern Hainan Island. Marine and coastal areas include the Bohai and Yellow Seas, the East China Sea, and the South China Sea, covering coral reefs, mangroves, seagrass beds, and important spawning and feeding grounds. These areas cover most of China's biodiversity hotspots, concentration areas for rare and endangered species, and representative ecosystems.

The *China National Biodiversity Conservation Strategy and Action Plan (2023-2030)*, released in 2024, maintains the 35 priority-area framework. It calls for strengthening conservation supervision in these areas based on biodiversity surveys and monitoring, and specifies that priority areas should be coordinated with the protected area system and the ecological redline to strengthen spatial conservation guidance.

Biodiversity conservation priority areas serve as macro-level spatial planning guidelines, with no explicit requirements on establishing fully developed management frameworks, targeted conservation measures and effectiveness evaluation mechanisms. Their boundaries are based on eco-geographic units and focus on broad ecological functional zoning. These priority areas provide a broad planning framework, and the gap-identification results of this report can further refine the

identification of priority sites based on species conservation needs. Priority areas outside protected areas have potential to become OECMs.

3) Other Policy-based Conservation Areas

In addition to the ecological redline and biodiversity conservation priority areas, China has developed a wide range of policy-supported conservation spaces through laws, regulations, and management policies. These areas provide important supplements to the in-situ conservation system, most of which have clear boundaries and long-term management mechanisms, meeting the basic criteria of OECM (Table 1.2, modified from Zhang et al., 2024b).

Natural forests, ecological public welfare forests, state-owned forest farms (with focuses on forest resource protection and cultivation), basic grasslands, important wetlands, general wetlands, and closed desertification-control areas are governed and managed under regulatory policies issued by forestry and grassland authorities that restrict logging, grazing and intensive industrial development. They help maintain the integrity of forest, grassland, wetland, and desert ecosystems. Important wildlife habitats, in-situ conservation sites for wild plants, and key habitats along migratory bird flyways are identified and managed under wildlife and wild plant protection laws, regulations, and conservation plans, playing important roles in species conservation. Drinking water source protection areas, aquatic germplasm resource reserves, and fishing moratorium areas are governed through legal and regulatory frameworks related to water resources and fisheries, helping protect aquatic biodiversity and surrounding terrestrial habitats. Such areas outside formal protected areas could become OECMs if regular monitoring and effectiveness assessment confirm their biodiversity conservation outcomes.

World Natural Heritage sites (and buffer zones), Biosphere Reserves, and UNESCO Global Geoparks combine domestic strict management with regular international monitoring and assessment, and have established complete conservation management mechanisms. These internationally designated conservation areas commonly overlap with or are embedded within existing protected areas in China. The portions outside formal protected areas may be included in OECM accounting.

Agricultural and urban spaces also contain areas with potential biodiversity value, supported by policies that encourage coordination between biodiversity conservation and production or livelihood functions. Agricultural heritage systems preserve traditional farming and grazing practices adapted to local natural conditions. They not only conserve local genetic resources but also provide stable habitats for wild species. Urban park regulations include biodiversity conservation as part of management objective, creating policy support for near-natural management of urban green spaces and the maintenance of native species communities. Where such areas have important biodiversity value and long-term low-disturbance management, they may become OECMs, strengthening the in-situ conservation network.

Table 1.2 Other Policy-based Conservation Areas (modified from Zhang et al., 2024b)

Conservation Type	Territorial Space	Policy-based Conservation Space
Primary conservation	Ecological space	Species conservation: important wildlife habitats, in-situ conservation sites for wild plants, key habitats along migratory bird flyways; Forest conservation: natural forests, ecological public welfare forests, state-owned forest farms; Grassland conservation: basic grasslands; Wetland conservation: important wetlands and general wetlands; Desert conservation: closed desertification-control areas; International frameworks: World Heritage sites and buffer zones, Biosphere Reserves, UNESCO Global Geoparks
Secondary conservation		Water source conservation: drinking water source protection areas; Aquatic germplasm conservation: aquatic germplasm resource reserves; Water landscape conservation: water conservancy scenic areas
	Agricultural space	Agriculture: agricultural heritage systems; Pastoralism: grazing prohibition and rotational grazing areas; Fisheries and aquaculture: fishing moratorium areas, marine ranching, ecological aquaculture such as integrated multi-trophic aquaculture zones
	Urban space	Urban parks
Ancillary conservation	Ecological/ Urban space	Tourist resorts and scenic tourism areas
	Special-use land	Military restricted zones and military management zones

It should be clarified that the conservation priority areas identified in this study differ from the priority areas officially designated by China NBSAP. The officially designated priority areas were delineated at the scale of eco-geographic units, with an emphasis on macro-level ecological functional zoning. This study, in contrast, focuses on the precise identification of conservation gaps, providing a micro-level basis for site-level OECM screening.

Chapter 2 Identification and Spatial Characteristics of Biodiversity Conservation Gaps in China

2.1 Methods and Data Sources

2.1.1. Selection of Biodiversity Indicator Taxa

In systematic conservation planning at regional and national scales, the selection of indicator taxa determines the accuracy of spatial priority area identification and the overall effectiveness of conservation networks. This report uses terrestrial vertebrate mammals (*Mammalia*) and birds (*Aves*) as indicator taxa, which are widely recognized as representative groups for assessing ecosystem function and integrity. Mammals and birds occupy the broadest ecological niches in terrestrial ecosystems, spanning the entire trophic hierarchy from primary consumers to top predators, making their community integrity a reliable indicator of ecosystem structural integrity (Gaston, 2000). Large mammals and birds at the top of the food chain have high requirements for habitat quality and ecosystem integrity, along with large home ranges; protecting these umbrella species can benefit many associated species within the same landscapes (Ripple et al., 2014). Furthermore, their high sensitivity to habitat fragmentation and climate change makes them early warning indicators for global environmental changes (Both et al., 2006). Their taxonomy is relatively complete, survey methods are well established, and distribution data are comparatively detailed, providing a strong basis for fine-scale spatial conservation analysis (Brooks et al., 2019; Lumbierres et al., 2022).

It should be noted that, due to limited data availability, other terrestrial vertebrate groups such as amphibians and reptiles, as well as aquatic species (except waterbirds), have not been included in this analysis. Amphibians and reptiles are highly sensitive to microhabitat changes and serve as important indicator taxa for assessing ecosystem health at local scales; aquatic species are also key taxa for evaluating conservation needs in river, lake, and wetland ecosystems. Future research may incorporate these groups when adequate data is available, so as to more comprehensively reflect China's biodiversity conservation needs.

2.1.2. Data Sources and Processing

The main datasets used in this report include species habitat spatial data, species threat status and conservation attributes, protected area boundary data, and spatial environmental variables.

Species habitat spatial data: This report utilizes Area of Habitat (AOH) data to characterize

the actual suitable habitat range of each species. The data source is the global terrestrial vertebrate dataset developed by Lumbierres et al. (2022), with a spatial resolution of 100 m. Based on species range maps from the IUCN Red List, the dataset removes unsuitable habitats according to species habitat preferences (i.e., land-use types) and elevation ranges. It therefore provides more refined maps of suitable habitat and reflects the actual available habitat within each species' distribution range (Rondinini et al., 2011; Brooks et al., 2019).

Species threat status and conservation attributes: To reflect species' conservation status at the national scale, this report adopts the *China Red List of Biodiversity: Vertebrates Volume (2020)* as the baseline for assessing threat levels (MEE & Chinese Academy of Sciences, 2023). This list provides a comprehensive and localized evaluation based on IUCN Red List categories and criteria, incorporating trends in population decline, habitat fragmentation, and geographic range reduction of species within China. Species are classified into standard categories: Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), and Data Deficient (DD). Additionally, this report adopts the national protected level, namely Class I and Class II, specified in the *List of National Key Protected Wild Animals (2021)* of China. It further defines the scope of endemic species distributed exclusively within China by cross-checking taxonomic literature and distribution databases.

Protected area boundary data: This report uses the spatial boundary dataset of China's protected areas compiled by the Peking University Center for Nature and Society and Shan Shui Conservation Center. The dataset encompasses 6 national parks (including proposed parks), 1,638 nature reserves (including 475 national nature reserves), 2,991 forest parks, 1,663 wetland parks, 38 grassland parks, 132 desert parks, 410 geoparks, and 7 glacial parks, totaling 6,885 protected areas, covering 17.47% of China's land area[1].

Spatial environmental variables: This report uses land cover, human activity intensity, ecosystem service, and elevation to analyze the characteristics of conservation gaps. Land cover data are from the 2015 CGLS-LC100 global land cover product (Buchhorn et al., 2020) with a resolution of 100 m, reclassified into six categories: forest, shrub and grass vegetation, farmland, urban land, bare land, and water bodies. Human activity intensity is represented by the Human Footprint Index for 2000 – 2018 developed by Mu et al. (2022), with a resolution of 1 km. It includes eight indicators: built-up areas, population density, nighttime lights, farmland, pasture, roads, railways, and navigable waterways. Ecosystem service data are from the China terrestrial

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According to China's seventh national report submitted to the Convention on Biological Diversity, China has established 11,800 protected areas of various types, covering approximately 18% of its terrestrial territory. This study exclusively included protected areas within terrestrial spaces; marine protected areas such as marine reserves and marine parks were not included in the analysis. Due to limitations in data availability, some terrestrial protected areas may have been omitted. Despite these data constraints, the study achieves high coverage (97.1%) of major terrestrial protected areas nationwide.

ecosystem service value (ESV) spatial dataset generated by Xu (2018) based on multi-year remote sensing data using the equivalent factor method, with a resolution of 1 km, encompassing 11 services including food production, soil retention, water conservation, carbon sequestration, and biodiversity. Elevation data employs the SRTM Global Digital Elevation Model (Farr et al., 2007) with a resolution of 30 m, and were used to support the assessment of topographic features of conservation gaps.

To ensure accurate and targeted conservation gap identification, all raw data were screened, calibrated, and standardized. Terrestrial mammals and birds distributed in China were extracted from the global AOH raster dataset. Species with taxonomic synonyms or recent taxonomic splits were checked and matched one by one to ensure valid and unique taxonomic units. To improve data reliability, this report excluded species assessed as Regionally Extinct (RE), marginal bird species with only occasional vagrant records and no stable breeding or wintering populations, and rare species with extremely narrow distributions in China for which reliable AOH raster data could not be generated under current remote sensing resolution. The final analysis included 1,246 bird species and 519 mammal species, for a total of 1,765 terrestrial vertebrate species.

All species AOH layers and spatial variables were projected to WGS84, spatially aligned, clipped to China's administrative boundary, and resampled to 1 km resolution. This ensured consistent spatial extent, projection system, and resolution across all data layers for model calculation.

2.1.3. Technical Workflow

Based on the theory of Systematic Conservation Planning (SCP), this report developed a multi-source spatial workflow to identify conservation priority areas and conservation gaps for terrestrial vertebrates.

First, AOH data for China's terrestrial mammals and birds were collected, cleaned, and standardized. Species attribute information was also integrated to build a multi-source spatial database.

Second, quantitative weighting rules were established based on species threat levels, national protected levels, and endemism, guiding spatial optimization algorithms to prioritize areas that support species with higher extinction risk, greater evolutionary distinctiveness, and higher irreplaceability.

Third, Zonation v4.0 model was employed to conduct spatial conservation priority calculations based on species richness and threat levels. The analytical approach utilized the Core-Area Zonation (CAZ) algorithm, selecting scenarios without accounting for existing protected areas or applying cost constraints. The top 30% and 50% priority areas were extracted at the

national scale, in line with the KM-GBF 30×30 target and the Half-Earth goal. Additionally, comparisons were made between the results obtained using the Additive Benefit Function (ABF) algorithm and scenarios incorporating existing protected areas or cost constraints, to assess differences among algorithms and scenarios (see Appendix).

Fourth, conservation priority areas were overlaid with protected area boundaries, and areas not covered by protected areas were identified as conservation gaps.

Finally, conservation gaps were overlaid with land cover types, human activity intensity, and other spatial variables to examine their spatial characteristics, and to assess the potential costs and feasibility of conservation through OECMs in each region.

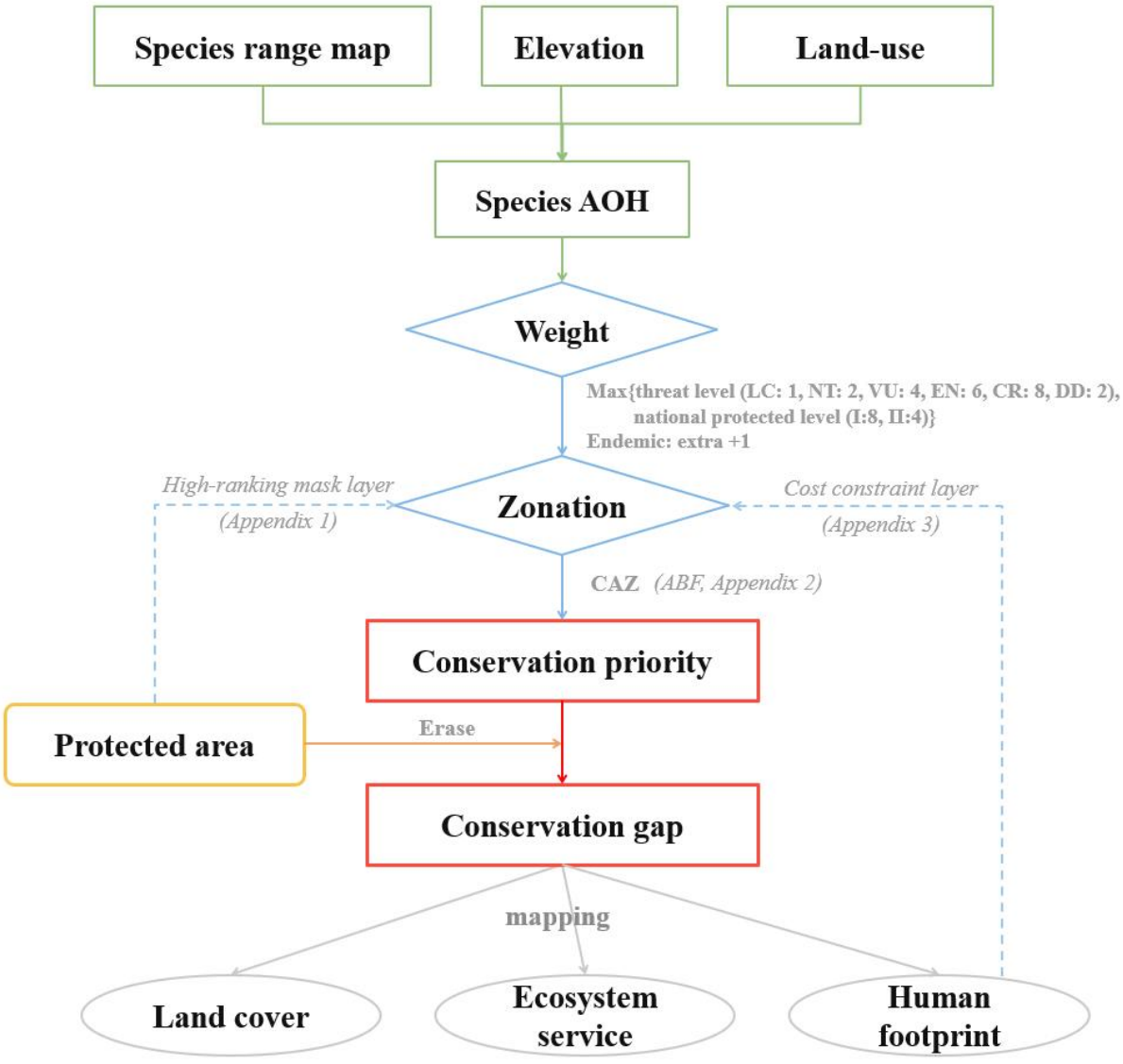


Figure 2.1 Technical workflow for identifying conservation priority areas and gaps

2.1.4. Identification of Conservation Priority Areas

This report uses Zonation v4.0 for large-scale spatial conservation prioritization (Moilanen et al., 2005). The Zonation model can integrate diverse biodiversity-relevant data (e.g., species, land cover types) and various cost factors (e.g., human activity intensity) to identify critical areas essential for maintaining habitat quality and connectivity (Lehtomaki & Moilanen, 2013).

For species weighting, this report used the higher of the threat status scores (LC = 1, NT = 2, VU = 4, EN = 6, CR = 8, DD = 2) and the national protected level scores (Class I = 8, Class II = 4) as the base weight. Endemic species in China are assigned an additional score of 1, thereby granting enhanced priority to spatial pixels hosting rare, endangered, or endemic species.

In the Zonation model, existing protected areas were not included as an analysis mask so as to simulate an ideal protection pattern driven by natural attributes such as terrestrial vertebrate habitats, thereby scientifically evaluating the coverage effectiveness of the current protected area system and identifying conservation gaps. A control scenario incorporating protected areas was also developed (see Appendix Section 1), where existing protected areas were designated as high-priority mask layers. The analysis prioritized retaining cells within protected areas, treating them as regions of high conservation priority, thereby fully recognizing their fundamental conservation roles while identifying high-value spatial gaps outside these areas.

In terms of spatial planning methodology, this report adopted the Core-Area Zonation (CAZ) algorithm to delineate conservation priority areas (Moilanen, 2007), while the results of the Additive Benefit Function (ABF) algorithm were used as a reference (see Appendix Section 2). Compared with the ABF algorithm, which maximized the summed local species value and prioritized areas with higher species richness (Moilanen, 2007), the CAZ algorithm adhered to the principle of minimizing maximum loss. It used the proportion of each species' distribution as the basis for calculation and removed raster cells iteratively according to the maximum relative loss for any single species. Therefore, CAZ placed greater emphasis on safeguarding the habitats of rare and range-restricted species, helping to ensure sufficient representation and protection coverage for all species in the conservation network (Lehtomaki & Moilanen, 2013).

To examine how human activity intensity and the cost of strict protection affect conservation priority layout, this report also designed a control scenario with conservation cost constraints (see Appendix Section 3). Human Footprint was used to represent marginal conservation cost, based on the assumption that strict protection is more difficult and costly in areas with high human activity such as cities, cropland, pasture, and transport infrastructures. The Human Footprint layer was assigned a negative weight whose absolute value equaled the sum of all species layer weights under the CAZ algorithm or the highest weight among all species layer weights under the ABF algorithm. Given that the OECM model is somewhat compatible with regional production and

livelihood activities, and that cost constraints tend to exclude human-dominated areas that support rare, endangered, or endemic species, the final delineation of conservation priority areas did not include cost constraints.

In the computation of the Zonation model, the edge removal algorithm was employed to eliminate only the lowest-value cells from the peripheral edges of habitat patches, preserving the spatial cohesion and structural connectivity of priority areas. The warp factor was set to 1,000, meaning that 1,000 edge cells with the lowest marginal value were removed in each iteration. This improved computational efficiency while maintaining analytical precision.

Based on the conservation priority layer and in line with the 30×30 and "half-the-world" conservation targets (Wilson, 2016), the top 30% and 50% priority areas were identified as core conservation priority zones, aligning with international conservation goals.

In addition, this report overlaid the identified conservation priority areas with China's terrestrial biodiversity conservation priority areas issued by the former Ministry of Environmental Protection. The official priority-area dataset was produced through georeferencing and digitizing the announced boundary maps (MEE, 2015). The overlay showed a spatial overlap of 42.2% between the two priority-area systems. These two sets of priority areas are complementary and can support conservation planning at different scales (see Appendix Section 5).

2.1.5. Identification and Characterization of Conservation Gaps

This report performed topological overlay and erase operations on the identified conservation priority areas and legally designated protected areas, extracting high-value patches located outside protected area boundaries as conservation gaps from the perspective of species representation.

To complement these fine-filter conservation gaps based on key species distributions, this report also incorporated coarse-filter gaps based on ecosystem representation and conservation gaps based on conservation network connectivity. This allowed a more integrated assessment of multidimensional conservation needs. For ecosystem representation, the report referred to Fan et al. (2023), who classified China's terrestrial natural ecosystems into six categories: forest, shrubland, grassland, wetland, desert, and alpine tundra, and further divided them into 691 subcategories. They calculated the percentage of each ecosystem category and subcategory covered by protected areas and compared it with the 30×30 target. For conservation network connectivity, the report referred to Zhao et al. (2022), who used Linkage Mapper to calculate least-cost paths between protected area patches. Patches requiring improved inter-patch connectivity were identified, and the corresponding least-cost paths were treated as priority ecological corridors. Areas with high ecological integrity along these corridors, namely wilderness areas with very low

human influence, were identified as priority areas for expanding existing protected areas or establishing new ones.

To analyze the spatial characteristics of conservation gaps, this report overlaid them with land cover, human footprints, and ecosystem services to calculate the land cover composition of conservation gaps, quantify human disturbance intensity, and assess ecosystem service potential. It provided a scientific basis for selecting appropriate conservation models that balance protection costs and land-use conflicts. The human footprint and ecosystem services were analyzed through bivariate spatial overlay visualization. Using the Jenks natural breaks, it categorized conservation priority, human footprint index, and ecosystem service value into four levels. Two bivariate matrices were then constructed: conservation priority-Human Footprint Index and conservation priority-ecosystem service value. These matrices were used to examine the spatial coupling relationship between human disturbance and ecological benefits within conservation gaps. This approach identified zones with conflicts between ecological conservation and socioeconomic development, as well as synergistic advantage areas, thereby providing a basis for understanding the practical constraints and development conditions of conservation governance in different regions.

2.2 Distribution Pattern of Terrestrial Mammals and Birds in China

Based on standardized AOH data for 1,765 terrestrial vertebrate species (including 519 mammal species and 1,246 bird species), spatial richness maps were generated through pixel-based GIS overlay analysis. The spatial patterns for mammals, birds, and overall species richness are summarized below.

2.2.1 Terrestrial Mammal Richness

Mammal richness in China shows strong spatial heterogeneity, generally following a distribution gradient that is higher in the south and north, with mountainous regions being more biodiverse than plains (Figure 2.2). South China, southeastern Xizang, southwestern Guangxi, and the central-southern part of Hainan Island constitute core areas with rich mammal richness, with more than 100 species in many individual grid cells.

In contrast, the hinterlands of the Qinghai-Xizang Plateau, northwestern inland basins, and the Alxa Plateau, constrained by harsh climatic conditions such as extreme cold and aridity coupled with homogeneous habitat structures, exhibit relatively lower mammal richness. However, these areas support endemic cold-and drought-tolerant species, such as wild yak (*Bos mutus*) and Przewalski's horse (*Equus ferus przewalskii*).

The central and eastern plains demonstrate moderate-to-low mammal richness with a patchy distribution pattern. Substantial reduction of primary forest habitats in this region due to prolonged agricultural development and urban expansion has led to habitat loss and fragmentation, resulting in significant declines among mammals dependent on continuous forest matrices. The remaining species are mostly taxa with some tolerance to human disturbance, and the current species richness is much lower than the potential historical baseline (Crooks, 2002).

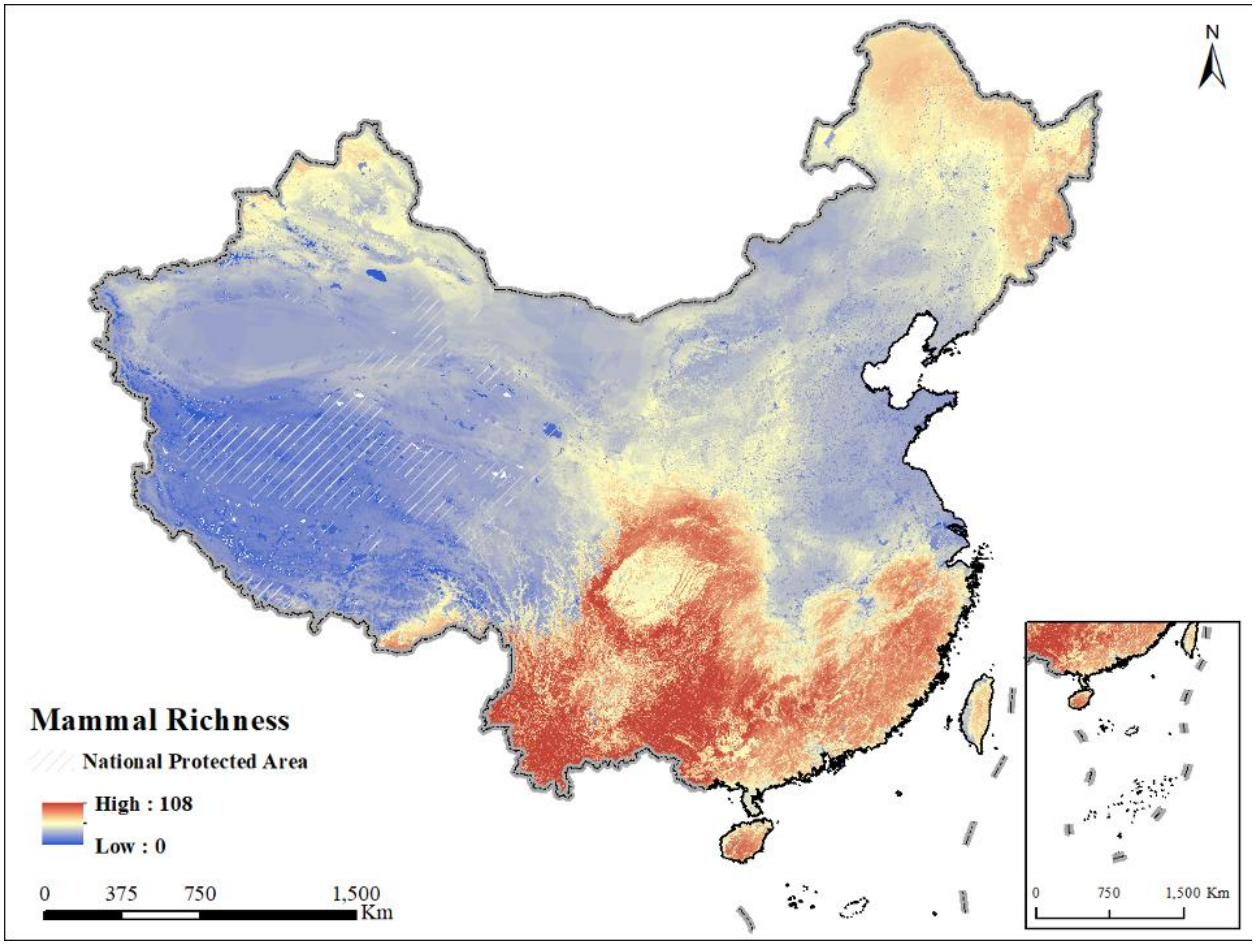


Figure 2.2 Mammal richness in China based on AOH data

2.2.2 Terrestrial Avian Richness

Compared with mammals, bird diversity in China shows a smoother latitudinal gradient but stronger local clustering in complex mountainous regions. Areas of high avian species richness are concentrated in the mountainous regions of southwest and southern China. Avian species richness can exceed 300 species in the Hengduan Mountains, the southern slopes of the eastern Himalayas, the Wuyi Mountains, and the Nanling Mountains. Birds have strong migratory capabilities, and

their distribution patterns are highly dependent on the vertical vegetation structure; the rich tropical and subtropical forests in these regions provide diverse habitats and foraging resources for different bird groups (MacArthur & MacArthur, 1961). In southwest China, high mountains and deep valleys create geographical isolation, accelerating long-term species divergence and making the region an important center of avian diversification in China (Chang et al., 2022).

In the eastern monsoon region, bird populations show significant seasonal fluctuations, with extensive agroforestry mosaics and various wetlands serving as crucial habitats. Although resident bird richness in this region is lower than in the southwestern mountains, this region lies along the East Asian-Australasian Flyway and provides key stopover and wintering habitats for migratory birds (Ma et al., 2014).

Bird diversity is generally lower in northwest inland areas and the interior Qinghai-Xizang due to climatic and topographic constraints; in desert ecosystems, birds predominantly inhabit along river systems and oases, while plateau bird communities are dominated by alpine endemic species (Jiang et al., 2025a; Li et al., 2025b; Song & Qu, 2025).

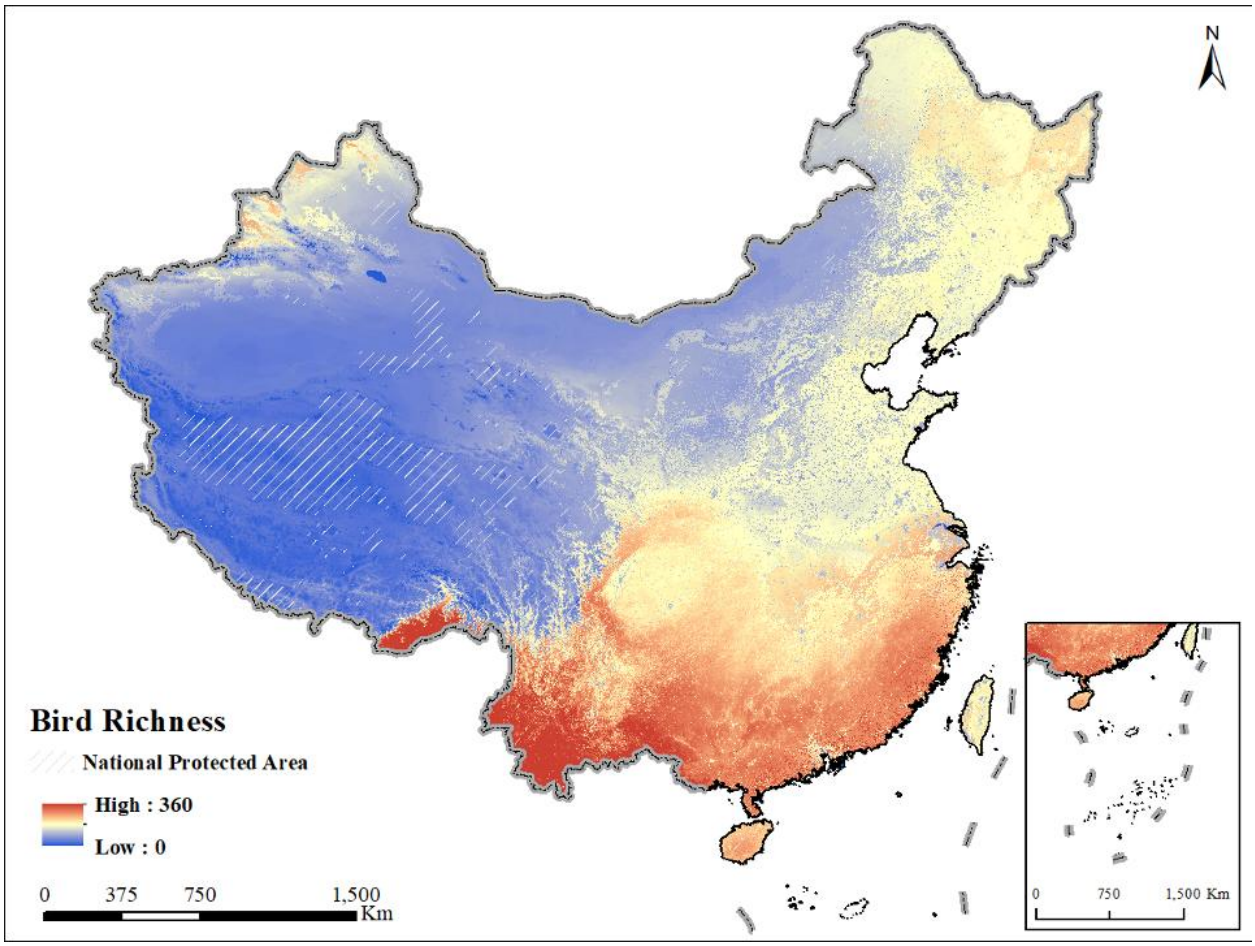


Figure 2.3 Avian richness in China based on AOH data

2.2.3 Comprehensive Spatial Pattern of Terrestrial Vertebrate Richness

The overall richness pattern of terrestrial vertebrates, using mammals and birds as indicator taxa, shows that high-richness areas are concentrated in southern and southwestern China (Figure 2.4). Southwestern Yunnan, southeastern Xizang, southwestern Guangxi, and the Hengduan Mountains form the core richness peaks, with more than 400 species in some local areas.

These regions are dominated by vegetation such as tropical monsoon forests and subtropical evergreen broad-leaved forests, featuring complex habitat structures, favorable hydrothermal conditions, and high productivity, supporting a wide range of ecological niches. In contrast, most of northwest China and the Qinghai-Xizang Plateau are constrained by cold and arid climates, with ecosystems primarily consisting of deserts, grasslands, and alpine meadows, resulting in generally lower overall terrestrial vertebrate richness.

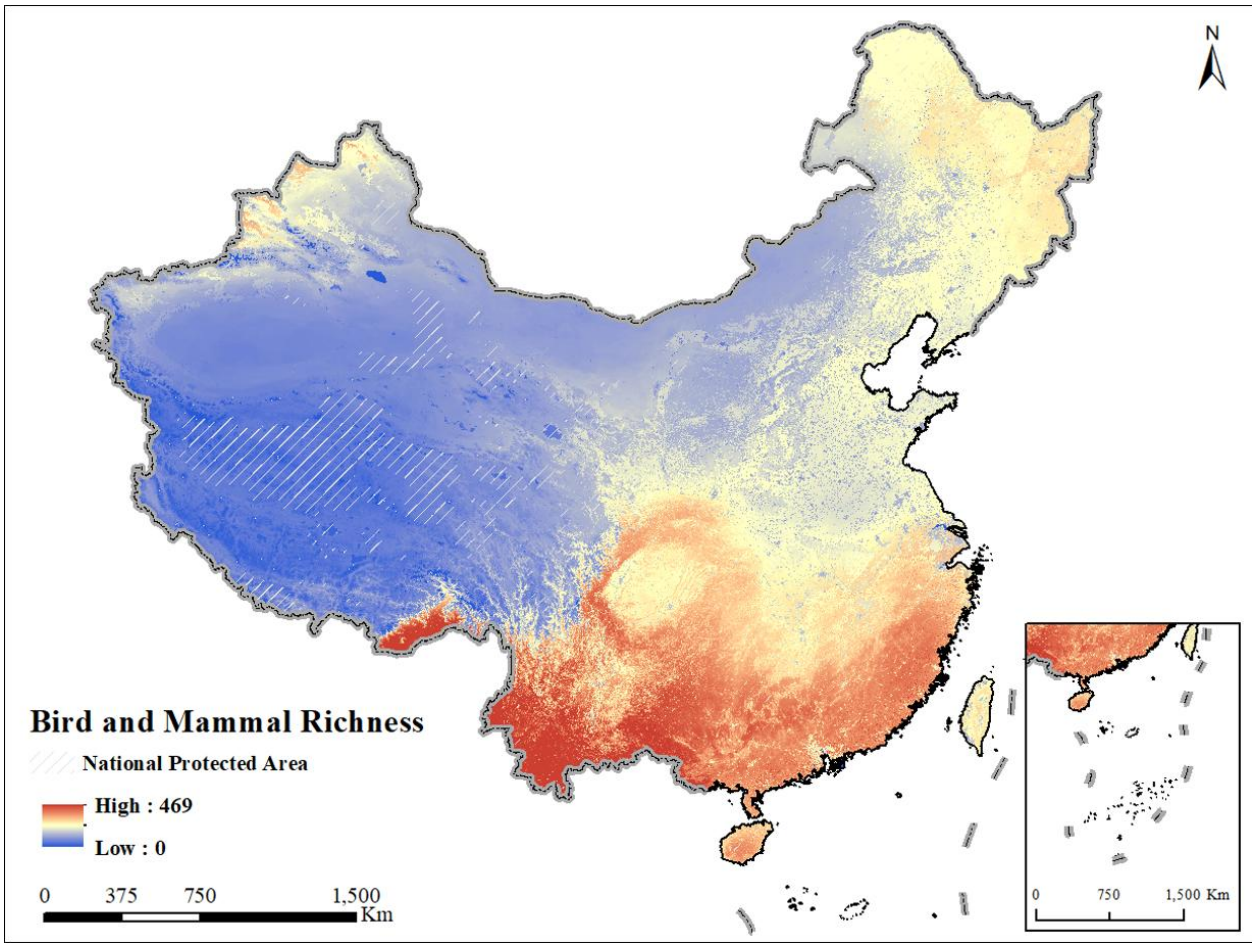


Figure 2.4 Overall mammal and bird richness in China based on AOH data

2.3 Spatial Patterns of Conservation Priority Areas and Conservation Gaps

2.3.1 Spatial Distribution of Conservation Gaps Based on Species Conservation Priority

At the national scale, the top 30% priority conservation areas exhibit significant spatial heterogeneity and geographic clustering (Figure 2.5). These areas are widely distributed across central-western Sichuan, southwestern Yunnan, southeastern Xizang, the middle and lower Yangtze River plain, central-western Zhejiang, northern Bohai Bay region, northern Inner Mongolia, northern Xinjiang, southern Guangdong and Guangxi, Hainan Island, and Taiwan Island. The top 50% conservation priority areas extend outward from these core areas. In southern China, they extend to the Nanling Mountains, Wuyi Mountains, and secondary vegetation zones of the Yunnan-Guizhou Plateau. In northern China, they form ecological corridors along the Greater Khingan Mountains, Taihang Mountains, and Qilian Mountains. Together, these areas form a fundamental conservation framework that maintains connectivity among terrestrial vertebrate communities and ensures stable ecosystem functioning. By prioritizing habitat representation for marginally distributed and regionally specialized species, the CAZ algorithm avoids concentrating priority areas only in the southern tropical regions with higher richness.

After overlaying the protected area layer, only 21.5% of the top 30% priority areas fall within existing protected areas, indicating large conservation gaps.

The mountains of southwest China and southeastern Xizang form a continuous conservation priority hotspot, which overlapped extensively with areas of high species richness. Current conservation efforts in this area are predominantly concentrated in low-cost, high-elevation zones, leaving extensive gaps in mid- and low-elevation forests.

The lake systems of the middle and lower Yangtze River and the coastal wetlands around the Bohai Rim are key hubs for migratory birds. Although mammal richness is relatively low, these areas are highly important for rare waterbirds and therefore have high conservation priority. Due to intensive agricultural and urban development, establishing large protected areas is difficult in these regions, resulting in extensive conservation gaps.

Island systems such as Hainan and Taiwan have high species endemism and are almost entirely identified as conservation priority areas. Although some areas are covered by protected areas, major gaps remain in low-elevation monsoon and coastal forests.

Northern Xinjiang, northern Inner Mongolia, and northeastern Heilongjiang have medium to low species richness but serve as crucial habitats for numerous Palearctic endemic species, sustaining the survival of specialized and rare species such as the Przewalski's horse, Mongolian wild ass (*Equus hemionus*), Amur tiger (*Panthera tigris altaica*), and desert rodents (Jiang et al., 2016). Conservation gaps in these areas are scattered, primarily concentrated in water source oases,

river-lake wetlands, and migration corridors that are vital for regional ecosystem stability and wildlife population survival.

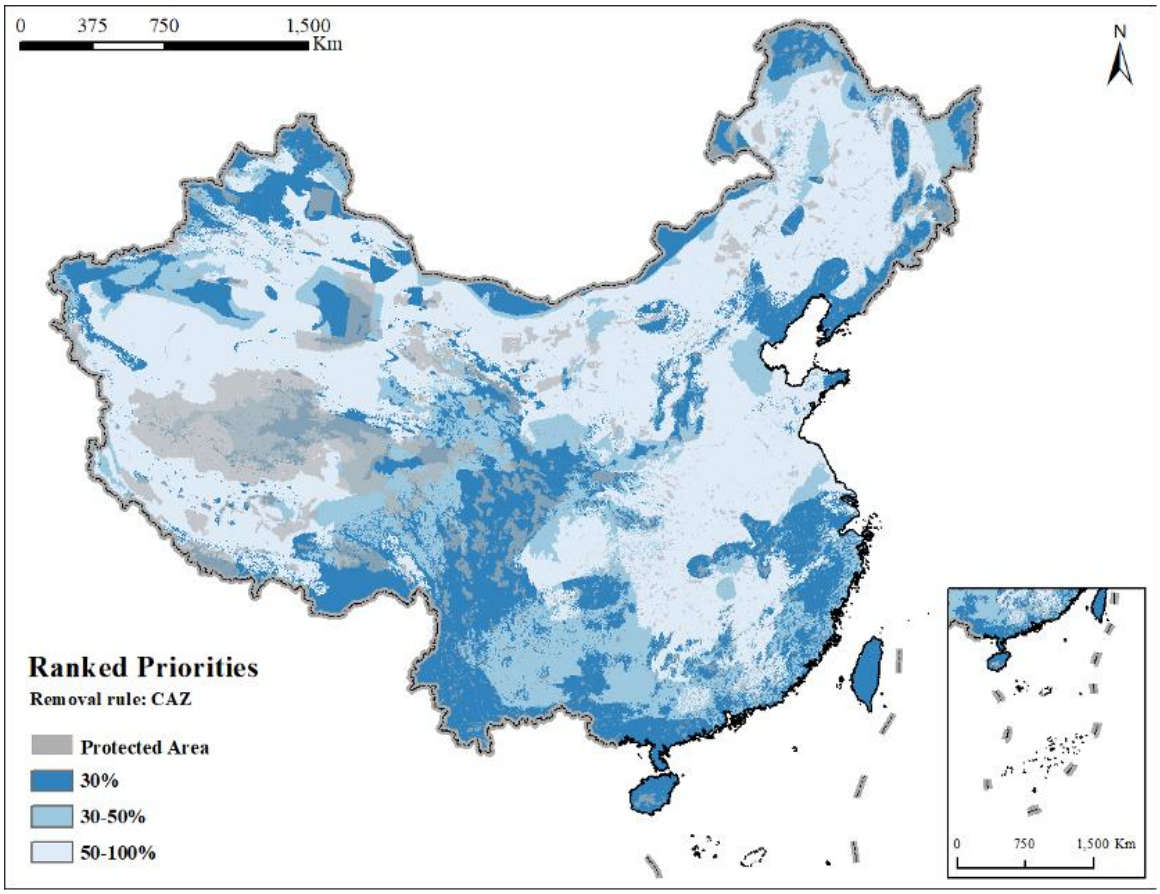


Figure 2.5 Top 30% and 50% conservation priority areas

Static spatial overlay analysis reveals the current pattern of conservation gaps. However, under climate change, the geographic distribution of species richness is shifting, adding temporal uncertainty to gap assessment. Observations and model simulations show that warming and changing precipitation are altering suitable habitats for terrestrial vertebrates. Many species are moving toward higher elevations and higher latitudes, and mammals and birds in the mountains of southwest China and the hills of central China are expected to shift upslope (Wen et al., 2017; Pan et al., 2019).

Climate-driven range shifts may further reduce the congruence between existing protected areas and suitable habitats (Buenafe et al., 2025). Under future climate scenarios, suitable habitats for particular species will shift beyond existing protected areas and form conservation gaps. Nevertheless, some gap zones can serve as vital climate refugia, owing to the presence of climatically stable microhabitats amid climate change. This may be especially important along

the Qinling-Huaihe transition zone and other biogeographic transition areas, where community turnover may occur more rapidly. This report does not systematically assess the dynamics of conservation gaps under different climate scenarios. Future studies could combine climate models to identify key refugial habitats with climate-buffering functions.

2.3.2 Integrated Conservation Gaps based on Ecosystem Representation, Ecological Connectivity, and Species Conservation Needs

1) Integrated Conservation Gaps Concerning Ecosystem Representation and Species Conservation Needs

Fan et al. (2023) assessed ecosystem representation in China's protected area network and found clear differences among ecosystem types. Wetlands (45.1%) and alpine tundra (31.2%) have higher protection coverage rates, and have already met the 30% conservation target. In contrast, grasslands (24.4%), shrublands (18.7%), forests (18.3%), and deserts (16.9%) remain underrepresented. Figure 2.6 shows the distribution of protected area coverage across natural ecosystem subcategories.

Among major ecosystem categories, the high conservation coverage of wetlands stems from the national strategic emphasis in recent years on water source conservation and protection of major river headwaters, with numerous critical inland water bodies and river sources incorporated into the core protection zones of national parks and nature reserves. The high coverage of alpine tundra is mainly due to very large protected areas on the Qinghai-Xizang Plateau and in high-altitude mountainous regions of northwest China (e.g., Sanjiangyuan, Qiangtang, and Altun Mountains). These areas have low human footprint and minimal opportunity costs for land development, making the designation of large-scale protected areas administratively feasible (National Forestry and Grassland Administration & Ministry of Natural Resources of the People's Republic of China, 2022; Hua et al., 2022; Wu & Liu, 2012).

Among underrepresented ecosystems, protected grasslands are mainly concentrated in alpine meadows on the Qinghai-Xizang Plateau. In contrast, large areas of temperate steppe and meadow steppe in central and eastern Inner Mongolia, which are traditional pastoral production landscapes, face trade-offs between livestock use and ecological protection (Fan et al., 2023; Ma et al., 2016), and have much lower protected coverage than alpine meadows.

Forest ecosystems exhibit heterogeneity in their conservation status across different latitudes, altitudes, and hydrothermal conditions. The cold-temperate coniferous forests of the Greater Khingan Range in northeastern China and some high-altitude subalpine coniferous forests benefit from natural forest protection policies that restrict logging, resulting in higher conservation coverage. However, subtropical evergreen broad-leaved forests, tropical monsoon rainforests, and

low-elevation deciduous broad-leaved forests in eastern, central, and southern China — often located in densely populated regions with a long history of agricultural development and predominantly collective forest tenure — show severe habitat fragmentation and have yet to be systematically incorporated into the formal protected area network (Zhang et al., 2020).

Although desert ecosystems have low population density, certain desert types (such as semi-fixed sand dunes with unique sand-fixing vegetation and desert-oasis transition zones) have relatively low conservation coverage due to their potential for mineral resource exploration or designation as reserve land resources.

Spatially, areas where ecosystem representation exceeds 30% are highly clustered, mainly in high-latitude and high-elevation regions of the Qinghai-Xizang Plateau and northern Heilongjiang. In contrast, natural ecosystems in southern China, along the eastern coasts, and around the margins of the Junggar and Tarim basins generally remain underrepresented.

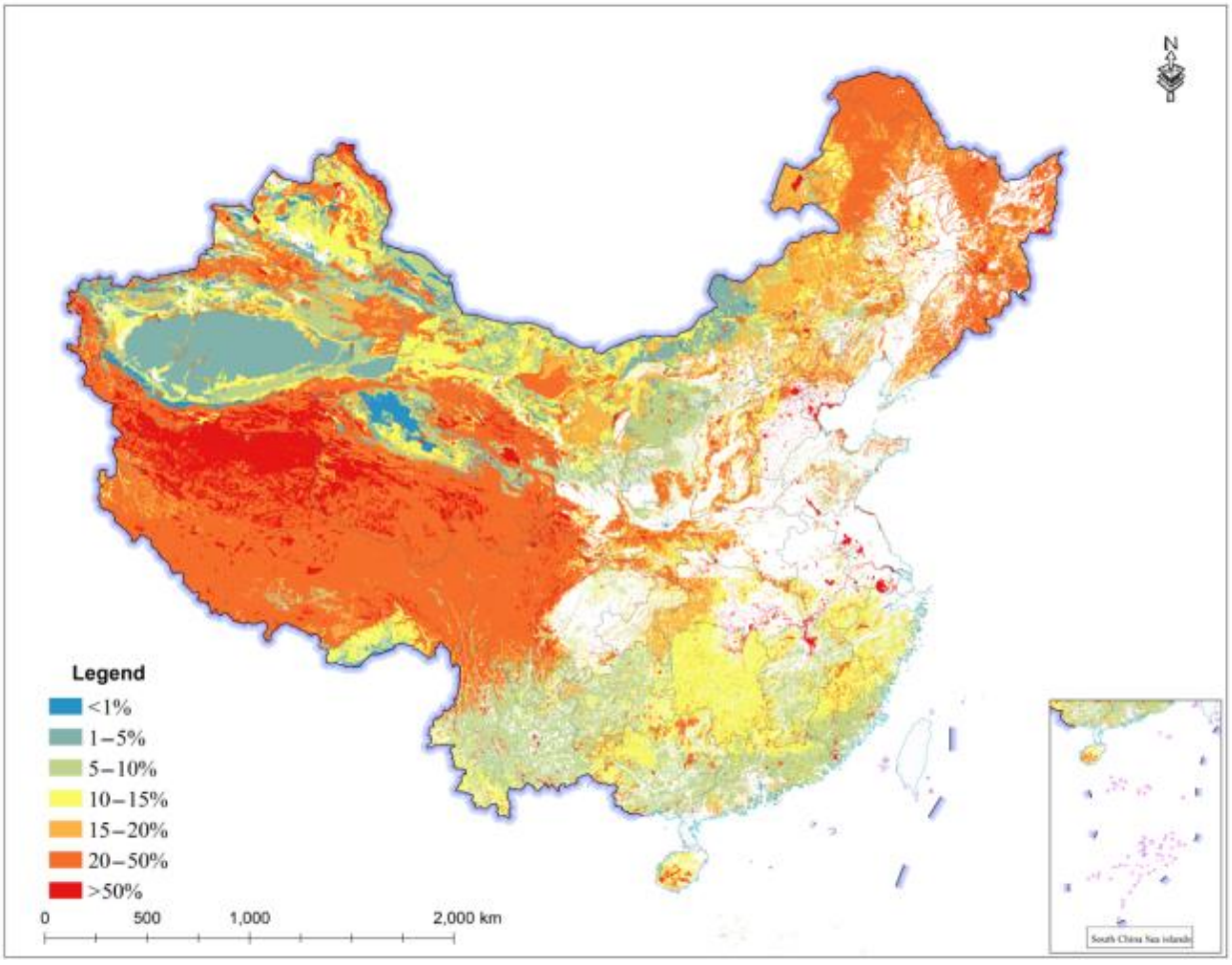


Figure 2.6 Protected area coverage of natural ecosystem subcategories in China, from Fan et al. (2023)

Combining the analysis of species-based and ecosystem-based conservation gaps shows that meeting ecosystem representation targets does not imply effective habitat coverage for all key vertebrates.

Taking the Western Sichuan Plateau region as an example, although its protected area coverage rate remains relatively low, according to Fan et al. (2023), the alpine tundra, alpine meadow, and alpine steppe ecosystems of the plateau have been adequately represented at the national level through protected areas across the Qinghai-Xizang Plateau, including Sanjiangyuan National Park, Sanjiangyuan National Nature Reserve, Qiangtang National Nature Reserve, and parts of Giant Panda National Park. However, in the conservation priority assessment based on the AOH for terrestrial vertebrate species (Figure 2.5), the Western Sichuan Plateau remains an important conservation gap for mammals and birds.

This difference reflects a mismatch between broad ecosystem classifications and the fine-scale microhabitat needs of species. The western Sichuan Plateau, as a major part of the Hengduan Mountains, is characterized by north-south mountain ranges alternating with deeply incised river valleys, such as the Jinsha, Yalong, and Dadu Rivers. Existing large-scale protected areas are primarily delineated along high-elevation ridges, glacial and snowline zones, and open plateau surfaces, encompassing vast alpine tundra and alpine meadows, thereby significantly enhancing conservation coverage of these ecosystems. In contrast, the valley floors between mountain ranges—characterized by deep, arid valleys and temperate valleys—develop unique local climates influenced by the foehn effects, nurturing numerous endemic vertebrate species while also serving as concentrated zones for human settlements, agriculture, and transportation infrastructure. To avoid land-use and management conflicts, protected area boundaries often stop above valley zones and rarely extend into them. This terrain-and human activity-based zoning bias results in substantial conservation gaps on the Western Sichuan Plateau: while the plateau demonstrates strong representativeness of alpine meadow ecosystems at the macro level, critical microhabitats—including valley forests, secondary shrublands, and agroforestry transition zones—remain largely unprotected. Many range-restricted birds, amphibians, and endemic small mammals dependent on valley microhabitats are still not effectively covered by the protected area system.

In complex mountain landscapes, increasing ecosystem coverage by protecting large high-elevation areas alone cannot ensure an effective umbrella effect for all species. Ignoring elevation gradients and local microhabitat differences can leave many endemic species unprotected (Mishra & Sahu, 2026). Therefore, conservation gaps should be identified by integrating the fine-filter perspective of species conservation needs with the coarse-filter perspective of ecosystem representation.

2) Integrated Conservation Gaps Concerning Ecological Connectivity and Species Conservation Needs

Zhao et al. (2022) assessed protected area connectivity in China and found that only 4.07% of China's terrestrial area consists of protected area patches with good inter-patch connectivity. For poorly connected protected area patches, the study identified 4,344 potential priority ecological corridors. It also selected ecologically intact areas along these corridors as priority patches for expanding the conservation network, including 1,253 priority patches for expanding existing protected areas, covering 11.7% of China's terrestrial area, and 9,284 priority patches for new protected areas, covering 7.4% of China's terrestrial area (Figure 2.7).

These ecological corridors are widely distributed within the species-based conservation gaps identified in this report using terrestrial vertebrate AOH data. In parts of northwest and northeast China, some conservation gaps overlap with conservation network expansion areas identified through ecological integrity. However, many key priority corridors in the middle and lower Yangtze River plain, southern China, northeast China, and western China do not fall within the species-based conservation gap patches identified in this report. This is because the species-based analysis prioritizes habitat representation and persistence needs for terrestrial mammals and birds, while the edge-removal procedure in Zonation only helps maintain some spatial cohesion and does not explicitly model functional connectivity, such as landscape resistance, least-cost pathways, gene flow, or seasonal dispersal. By contrast, connectivity analyses based on existing protected areas focus on corridors and expansion patches needed to strengthen linkages between protected area patches.

The two approaches are therefore complementary. Areas where species-based gaps overlap with priority ecological corridors could be prioritized to jointly improve species conservation and network connectivity outcomes.

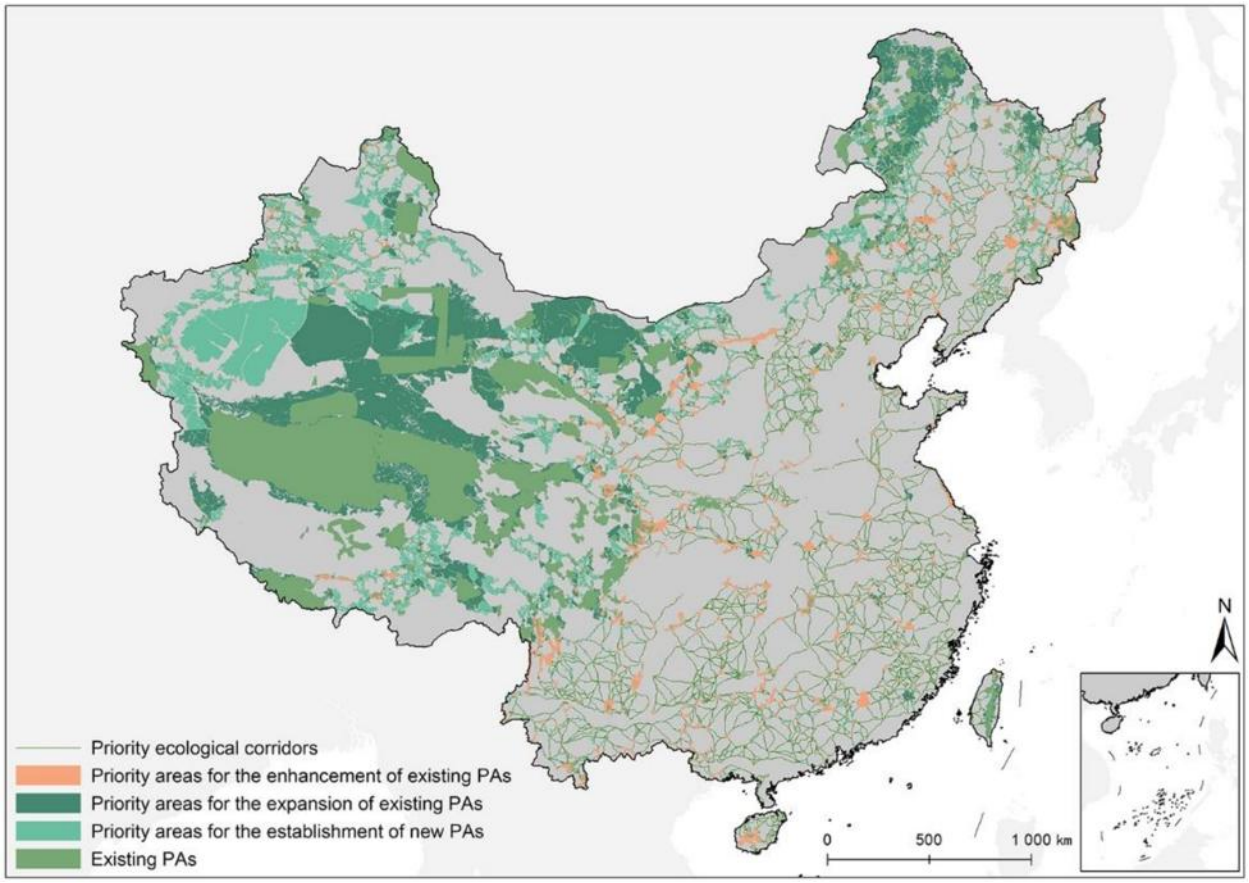


Figure 2.7 Priority areas for improving protected area network connectivity, from Zhao et al. (2022)

2.3.3 Characteristics of Conservation Gaps in Typical Regions

This report selects several typical conservation gap regions for analysis, including the southwestern mountainous regions, southeastern Xizang, the plains of the middle and lower Yangtze River basin, the hilly areas of east China, coastal tidal flats and islands, the arid northwest region, and the northern part of Qinghai-Xizang Plateau. The analysis focuses on their spatial distribution and biodiversity features, examining the drivers of conservation gaps and limitations of the existing protected area network.

1) The southwestern mountainous region and the southeastern Xizang area

Southwestern and northwestern Yunnan, western Sichuan, and southeastern Xizang represent the areas with the highest biodiversity of terrestrial mammals and birds in China (Lu et al., 2025) (Figures 2.2 – 2.4). Long-term interactions between the uplift of the Qinghai-Tibet Plateau and the Indian monsoon have created highly heterogeneous terrain, with alternating mountains and valleys and complete vertical vegetation belt spectrum (Zhang et al., 2024a). This multidimensional

habitat structure provides diverse ecological niches for vertebrates and served as a climatic refuge during the Pleistocene glaciation, preserving numerous relict species and phylogenetic evolutionary branches (Wu et al., 2023).

Although several national and provincial nature reserves have been established in the region, large and continuous conservation gaps remain from the perspective of species conservation needs. The primary causes are elevational bias in protected area placement and disrupted transboundary connectivity.

Existing protected areas are predominantly concentrated in relatively high-elevation regions with steep terrain, such as alpine bare rock, glacier and snow zones, and alpine coniferous forests (Joppa & Pfaff, 2009). These regions have relatively low economic development potential and correspondingly reduced conservation costs. However, many endemic mammals (e.g., gibbons and langurs) and birds (e.g., hornbills and parrots) primarily inhabit valley forests and slope forests at mid-to-low elevations, relying heavily on the three-dimensional canopy structures of tropical rainforests, monsoon forests, and subtropical evergreen broad-leaved forests, along with amphibians and reptiles sensitive to microenvironmental temperature and humidity. These areas are flatter, more suitable for agriculture and settlement, and are therefore less covered by protected areas. The lack of protection for these forests leads to habitat fragmentation, compressing the activity ranges of ecologically important birds and mammals —such as seed dispersers—and disrupting long-established co-evolutionary networks between flora and fauna. This weakens ecosystem resilience and results in systemic deficiencies in vertical ecological connectivity and food web nodes.

Furthermore, the cross-border connectivity gaps along the southwestern Yunnan and southeastern Xizang borders exacerbate conservation gaps. Species such as Asian elephant (*Elephas maximus*) and Indochinese tiger (*Panthera tigris corbetti*) move across national borders, but existing protected areas are often planned within administrative boundaries and do not fully account for transboundary migration corridors. Additionally, topographical barriers lead to habitat fragmentation, and prolonged isolation increases the risk of extinction for endemic populations, underscoring the urgent need for enhanced transboundary collaboration.

2) The middle and lower reaches of the Yangtze River Plain and the east China Hills

The middle and lower Yangtze River plain, the Jianghuai region, as well as the hilly areas of eastern China such as central-western Zhejiang and northern Fujian support medium-high terrestrial vertebrate richness relative to the rest of the country (Figure 2.4). This region features flat terrain, well-developed river networks, and warm, humid climate conditions, constituting a typical alluvial and lacustrine plain with China's most concentrated network of inland freshwater lakes and river networks. Under natural conditions, this region was once covered by contiguous

subtropical evergreen and deciduous broadleaf mixed forests and vast floodplain wetlands, supporting high-density populations of terrestrial birds, waterbirds, and small-to-medium-sized mammals, thus having a high conservation priority (Figure 2.5).

Conservation gaps in this region are extensive and continuous, but highly fragmented internally, resulting from prolonged intensive human activities and changes in land use patterns. As an economic belt with a long history of agricultural development, dense population, and rapid urbanization, the native forests and natural wetlands here have been widely converted into farmland, aquaculture ponds, and urban construction land.

In this highly disturbed human-dominated landscape, areas with high species richness are primarily found in fragmented secondary forests, agroforestry transition zones, and the peripheral regions of lake areas. Since the size of individual habitat patches often fails to meet the criteria for traditional protected areas, and the land is often collectively owned by local communities with relative high land acquisition costs, these important habitats for waterbirds and forest-dwelling birds have not been incorporated into the protected area system. The landscape matrices, dominated by farmland and urban areas, have low landscape permeability, hindering the migration and gene flow of mammals and resident birds between habitat patches. Remaining forests and wetlands, however, can function as ecological corridors and key buffers that maintain regional species persistence (Crooks, 2002). These identified conservation gaps underscore the urgency of preserving ecological corridor connectivity within human-dominated landscapes.

3) Coastal tidal flats and islands

Along the eastern and southern coastlines of China, including the northern Bohai Bay region, the coastal areas of Jiangsu, the southern coasts of Guangdong and Guangxi, as well as parts of Hainan Island and Taiwan Island, conservation gaps are shaped by both temporal dynamics and geographic isolation.

Although coastal wetlands do not have the highest annual average species richness nationwide, these areas are core hubs of the East Asian-Australasian Flyway (Ma et al., 2014). A significant number of migratory birds rely on the exposed intertidal mudflats at low tide to forage for benthic organisms and accumulate energy reserves for their long-distance migrations. Spatial analysis reveals that although some coastal wetlands have been designated as national nature reserves, many key tidal flats remain unprotected, forming elongated, continuous high-priority conservation gaps. These unprotected zones face intense interference from industrial land reclamation, port development, and intensive nearshore bivalve aquaculture, leading to declines in intertidal mollusk and benthic invertebrate communities. This disrupts the food web foundation for waterbirds during their stopover periods, reduces the region's food availability for migratory birds, and threatens the survival of many globally threatened waterbird species.

In tropical and subtropical island habitats such as Hainan Island and Taiwan Island, island biogeographic isolation has generated high species endemism. Although central mountain areas on these islands have relatively complete protected area coverage, major gaps persist in the surrounding low-elevation tropical monsoon forests and coastal forest edges. The physical constraints imposed by island size prevent species from migrating over long distances to escape environmental pressures, and the loss of low-elevation habitats further increases extinction risks for island-endemic mammals and birds.

4) The arid northwest region and the northern part of Qinghai-Xizang Plateau

In the vast regions of northern Xinjiang, western Inner Mongolia, the Hexi Corridor in Gansu, and northern Xizang Plateau, terrestrial mammal and bird species richness generally remains low due to the extreme arid inland climate, scarce surface water resources, and the cold, oxygen-deficient physical environment (Figures 2.2 – 2.4). However, these regions support many species adapted to arid and cold environments, such as desert rodents, large ungulates (e.g., Przewalski's horses, Tibetan wild ass, and goitered gazelles), and raptors. As a result, these regions still have high conservation priority and show scattered patch-like and strip-like conservation gaps, which are primarily concentrated at key resource distribution nodes—including oasis vegetation belts along inland rivers, areas surrounding seasonal lakes, and migration corridors linking different foraging patches (Figure 2.5).

Conservation gaps in the northwest and northern Qinghai-Xizang Plateau have low population density, minimal direct physical interference from human activities, and relatively high habitat integrity. However, due to water scarcity, these water source patches within these vacant zones become critical bottlenecks for the survival of entire ecosystems. Against the backdrop of glacier retreat and changes in the hydrological regimes of inland lakes driven by climate warming, these oasis-like water bodies isolated from protected areas face the risk of desiccation and salinization. Thus, the ecological significance of conserving these low-biodiversity regions lies in preserving the foundational functions and critical connectivity hubs of desert and alpine ecosystems, rather than merely increasing species diversity.

Overall, species-based conservation gaps are closely linked to geographical environment, geological evolution, and socioeconomic development intensity. Key issues include missing protection along mid- and low-elevation gradients in the mountains of southwest China, habitat fragmentation and corridor disruption in eastern plains, fragmented migratory bird corridors along coastal tidal flats, and insufficient protection of key water-source areas in the arid northwest and northern Qinghai-Xizang Plateau. These patterns reflect the limitations of traditional protected areas—characterized by static, isolated layouts biased toward low-interference zones—which are not fully aligned with the spatial needs and connectivity requirements of terrestrial vertebrates.

Expanding strictly protected areas alone is no longer sufficient for biodiversity conservation across the whole landscape. Future conservation planning must transcend administrative boundaries, adopt more spatially adaptive and flexible management approaches, balance ecological connectivity with community development, tailor strategies to regional specificities, and establish a more scientific and adaptive national biodiversity conservation system.

2.4 Land cover and Human Activity Characteristics of Conservation Gaps

2.4.1 Land Cover Composition of Conservation Gaps

Conservation gaps for terrestrial vertebrates in China show highly complex and heterogeneous land cover structures (Figure 2.8). In terms of area proportion, forests account for the largest share, at 42.0%, followed by shrubland and grassland at 23.3% (including 1.3% wetland vegetation), bare land at 15.8%, and farmland at 15.6%. Urban land and water account for smaller shares, at 2.5% and 0.8%, respectively. This spatial composition highlights the systemic biases of traditional conservation frameworks, especially in the protection of species-rich forests and productive landscapes. The following sections analyze the spatial distribution, ecological functions, and mechanisms underlying conservation gaps for each land cover type.

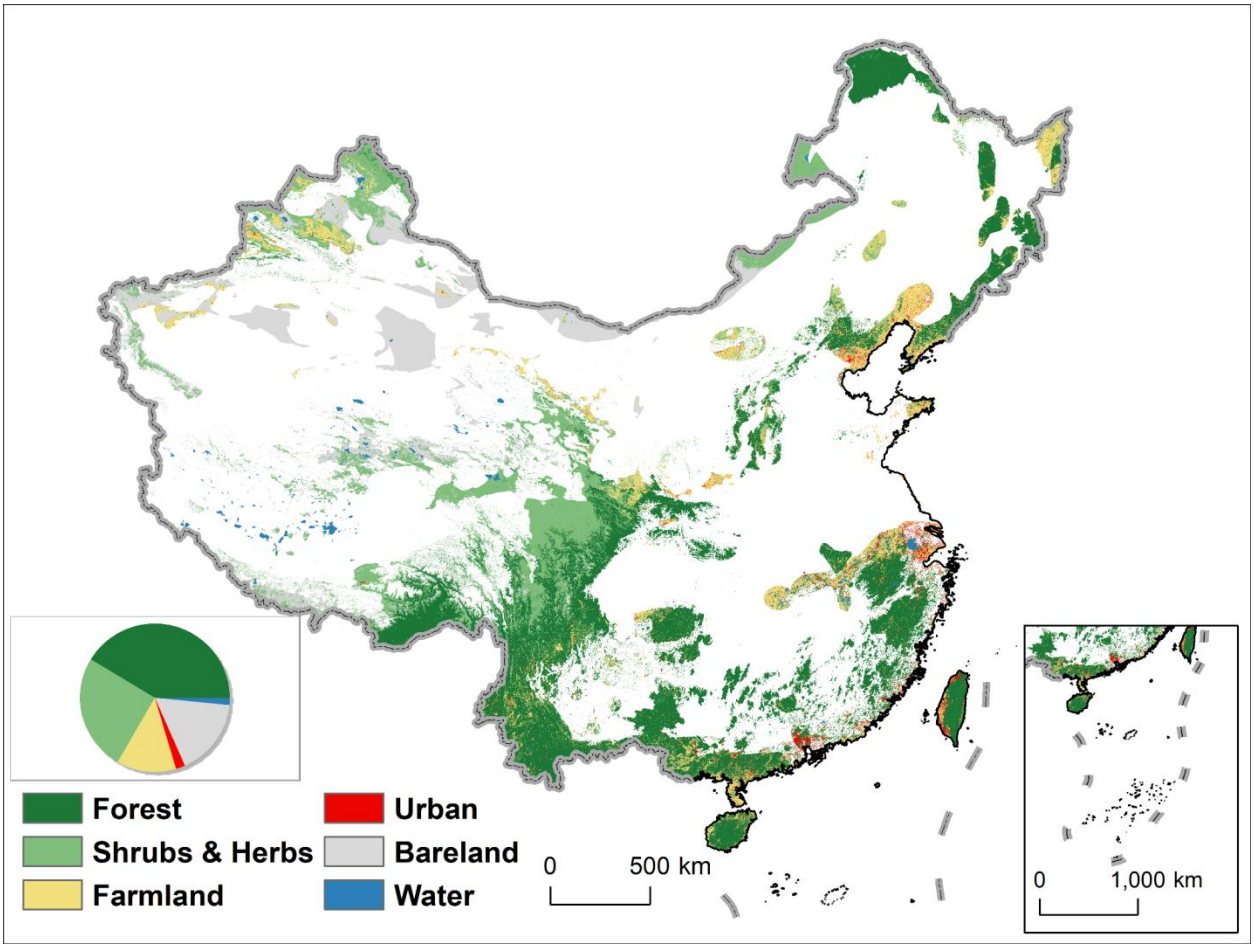


Figure 2.8 Distribution and spatial proportion of land cover in conservation gaps

1) Forest Ecosystems: Critical Conservation Gaps Under Topography and Socioeconomic Constraints

Forests account for the largest share of conservation gaps, which corroborates the finding by Fan et al. (2023) that protected areas cover a relatively low percentage of forest ecosystems. These gaps are primarily concentrated in southern and northeastern China, especially along the southwestern Yunnan border, southeastern Xizang, and the Sichuan-Gansu border area. Many high-quality natural forests and secondary forests have not been incorporated into the protected area system due to topographic and socioeconomic constraints.

Topographically, border regions and deeply incised forested valleys are fragmented and difficult to access. Early protected area designation often favored areas that were easier to manage and had lower development costs, such as high-elevation ridges, steep slopes, and areas above the forest line with limited economic value. In contrast, mid- and low-elevation evergreen broadleaf forests and monsoon forests, which have favorable hydrothermal conditions and higher species concentrations, have long been disrupted by timber harvesting, agricultural cultivation, and road

construction. The retreat of protected area boundaries toward higher elevations has left typical mid- and low-elevation forest ecosystems insufficiently covered, creating clear vertical conservation gaps in mountain landscapes (Joppa & Pfaff, 2009).

In terms of land tenure and socioeconomic conditions, large areas of secondary forests and well-preserved natural forests in southwestern provinces such as Yunnan, Guangxi, and Sichuan are collectively owned by rural communities. In many forest areas, contracted forest-use rights have been allocated to households (Wang, 2018; Guangxi Forestry Administration, 2025; Pang & Chen, 2025). These collective forests not only fulfill ecological functions like water conservation and carbon sequestration but also serve as material assets for local communities through non-timber forest products and understory economies. Establishing strictly controlled protected areas would directly restrict forest management and use rights. Due to limited local fiscal capacity and insufficient ecological compensation, the costs of protected area establishment and forest land acquisition are high (Xu et al., 2017). Consequently, numerous collective forest patches with high species richness and relatively intact forest ecosystems remain outside the conservation system, resulting in contiguous or scattered forest conservation gaps.

2) Farmland Ecosystems: Productive Landscapes with High Conservation Priority Yet Long-Neglected

Agricultural land accounts for 15.6% of the conservation gaps, indicating that this human-managed productive landscape has high biodiversity conservation value but has long been overlooked in traditional spatial conservation planning. Many studies show that agricultural land in China plays an important role in maintaining avian biodiversity, with nearly 25% of nationally protected bird species and 20% of threatened bird species utilizing farmland as habitats (Li et al., 2020), and over 30% of farmland identified as priority areas for bird conservation (Hou et al., 2022).

In China, farmlands are strictly defined by national law as production space for safeguarding food security, with the designation of permanent basic farmland areas. There is almost no practical room to convert farmland at large scales into protected areas that restrict human production activities. However, the potential role of farmland in in-situ conservation should not be overlooked. Farmland landscapes with clear biodiversity values and long-term management capable of maintaining conservation outcomes can be identified and strengthened through compatible conservation tools such as OECMs.

It should be noted that when highly human-modified landscapes such as farmland are brought into the conservation perspective, their actual contributions to the in-situ conservation of important biodiversity values should be assessed to determine whether they can contribute to the 30 × 30 target, or are more appropriately considered under other targets of the KM-GBF. China is currently

promoting agricultural non-point source pollution control, soil testing and formula fertilization, and broadly applied organic dryland farming. These measures mainly improve soil and water conditions, maintain soil micro-ecology, and support basic agricultural productivity. As broad biodiversity-friendly agricultural transitions, these practices are viewed primarily as direct contributions to Target 10 on the sustainable management of agriculture, forestry, and fisheries.

By contrast, some agroforestry mosaic landscapes within the high-priority conservation gaps identified in this report may have potential value that goes beyond general agricultural sustainability. For example, some rice paddies and aquaculture ponds in the floodplains of the middle and lower Yangtze River and around the Yellow and Bohai Seas are indispensable nodes along the East Asian-Australasian Flyway.

Where local communities maintain traditional farming systems that integrate cultivation and aquaculture, adapt to local conditions, and support circular use, and thereby avoid intensive monoculture, diversify native crop varieties, retain native vegetation within and around cropland, providing stable habitats for wildlife; or where communities or agribusinesses adjust farming schedules to meet wildlife needs, for example by maintaining winter-flooded fields during the fallow season or retaining spilled grain and non-commercial aquatic plants after harvest, and commit to these practices through village rules or ecological compensation agreements to support foraging and roosting habitats for wintering waterbirds such as Siberian Crane and Oriental Stork, these practices go beyond general green agricultural improvement and generate clear secondary or ancillary conservation outcomes. In such cases, agricultural production becomes closely coupled with conservation outcomes that support the persistence of threatened migratory bird populations. These farmland patches are no longer limited to Target 10, but can be further identified as high-quality productive-landscape OECMs and included in the in-situ conservation area accounting system under Target 3.

3) Urban Ecosystems: Ecological Connectivity Nodes from an Integrated Ecological Perspective

Urban land accounts for only 2.5% of conservation gaps. Urbanization is the primary human factor contributing to habitat loss and homogenization; extensive paved surfaces in urban built-up areas, altered soil and water environments, coupled with noise and light pollution, generally reduce habitat suitability for wildlife. Nevertheless, spatial planning models still identify some urban fringe areas with high conservation priority. These areas primarily include the urban-rural transition zones, large linear urban wetland parks, areas surrounding river estuary breakwaters, and suburban mountain forests with historical significance, located in coastal city clusters such as the Bohai Rim, Yangtze River Delta, and Shandong Peninsula.

Constrained by factors such as high urban land prices and land use primarily focused on residential and economic development, these areas are unable to establish large-scale exclusionary

protected zones (McKinney, 2002). As a result, high-quality ecological patches and connectivity nodes remaining in cities have long lacked formal protection. The identified high-value urban areas suggest that even in areas with relatively high human disturbance, biodiversity conservation potential can be mobilized through flexible management approaches, such as green infrastructure development, suburban microhabitat creation, and ecological corridor networking, thereby contributing to in-situ conservation targets.

Similar to farmland gaps, the recognition of conservation contribution in urban gaps also requires distinguishing among different conservation targets. Conventional road greenbelts, artificial municipal parks mainly designed for recreation, and intensively managed residential lawns primarily improve urban microclimates and provide leisure spaces. These highly homogenized green spaces, often lacking complex native plant communities, should be treated as typical contributions to Target 12 on increasing urban blue and green spaces and biodiversity-inclusive urban development.

By contrast, some peri-urban areas in coastal city clusters still retain small but critical conservation gaps for regional ecological connectivity, such as remnant natural wetlands, suburban native forests, and ecological buffer zones near coastal breakwaters. If urban planning and management department shifts away from intensive landscaping and adopts nature-based or rewilding measures, these areas can generate secondary or ancillary conservation outcomes. Examples include setting no-entry zones in large urban wetlands and retaining natural muddy shores for shorebird foraging and breeding; maintaining or creating multi-layered vegetation structures in urban forests, and retaining leaf litter and fallen logs to provide habitat for native small mammals, birds, amphibians, and other species; applying dark-sky protection to reduce light pollution for nocturnal animals. Such management measures give up some recreational convenience to maintain the habitat for certain wildlife communities. These areas therefore go beyond general urban landscape improvement and provide important conservation benefits for native species. Although small in area, these urban ecological patches are resilient to development pressure and have the potential to become urban OECMs, serving as micro ecological anchors for the in-situ conservation network within densely populated urban areas, contributing to Target 3.

2.4.2 Spatial Differentiation and Correlations of Human Activity Intensity in Conservation Gaps

In the implementation phase of the system conservation planning, the identification of biodiversity conservation priority areas only involved measuring natural baseline characteristics; conservation practices must also integrate regional socioeconomic patterns and account for the multiple ecosystem service benefits. Relying solely on species distribution data makes it difficult to assess development conflicts and ecological spillover benefits associated with conservation

actions (Naidoo et al., 2008). This report conducts spatial overlay and correlation analyses between the identified terrestrial vertebrate conservation priority areas and the Human Footprint Index (HFI) and Ecosystem Service Value (ESV), revealing spatial heterogeneity in human activity intensity and ecosystem services across conservation gaps, thereby providing data support for differentiated conservation strategies (Figures 2.9 and 2.10).

1) Spatial Relationship Between Human Footprint and Conservation Priority

Overlaying conservation priority with the Human Footprint Index (HFI) helps distinguish conservation gaps by the level of human pressure and implementation feasibility. Three main spatial types can be identified: high-priority and high-human-footprint overlap areas, high-priority and low-human-footprint synergy areas, and heterogeneous mosaic areas (Figure 2.9).

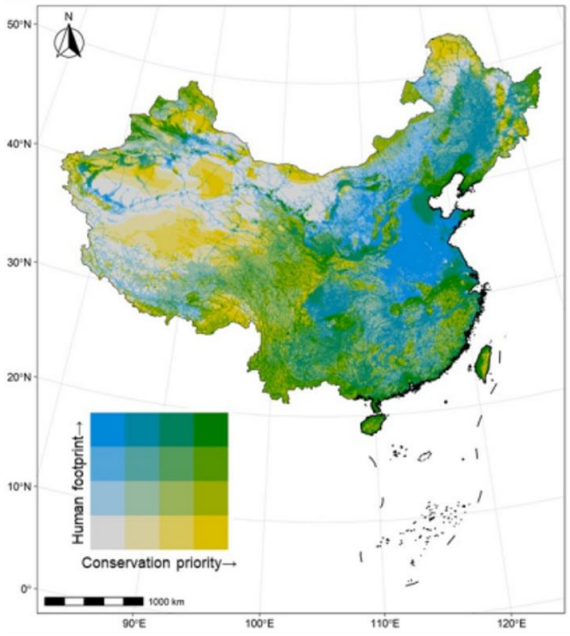


Figure 2.9 Spatial relationship between conservation priority and human footprint

High-priority and high-human-footprint overlap areas are mainly found in the northern Bohai Rim, the middle and lower Yangtze River plain, the South China coast, the margins of Hainan Island, and parts of Taiwan Island (green areas in Figure 2.9). These areas support key habitats for migratory waterbirds, lowland wetland species, and other vertebrates, but are also subject to intensive agriculture, aquaculture, urban development, and transport infrastructure. Because large-scale strict protected areas are difficult to establish under these land-use conditions, conservation should rely more on flexible, production-compatible approaches, such as biodiversity-friendly farming, wetland restoration, urban green corridors, and other OECM-type measures.

High-priority and low-human-footprint synergy areas are mainly located in southeastern Tibet, northern and central Xinjiang, northern Inner Mongolia, and the Greater Khingan Mountains

(yellow areas in Figure 2.9). These areas have relatively intact ecosystems, low development pressure, and lower opportunity costs for conservation. The land is predominantly state-owned forest areas or uninhabited regions, free from complex collective property issues, making administrative feasibility for conservation implementation high (Pimm et al., 2014). Where tenure and management conditions allow, they can be prioritized for protected area expansion to help fill gaps in the national conservation network.

Heterogeneous mosaic areas occur in regions such as southwestern Yunnan, northern Xinjiang, eastern Heilongjiang, and western Zhejiang, where high-quality habitats and human-used landscapes are closely interwoven, stemming from intricate topographic variations and historical land use patterns. In these areas, blanket protection or blanket development is unlikely to be effective. A source-sink landscape strategy is more appropriate: relatively intact habitat patches can be managed as source areas, while surrounding agricultural, forest-use, or settlement landscapes can serve as buffer zones and ecological corridors. Through reduced disturbance and adaptive land-use practices, these surrounding areas can safeguard source habitats and support animal dispersal. This approach can improve connectivity while maintaining compatible local livelihoods.

Overall, the HFI-priority overlay shows that conservation gaps require differentiated governance model. High-footprint gaps call for inclusive and flexible conservation tools, low-footprint gaps are more suitable for strict protection, and mosaic landscapes require zoning-based landscape management.

2) Relationship Between Ecosystem Service Value and Conservation Priority

Identifying areas where high conservation priority overlaps with high ecosystem service value (ESV) provides a basis for linking biodiversity conservation with natural capital and ecological compensation policies. Spatial overlay results show that large forest areas in southern and southwestern China, including the Hengduan Mountains, Wuyi Mountains, Nanling Mountains, and some major lake-wetland systems in eastern China, are core overlap areas between biodiversity hotspots and high ESV (green area in Figure 2.10).

These areas are dominated by highly productive subtropical and tropical forests and wetland ecosystems, which provide strong regulating services such as carbon sequestration, soil retention, water conservation, water purification, and climate regulation. The ecological spillover benefits generated from biodiversity conservation in these regions hold significant potential for transformation. Innovative market-based mechanisms, such as biodiversity finance, can be leveraged to broaden funding channels, address funding gaps, and ensure the sustainable and stable advancement of conservation efforts.

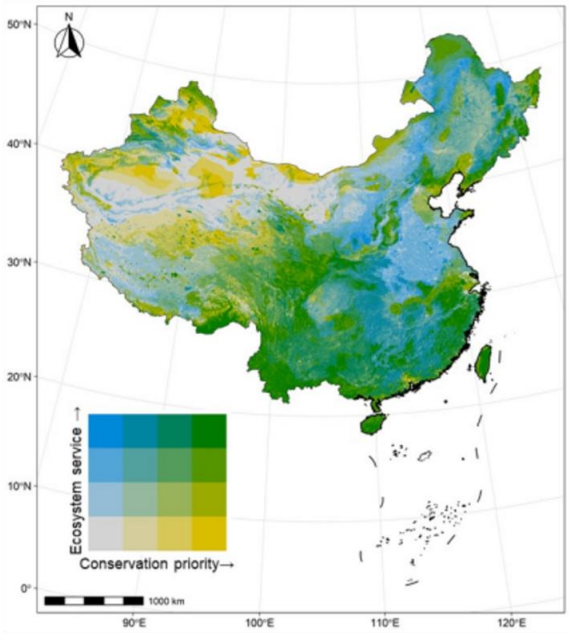


Figure 2.10 Spatial relationship between conservation priority and ecosystem service value

3) Policy Implications of Bivariate Spatial Correlation Characteristics for Governance Framework Systems

The two sets of bivariate spatial patterns suggest that filling terrestrial vertebrate conservation gaps in China requires moving beyond a single-dimensional administrative command approach toward a composite governance framework based on spatial heterogeneity.

In the developed eastern and southern regions, where the "high-footprint-high-priority" and "high-service-high-priority" zones overlap, traditional exclusive protected area establishment proves ineffective. Policy tools should shift toward establishing a market-based natural capital management system. Leveraging the high ecosystem service value of these areas, mechanisms for realizing the value of ecological products can be explored—such as carbon trading, transboundary ecological compensation within river basins, and green financial instruments—to convert the positive externalities of biodiversity conservation into economic benefits for local communities and collective forest tenure holders (Daily et al., 2000). This approach not only compensates local residents for the opportunity cost of relinquishing partial development rights but also incentivizes communities to adopt flexible management practices that enhance habitat quality. Furthermore, involving multiple stakeholders (e.g., rural collectives, enterprises, environmental NGOs) and implementing spatially compatible microenvironmental management measures—such as seasonal pesticide restrictions and preservation of ecological buffer strips—allows for localized biodiversity conservation within high-human-footprint ecosystems without triggering land expropriation

conflicts.

In summary, integrating human activity intensity, ecosystem service value, and species conservation priorities through spatial coupling analysis helps clarify the multiple practical constraints facing conservation gaps. Improving a whole-landscape biodiversity conservation network cannot rely solely on expanding traditional protected areas. It requires region-specific conservation approaches that combine strict protected areas, market-based incentives, and inclusive conservation models into a holistic conservation framework characterized by diversified synergy and precise adaptation.

Chapter 3 Spatial Needs and Practical Feasibility of OECMs Development in China

3.1 Practical Constraints on Establishing New PAs in Conservation Gap Areas

Spatial analysis reveals that numerous conservation gap patches are subject to moderate and high-intensity human disturbances. Under China's current legal, social and economic conditions, simply expanding enclosed protected areas through conventional administrative approaches faces prominent practical constraints and governance challenges. In biodiversity conservation hotspots across densely populated and highly developed areas of central, eastern, and southern China, the traditional exclusionary protection model is in tension with land tenure, economic development aspirations, and community livelihoods.

1) Restrictions of Land Tenure

The legal definition, distribution pattern, and historical evolution of land tenure constitute the institutional foundation for the feasibility of national macro-scale spatial conservation policies. Land tenure characteristics lie at the core of governance for biodiversity conservation gaps in China. Most areas requiring conservation are located on collectively owned rural land. Establishing PAs in regions with complex land tenure where local communities depend heavily on land resources for livelihood may impose certain restrictions on land use and related income, requiring coordinated compensation policies and development mechanisms. When coordinating with a large number of dispersed rural households, the costs of land coordination and ecological compensation increase substantially. In the collectively owned forests of southern China, forest tenure is fragmented, and disputes over forest boundaries often exist within and between communities. Without clear land tenure and community consensus, the administrative, time, and

communication costs of land requisition or long-term land transfer often exceed the capacity of grassroots governance. Addressing these challenges requires moving beyond exclusive regulations to develop inclusive institutions within the current property rights framework, which recognize and respect community interests, maintain the multifunctional values of land, and achieve biodiversity conservation goals.

2) Constraints of Population Agglomeration and Socio-economic Dependence

From the perspective of environmental economics, establishing PAs with full or partial restrictions on human activities in densely populated, economically developed regions with high land productivity entails substantial fiscal and opportunity costs. Early conservation strategies focused on minimizing costs have left numerous biodiversity conservation gaps across eastern and southern China. Taking the remaining patches of secondary evergreen broad-leaved forests in East China as an example, these ecosystems not only provide carbon sequestration and water conservation functions but also harbor substantial economic value through understory resource use. Under conditions of limited land resources, strict closed-off protection will directly result in economic losses for local communities. Moreover, as the conservation network expands from low-cost areas into densely populated regions and areas with high agricultural output, the costs of land coordination, resettlement, and social governance rise sharply, rendering the traditional rigid conservation models unsustainable. To address this dilemma, innovative spatial governance tools are required that fully recognize and internalize conservation opportunity costs, allow lands to maintain multiple productive and ecological functions, and thereby reduce the marginal costs of biodiversity conservation.

3) The Distinct Conservation Dilemma of Fragmented Ecological Corridors

Conservation gaps are prevalent along ecological corridors, significantly raising management costs and posing implementation challenges under the PAs governance framework. This is partly because stepping-stone patches within ecological corridors are typically too small to meet the administrative requirements for designation as protected areas, such as the minimum area requirements for core zones of nature reserves. Furthermore, fragmented corridors require ongoing dynamic management rather than static enclosed protection. Many semi-natural spaces with moderate human activities, including farmland and urban green spaces, can serve as functional stepping stones for species migration and dispersal, effectively connecting core conservation areas and improving overall ecological connectivity. For instance, ecological corridors identified in Yunnan Province run through farmland, towns, and other human-dominated landscapes. Their ecological functions rely on seasonal land-use management— fallow fields serve as stopover sites for migratory birds in winter—rather than year-round restrictions on human activities, making rigid enclosure management unsuitable. To ensure effective conservation for such ecological corridors, it is urgent to adopt flexible conservation tools that accommodate sustainable human

activities. Recognizing multi-stakeholder governance and allowing reasonable ecological production and sustainable land use can deliver conservation outcomes, maintain landscape connectivity, coordinate regional development demands, and achieve synergistic progress between conservation and socioeconomic development.

3.2 Rationality of OECMs as a Core Approach to Filling Conservation Gaps

Land management is challenged by scattered tenure, economic constraints and conservation issues across fragmented landscapes. With inclusive governance frameworks, flexible conservation goals, and multi-party participation mechanisms, OECMs offer an innovative in-situ conservation pathway for densely populated and highly developed regions, and present viable solutions to fill the conservation gaps in China.

1) The Flexibility of OECMs in Accommodating Human Activity Patterns within Conservation Gaps

Spatial overlay analysis reveals that a large share of high-quality habitats for terrestrial vertebrates is predominantly concentrated within agricultural landscapes with high human footprint indices, urban fringes, traditional communities, or resource-use areas. OECMs do not need to be governed and managed primarily for biodiversity conservation, as long as sustained management delivers long-term effective biodiversity outcomes. Accordingly, sites supporting farming, urban development, community livelihood activities, or sustainable fisheries are eligible to be integrated into the overall conservation network. Compared with protected areas, OECMs can recognize and strengthen existing conservation-compatible practices, rather than requiring a change in land tenure or the primary land-use function. Sites that can demonstrate effective long-term biodiversity conservation outcomes may be recognized as OECMs without requiring costly fiscal ecological resettlement of local communities or changes to existing collective land tenure. OECMs support the conservation of key species via modest adjustments to human-led management regimes without compromising the primary economic functions of these areas (Cook, 2024; Jonas et al., 2021). This flexible approach internalizes ecological conservation objectives into existing production and management systems.

2) Biodiversity Value of China's Semi-Natural Landscapes and Their Conservation Compatibility with OECMs

Approximately 18% of the conservation gaps identified in this report are distributed across farmland or urban fringes, revealing the potential of semi-natural landscapes to host terrestrial vertebrate biodiversity. Across China's widely distributed semi-natural agroforestry landscapes, traditional community farming activities create moderate disturbance that sustain ecosystem

dynamic balance. Such systems accommodate plant communities at varying successional stages and provide diverse niches for forest-dependent birds and mammals. Recognizing the identified semi-natural landscapes with moderate disturbance regimes as OECMs would represent a policy response grounded in ecological science. The OECM assessment prioritizes long-term biodiversity conservation outcomes over ecosystem intactness. This grants institutional legitimacy and sustained formal recognition to traditional agricultural and pastoral management practices (such as agricultural heritage systems), as well as local ecological knowledge that supports rare and endangered species and safeguards vital local genetic resources within modern conservation frameworks.

Take the Honghe Hani Terraces in Yunnan as an example. Local communities with traditional livelihoods have formed an integrated landscape structure consisting of forests, villages, terraces, and water systems, which builds a stable material circulation and hydrological regulation system. This system serves as a crucial alternative habitat as wetlands shrink, boasting higher ecological stability than monoculture commercial forests and sustaining diverse amphibians and waterbirds. Maintaining the dynamic balance of such landscapes requires moderate human disturbances, such as regular irrigation, ploughing, and weeding. If enclosed protection management were adopted to designate this area as human-free zones, the water system would collapse, the terrace would dry up, shallow-water habitats would disappear, ultimately leading to consequent local extinctions of associated species.

Incorporating semi-natural landscapes with biodiversity values into the identification of OECMs can compensate communities for the opportunity costs of upholding traditional farming through developing ecological products (such as organic red rice and terraced ecological fish from Honghe Hani Terraces) and ecotourism. This encourages local communities to consistently adopt biodiversity-friendly land management and promote synergistic advancement of nature conservation, cultural heritage and local economic benefits (Jonas et al., 2021; Liang et al., 2025a).

3) OECM Enhances Social Participation in Biodiversity Conservation

By promoting multi-stakeholder governance and benefit-sharing, the framework of OECMs can shift biodiversity conservation toward inclusive public participation (Cook, 2024; Jonas et al., 2021). Shared governance, alongside private and community-based management regimes, dominates all reported OECM sites worldwide. Due to the exclusionary nature of PAs, non-state actors have limited avenues to take part in spatial conservation. OECMs help overcome this barrier by providing opportunities for inclusive governance.

For different types of entities, social organizations can serve as bridges to facilitate multi-stakeholder cooperation within the framework. Leveraging their professional strengths in ecological monitoring, community mobilization, and fundraising, environmental social organizations assist grassroots communities in identifying potential OECM sites, drafting long-

term management plans, and performing third-party monitoring and verification. For corporates with sustainability goals, OECMs provide a tangible spatial platform. As the *Taskforce on Nature-related Financial Disclosures (TNFD) Recommendations* gain traction across global business sectors, assessing and disclosing the dependencies and impacts of corporate activities on biodiversity has become a key component of corporate compliance and risk management. Enterprises can achieve measurable biodiversity gains by purchasing ecosystem services provided through OECMs, supporting conservation efforts with capital, human, and technical resources, or managing their ecologically-valuable commercial lands in accordance with OECM criteria (Macfarlane et al., 2021). For grassroots community organizations and individual land users, OECMs recognize their roles as ecological stewards.

Targeted social capital investment and in-depth empowerment of community spaces transform in-situ biodiversity conservation from a sole fiscal burden on governments into sustainable spatial governance with the shared participation and benefits for all stakeholders.

3.3 Practical Feasibility of Conservation Gap Areas as Potential OECMs

To verify the practical feasibility of converting conservation gaps into potential OECMs, this report conducts spatial overlays between potential OECMs and conservation gaps in China, so as to confirm their compatibility and transformation potential.

3.3.1 Collection and Identification of Potential OECM Cases in China

Exploration of the OECMs framework by Chinese government departments, authoritative research institutions, and environmental social organizations has progressed from theoretical research and discussions to the collection of potential cases, analysis of their characteristics, and multi-dimensional assessment of their effectiveness.

From 2024 to 2026, two nationwide OECM Potential Case Collection jointly organized by multiple social organizations received a total of 136 submitted applications. For this case collection, localized OECM criteria were formulated by referring to the OECMs criteria by IUCN, alongside two documents: *Recognising and reporting other effective area-based conservation measures (2019)* and *Site-level tool for identifying other effective area-based conservation measures (OECMs): first edition (2023)*.

The localized criteria cover at least the following:

1. The site should have clear geographic boundaries, and shall not fall within the scope of

PAs in China;

2. The site shall have clearly defined governing entities with well-demarcated powers and responsibilities. Institutionalized decision-making and implementation mechanisms shall be established regardless of the governance model, whether government governed, community governed, private governed, or multi-stakeholder co-governed;

3. The site hosts significant biodiversity value reflected in rare and endangered species, representative ecosystems, ecological connectivity of conservation networks and other key attributes;

4. In terms of conservation effectiveness, the case must provide verifiable evidence of conservation outcomes. Such supporting materials can consist of baseline survey data, routine monitoring records, third-party assessment reports, or local communities' traditional ecological knowledge, which collectively demonstrate that biodiversity within the site has been maintained or enhanced throughout the management;

5. Long-term institutional arrangements shall be in place to sustain conservation performance for a minimum of five years into the future. Relevant arrangements cover secure long-term land use rights, formal rules and agreements governing site governance and management, guaranteed long-term funding streams, as well as a permanent, professional on-site conservation team.;

6. Informed consent must be obtained from holders of land use rights before they participate in application and assessment.

These criteria enabled the expert panel to conduct comprehensive evaluations of submitted cases. There are 85 cases basically meeting the criteria, among which 27 are identified as exemplary cases.

These potential OECM sites cover a total area of 221,800 hectares, encompassing ecosystems such as forests, urban areas, freshwater/wetlands, grasslands, farmlands, marine/coastal zones, and deserts—basically representing all major terrestrial and marine ecosystem types across China. These sites safeguard numerous rare and endangered species, including the Amur tiger, Amur leopard, North China leopard, snow leopard, giant panda, small Indian civet, black muntjac, Yunnan snub-nosed monkey, oriental stork, Asian houbara, yellow-breasted bunding, common water monitor, spotted seal, green sea turtle, *Phoebe zhennan*, and *Cycas pectinata*. The sites include various types such as state-owned forest farms, critical wildlife habitats, government-managed wetlands, rehabilitated district, community conserved areas, conservation areas managed by social organizations, drinking water sources areas, closed fishing areas, nature-friendly farmlands and pastures, urban parks, campuses, corporate premises, and tourist attractions (Shan shui Conservation Center, etc., 2026).

Outcomes from these two case collections demonstrate that China boasts abundant potential OECMs. Numerous areas outside PAs whose conservation contributions remain unofficially recognized continuously sustain regional biodiversity. More importantly, through the workflow of collection, review, identification and long-term management, OECMs are being translated from international concepts and identification criteria into an assessment tool for conservation outcomes in China.

3.3.2 Feasibility and Adaptability of Potential Regional OECMs Based on Case Validation

From the perspective of spatial distribution, potential OECMs nationwide show a distinct pattern of dense coverage in the southeast and spare coverage in the northwest, which closely aligns with China's long-standing demographic and economic spatial pattern demarcated by the Hu Huanyong Line. (Short for Hu Line, also known as the Heihe-Tengchong Line: Its southeast dominated by plains and hills, concentrates about 94% of China's population, while the northwest featuring plateaus and mountain ranges accounts for merely 6%.) In this report, over 90% of potential OECMs are located within the conservation gaps, providing empirical evidence that OECMs can partially mitigate such conservation shortfalls (Figure 3.1).

Specifically, the southeast of the Hu Line contains 70 cases, accounting for 82.4% of the total. These sites are densely distributed with diverse types and reflect multiple models of social participation; the vast majority cover fragmented priority conservation areas. In contrast, the northwest section hosts only 15 cases less than 20%. Though small in quantity, these sites feature larger individual areas and represent community-led conservation based on sustainable natural resource use. They are mainly located in conservation gaps or surrounding PAs, serving as valuable complement to regional conservation network.

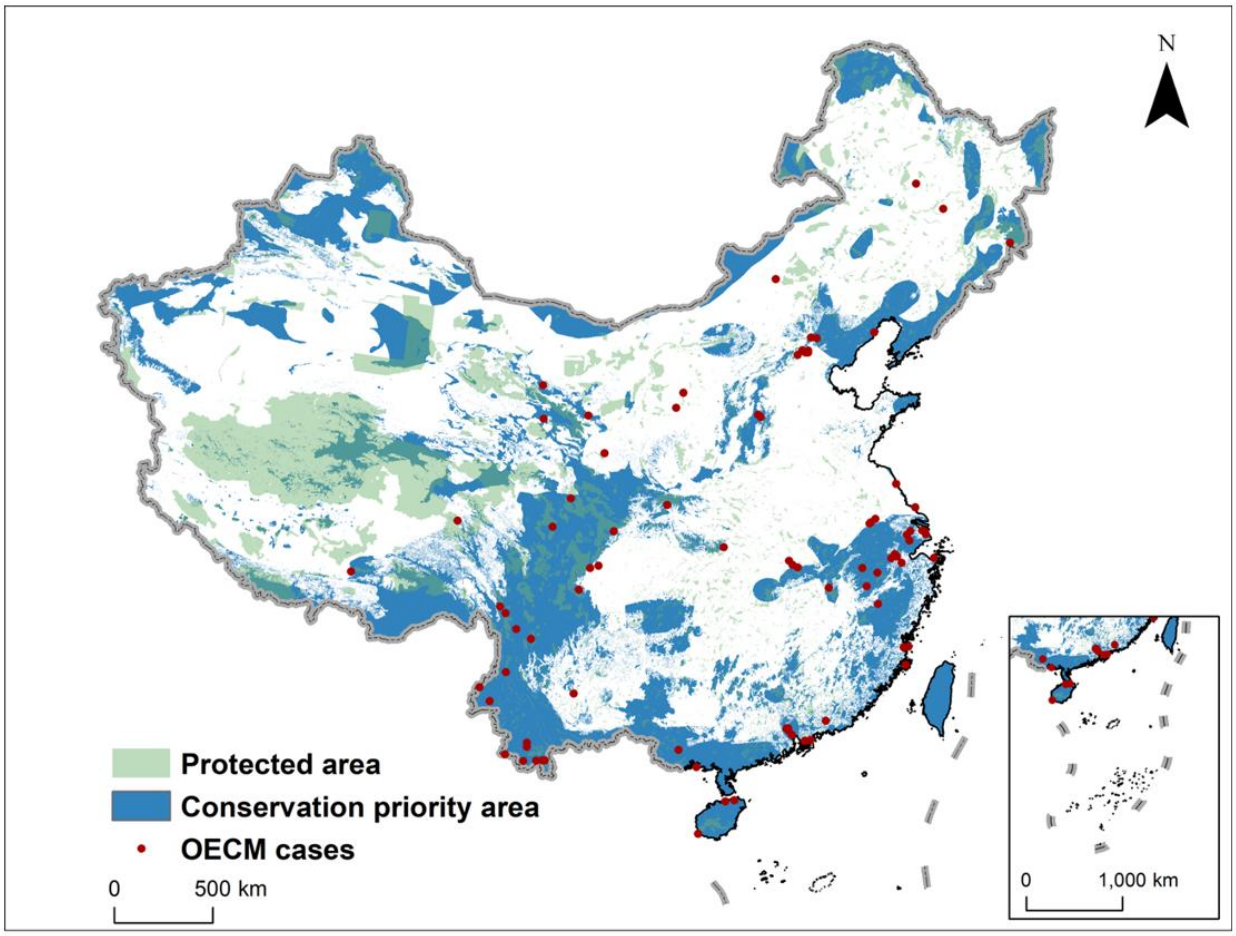


Figure 3.1 Distribution of OECM potential cases and conservation gap areas

The potential OECM cases feature diverse forms of participation. In terms of governing authorities, communities account for 39% of the total, government agencies for 22%, social organizations for 21%, the private sector for 11%, and educational institutions for 7% (Figure 3.2 left).

Classified in reference to the governance type by IUCN, the cases fall into four types of governance: governed by government, shared governance, community governance, and private governance (covering both non-profit and for-profit organizations). Their proportions are relatively balanced, standing at 18%, 33%, 22%, and 27% respectively (Figure 3.2 right). This composition markedly differs from the WD-OECMs database by governed by government (51.6%) and shared governance (40.9%) (Jonas et al., 2024). This distinction underscores the prominent bottom-up character inherent to the exploration of OECMs in China. Cases such as community conserved areas, voluntary conserved areas, campus conservation zones, enterprise conserved areas, and nature-friendly farmlands are not driven by government. They represent voluntary

conservation initiatives developed by a wide range of social actors, based on their respective interests and recognition of ecological values.

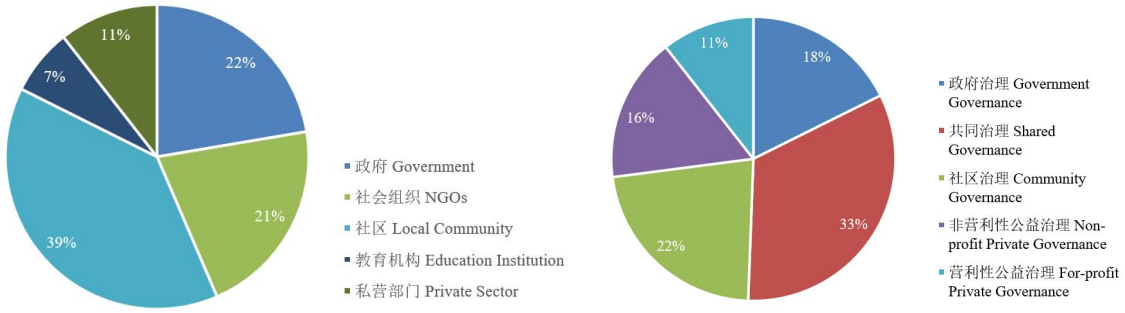


Figure 3.2 Proportion of main contributors (left) and governance types (right) in OECM potential case studies

While the scope of case collection has certain limitations, the spatial distribution patterns and diversified governance of these candidate sites still verify the rationality and applicability of the identified conservation gaps at the regional scale.

First, OECMs are well-suited for refined conservation supplementation in densely populated and economically active regions. Cases located east of the Hu Line account for 82.4% of the total with rich typological diversity, which confirms their strong adaptability to core conservation gaps featuring dense human settlements and intensive development. Restricted by complicated land tenure and human activities, PAs can hardly expand within such zones. In contrast, OECMs including community conserved areas, urban parks, corporate premises, and nature-friendly farmlands help integrate fragmented biodiversity habitats into the overall in-situ conservation area accounting via outcome certification,without disrupting prevailing land-use arrangements.

Beijing ranks third nationwide with five cases covering a total area of 12,524 hectares. These sites are generally small in scale yet cover a wide range of OECM types. This demonstrates that OECMs can thicken urban conservation networks through a scattered multi-site layout with complementary ecological functions. Such an approach is unachievable by PAs and serves as a key institutional strength of the OECM frameworks.

Second, OECMs demonstrate the feasibility of large-scale integrated conservation in ecologically fragile zones. There are only 15 potential OECMs west of the Hu Line, yet they feature intact ecosystems and large individual site sizes. For instance, community conserved areas in the Ruoergai Grassland and Maake River Valley of Kehe village in Sichuan Province each span

over 30,000 hectares. This confirms that OECMs are viable for consolidated large-area conservation across sparsely populated, ecologically vulnerable landscapes. These sites not only sustain integral ecosystems, but also function as peripheral buffer zones and ecological connectivity corridors complementing the conservation network.

Unlike the potential OECMs in eastern regions, western sites are largely livelihood-driven community conserved areas. Herdsmen carry out voluntary patrols, grassland restoration and sustainable grazing management to sustain traditional pastoral agriculture. Their conservation motivation stems from internal demands and traditional belief rather than external policy incentives. Leveraging OECMs' adaptable certification framework to align with indigenous resource stewardship enables synergies between conservation and community livelihood development.

Third, the results verify social participation through typological diversity and multi-stakeholder governance of OECMs. There are multiple governance entities involved, including communities, governments, social organizations, enterprises, and universities. As aforementioned, relying solely on government efforts is insufficient to establish a full-coverage biodiversity conservation network. By contrast, the framework of OECMs provides a feasible pathway and standardized guidance for broader participation in biodiversity conservation.

Potential OECMs in China show that China's bottom-up and multi-stakeholder conservation practices have accumulated solid empirical foundations. Compare with PAs, OECMs have more flexible eligibility criteria while upholding requirements for long-term, effective conservation outcomes, allowing context-specific implementation adaptable to regional development conditions. By leveraging the OECMs framework, stakeholders can be fully mobilized to consolidate joint conservation efforts, complement conservation networks, and continuously promote the mainstreaming of biodiversity conservation.

Chapter 4 Opportunities, Challenges, and Localization Pathways of OECM Development in China

4.1 Opportunities and Local Potential for OECMs in China

Currently, China is deepening the reforms to Ecological Civilization Framework and advancing modernization that fosters harmony between humanity and nature. The development of OECMs in China aligns with global biodiversity governance trends while serving as a critical component in optimizing China's in-situ biodiversity conservation. This presents multiple strategic opportunities for advancing and implementing the OECMs framework of China. Grounded in China's national context, the OECMs already possesses a solid practical foundation, enabling the

adaptation of international conservation concepts into practices suited to China's conditions and demonstrating considerable potential for domestic growth.

1） Coordination and Alignment Between International Treaty Obligations and National Policy Architecture

Following the official implementation of the KM-GBF, global biodiversity governance has entered a new phase. As a key contributor and promoter of the GBF, China has strived to deliver all action targets set out under the framework. In 2024, the Ministry of Ecology and Environment issued the China NBSAP (2023–2030), which explicitly outlines the innovation of OECMs in Priority Action 9: In-situ Biodiversity Conservation (MEE, 2024). This action supports diverse forms of grassroots in-situ biodiversity conservation efforts and explores OECMs framework with pilot demonstrations, providing robust policy opportunities for the implementation of OECMs in China.

2）Robust Empirical Basis for Indigenous Voluntary Conservation Initiatives

China has a wealth of diverse locally voluntary conservation practices involving multiple stakeholders. These grassroots initiatives encompass two kinds of regions. One includes agroforestry systems, agricultural cultural heritage sites, sacred mountains and landscapes, and fengshui forest, which communities conserve through traditional beliefs, ecological cultures, and sustainable resource management. The other covers areas in wilderness and urban spaces that utilize modern monitoring technologies and scientific conservation management to preserve and enhance wildlife habitats, including public welfare conservation areas, nature-friendly campuses and enterprise conserved areas. These practices satisfy human production and livelihood demands while delivering effective biodiversity conservation. They are highly consistent with the core principles of OECMs: reconciling human activities and valuing sustained conservation results, which builds robust practical foundation for OECMs localized implementation in China.

3）Spatial Basis for OECMs from Conservation Policies Including ERLs

Although China has not yet formulated a localized OECMs framework, a range of existing laws, policies and administrative regulations offer legal basis and reference for carrying out and scaling up conservation management in areas that are not designated as PAs but possess conservation value and needs. ERLs establish a nationwide ecological spatial governance fromework that imposes stringent control on development and construction activities to safeguard key ecological functions and biodiversity. Zones within such redlines that are not included in PAs yet hold high biodiversity values represent key potential sites for OECMs. A variety of legally protected special zones also hold potential for OECMs. Examples include critical wildlife habitats, areas supporting naturally rich assemblages of wild plant species, protected stopover sites along migratory bird flyways, natural forests and ecological welfare forests, key grazing lands, core and

general wetlands, drinking water source protection zones, aquatic germplasm resource reserves, and conservation zone of fishes resources. Endowed with rich biodiversity and effective governance measures, such zones further expand the spatial reserve of OECMs.

4）Active Social Participation in Biodiversity Conservation and OECM Research

Public enthusiasm for participating in biodiversity conservation across Chinese society keeps growing, with an expanding spectrum of participating actors. On the practical front, diversified conservation approaches have become commonplace, including community efforts, corporate investments in green transition, professional support from social organizations and research institutions, as well as public involvement in ecological monitoring and routine stewardship. A multi-stakeholder collaborative conservation structure has taken initial shape, creating a favorable social environment for the rollout and implementation of OECMs.

From academic and institutional research perspectives, scholars from numerous research institutes and universities, along with social organizations, have successively carried out relevant studies. They have conducted systematic evaluation and analyses concerning the definition, applicable types, and localized adaptation pathways of OECMs, and facilitated the development and refinement of assessment tools and identification guidelines for OECMs (Zhang et al., 2025b; Beijing Academy of Landscape Architecture and Greening, unpublished).

Overall, grassroots stakeholders lend strong momentum to the development of a localized OECMs framework in China.

4.2 Core Challenges in Implementing OECM in China

OECMs in China hold significant practical potential, yet their current implementation and promotion still face substantial constraints and challenges across multiple dimensions, including institutional frameworks, operational management, technical and financial support, as well as public awareness.

1）Incomplete Top-level Institutional Design and Lack of Legal Status

OECMs have not yet been incorporated into existing ecological conservation laws and regulations. Their legal status and competent authority remain unclear, top-level coordination is insufficient, and local governments lack clear policy guidance and institutional support. Non-state actors also lack systematic guidance for participating in OECMs.

2）Lack of Localized Standards

Existing international criteria cannot fully match China's territorial spatial governance system and ecological conservation context. China has not yet developed unified and operational standards

or technical guidelines for OECM identification, assessment, and recognition, resulting in inconsistent practices across regions and a generally low level of standardized development.

3）Insufficient Multi-stakeholder Coordination

OECM development involves multiple sectors, including ecology and environment, natural resources, forestry and grassland, agriculture and rural affairs, and urban-rural development. Overlapping responsibilities and fragmented management among departments persist, and an effective cross-sector coordination mechanism has yet to be established.

4）Limited Biodiversity Baseline Data and Monitoring Capacity

Many potential OECM sites lack systematic and comprehensive baseline surveys on biodiversity. Regular dynamic monitoring networks remain insufficient, making conservation outcomes difficult to quantify and assess. A complete, standardized, and verifiable evaluation system for conservation effectiveness is still lacking.

5）Lack of Long-term and Diversified Financing Framework

Management of existing policy-based conservation areas primarily relies on fiscal funds, while grassroots conservation efforts predominantly depend on philanthropic funding as well as self-raised resources. Market-based investment and financing channels remain underdeveloped, pathways for converting ecological product values are inefficient, and private capital mobilization faces significant challenges. A stable and sustainable funding mechanism has yet to be formed.

6）Low Public Awareness and Limited Participation Incentives

OECMs, including the direct Chinese translation "other effective area-based conservation measures," remain technical concepts that are not widely understood. Many potential participants have limited awareness of their meaning and value. In addition, recognition and incentive mechanisms are still incomplete, making it difficult to fully motivate social actors to actively participate in OECM development and recognition.

4.3 Synergistic Integration Paths of OECMs with China's Existing In-situ Conservation System

OECMs are not an independent concept separate from existing protected areas and conservation policies. Rather, they can complement and connect protected areas, ecological redlines, various policy-based conservation zones, and diverse voluntary conservation practices to build an integrated, multi-level, whole-landscape biodiversity conservation network. The implementation of OECMs in China should be aligned with national five-year plans, medium- and long-term ecological conservation plans, including the protected area system development plan.

The methodology employed in this report for identifying conservation priority areas and gaps can provide a scientific basis for optimizing ecological spatial layout in territorial spatial planning.

The following section discusses feasible pathways to embed OECMs into existing ecological conservation policies and frameworks for stronger synergistic effects.

1）Linking with Protected Areas

The conservation gaps identified in this report are predominantly located around protected areas, along ecological corridors, and at critical nodes. OECMs can primarily cover peripheral buffer areas, ecological corridors, stepping stone patches, and edge areas of protected areas, serving as connectivity nodes and ecological buffer spaces that effectively bridge gaps between protected areas, thereby enhancing the overall connectivity, integrity, and stability of the conservation network. OECMs in areas surrounding existing protected areas can be closely integrated with protected area conservation management plans, leveraging the technical expertise and professional capabilities of protected area management authorities to promote community co-management, joint patrols, collaborative monitoring, and adaptive management. These arrangements can reduce edge effects, maintain habitat quality in surrounding production and living landscapes, and improve the long-term conservation outcomes of the broader protected and conserved area network.

2）Supporting Ecological Corridor Development

China has made significant progress in ecological corridor development, which has become an important practice area for biodiversity conservation and ecological restoration. At the policy level, national-level plans including the *Master Plan for Major Projects for the Protection and Restoration of National Important Ecosystems* (2021–2035) have included ecological corridor development into the territorial spatial ecological restoration framework. At the practical level, regional corridor projects represented by the Giant Panda National Park have yielded outstanding results, effectively alleviating habitat fragmentation through measures such as fence removal, vegetation restoration, and wildlife passage construction. Following the northward movement and southward return of Asian elephants in Yunnan, the Pu'er–Xishuangbanna biodiversity conservation corridor has received increased attention and became a typical case for mitigating human-wildlife conflicts and maintaining ecological connectivity. Other efforts, such as ecological corridors in the Beijing–Tianjin–Hebei region, restoration of Yangtze River aquatic migration routes, and protection of migratory bird flyways, are also advancing. However, current ecological corridor development still faces challenges including difficulties in cross-jurisdictional coordination, complex land tenure, and inadequate funding mechanisms.

In converting these ecological corridors into OECMs, priority segments can be identified based on species conservation needs and connectivity indicators, such as in Zhao et al. (2022).

Adaptive management can then be implemented relying on long-term stewardship and result-oriented monitoring and evaluation mechanisms under the OECM framework.

3）Deep integration with the Ecological Redline

Ecological redline serves as a major spatial foundation for OECMs in China. As a top-down, government-led potential OECM, the redline represents an institutional innovation with Chinese characteristics. Through strict spatial control requirements, it provides a basis for the long-term and effective conservation of biodiversity within redline areas. Existing studies have been exploring institutional pathways for transforming the ecological conservation redline into OECMs (Li & Chen, 2025)2. In practice, priority could be given to areas within the redline but outside protected areas that have high ecological value and relatively mature management mechanisms. Incorporating these areas into the OECMs framework could strengthen biodiversity-oriented management objectives, support the enhancement of the ecological redline from macro-level spatial control to more refined and outcome-oriented management, and help maintain and enhance ecological values over the long term.

4）Integrating with Policy-based Conservation Areas

Policy-supported conservation areas with clear boundaries and mature governance, such as important wildlife habitats, water source protection areas, ecological public welfare forests, state-owned forest farms, important and general wetlands, agricultural heritage systems, and urban parks, can be integrated into the OECM framework. Based on existing management systems, relevant authorities can establish differentiated recognition, management, and effectiveness assessment mechanisms. Areas meeting the OECM criteria can be incorporated into the OECM database in a systematical and standardized manner.

5）Scientific and Standardized Guidance for Voluntary Conservation Practices

OECM criteria can provide technical guidance and standardized pathways for voluntary conservation practices led by communities, social organizations, enterprises, and universities. Mature voluntary conservation practices can be incorporated into the OECM framework or a potential candidate inventory to secure institutional and official recognition, thereby boosting public conservation motivation and long-term sustainability.

6) Localized Application of Long-term Effectiveness Criterion in China

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[2] In January 2026, the CCICED-TNC thematic policy research project on "Policy and Practice Innovation for Nature Positive" was launched online. https://www.jxau.edu.cn/info/1891/316941.htm

When applying the IUCN guidance to identify potential OECMs, defining and operationalizing "long-term" is both a common challenge in global OECM practice and a key issue for practical implementation in China.

Under IUCN criteria, OECMs differ from short-term restoration projects or temporary recovery measures, such as 3–5-year mountain closures for forest restoration or short-term ecological compensation projects. The governance and conservation outcomes of OECMs must be supported by long-term arrangements. Given China's land tenure system, where land tenure and land-use arrangements are separated, the assessment of long-term mechanisms should not rigidly require permanent conservation commitments. Instead, long-term arrangements should be interpreted in relation to China's land tenure arrangements, statutory contract periods, and local governance agreements.

7) Building a Diversified and Hierarchical Governance System

Coordination between top-down planning, policy-based conservation areas and bottom-up voluntary applications and contributions is essential. A multi-stakeholder governance model featuring government leadership, community co-management, public involvement and corporate cooperation should be adopted to build a system of governmental guidance and supervision, societal delivery, joint multi-stakeholder governance and shared benefits, so as to mobilize all relevant actors to participate in biodiversity conservation.

Key Findings

The localization of OECMs in China does not start from scratch, but is rooted in the long-standing social conservation practices and existing policy frameworks. It currently stands at a critical juncture where "practice comes first with institutional development to follow."

From the perspective of terrestrial vertebrate conservation, China's in-situ conservation network still faces many gaps. Nearly 80% of conservation priority areas are not covered by existing protected areas, necessitating novel conservation tools to address these gaps. Except for some remote regions with low human activity intensity, most conservation gaps overlap heavily with human-used landscapes. Due to complex land tenure, livelihood needs, socioeconomic development pressures, and the small size, patchy, and mosaic distribution of habitat hotspots, these areas are difficult to protect through large exclusionary protected areas. Additionally, nearly 18% of conservation gaps are located in semi-natural habitats such as farmlands and agroforestry transition zones, as well as ecological connectivity nodes within and around urban areas. The

conservation needs of these regions cannot be met by rigid protection models. Flexible conservation tools such as OECMs are needed to reconcile biodiversity conservation with moderate human activities. The potential case collection also supports this feasibility: over 90% of cases are located in conservation gaps and show strong potential to fill gaps and improve conservation network integrity, serving as important complements to protected areas.

From a macro perspective, China's active implementation of KM-GBF under the CBD, coupled with continuous improvements in national ecological civilization policies, has created favorable policy opportunities for the development of OECMs. Meanwhile, China's long-established voluntary and local conservation practices largely align with OECM's core principles, providing a solid practical foundation for their localization. The spatial management system established by existing policies, especially the ecological redline, further strengthens the spatial basis for OECMs. The growing participation of diverse social actors in biodiversity conservation also provides broad support. These existing foundations can be effectively linked to the development of OECMs, collectively forming solid potential for OECM advancement in China. However, China still faces several challenges, including inadequate top-level institutional design, weak multi-stakeholder coordination, limited monitoring capacity, insufficient funding and resources, and low public awareness. Targeted measures are needed to promote standardized and orderly OECMs development, fully leverage their supplementary role, and build an effective, connected, and inclusive whole-landscape biodiversity conservation network.

Policy Recommendation

Based on the spatial identification of conservation gaps and the analysis of resource and governance characteristics, and grounded in China's institutional framework and spatial patterns, this report proposes the following policy recommendations:

1) Strengthen top-level institutional design, improve cross-departmental coordination, and encourage local governments to pilot initiatives first.

Clarifying the legal status, competent authorities, recognition procedures and dynamic management rules, alongside developing localized identification and assessment criteria, is key to accelerate the establishment of an OECM institutional framework. A cross-sector coordination platform involving ecology and environment, natural resources, forestry and grassland, agriculture and rural affairs, housing and urban-rural development, and water authorities could be established under the State Council coordination mechanism for biodiversity conservation. This would help coordinate spatial planning, land-use control, and effectiveness management for OECMs and the comprehensive conservation network, addressing issues of fragmented governance to create a clear,

efficient, and collaborative governance framework.

Provincial or municipal pilots could be encouraged in biodiversity-rich regions with active conservation practices. Local recognition guidelines and management measures could provide practical experience and case support for future national standards management mechanism development.

2) Target conservation gaps to systematically map priority zones for OECM identification and recognition

The conservation gaps identified in this report based on terrestrial vertebrate conservation needs can serve as core spaces for prioritized OECM zoning. These areas could be further assessed together with additional conservation network evaluation metrics including ecosystem representativeness (e.g., Fan et al., 2023) and connectivity (e.g., Zhao et al., 2022), alongside comprehensive considerations such as land use attributes, existing governance mechanisms and local stakeholders' implementation willingness, drawing on the zoning approach for biodiversity conservation priority areas. On this basis, priority OECM development areas could be systematically delineated, with emphasis on key gap patches, ecological corridors, and buffer areas around protected areas. This would support a complementary "protected areas + OECMs" that maximizes conservation benefits, optimizes implementation costs, and enhances the overall effectiveness of the conservation system.

3) Integrate with the existing conservation system and incorporate policy-based spaces into potential OECM inventories

Existing policy-based conservation spaces, such as ecological redline, water source protection areas, and ecological public welfare forests, have clear boundaries and relatively mature and sustainable governance and management mechanisms, and possess ecosystem services and socio-economic value, meeting the basic criteria of OECM. However, most regions still lack systematic baseline biodiversity data, limiting empirical verification of their conservation outcomes. Based on the conservation priority areas identified in this report, sites with higher potential biodiversity value within these existing conservation spaces can be systematically screened and incorporated into the national OECM potential database. Meanwhile, current monitoring frameworks can be enhanced by incorporating biodiversity indicators. Specifically, integrating multiple approaches such as remote sensing, environmental DNA, local community traditional ecological knowledge, and citizen science helps lower monitoring costs. The improved monitoring system will refine effectiveness evaluation, facilitate the transition from spatial control to outcome-focused management, and rapidly expand the scope of effective conservation.

4) Explore localized grading and classification approaches, and extensively mobilize social participation

Differentiated classification standards could be developed based on regional ecological characteristics, land tenure, and governance models, enabling context-adaptive conservation and management approaches. Accessible localized terms, such as "nature coexistence areas," may help reduce barriers to understanding and enhance public awareness. Guided by principles of moderate access and gradual enhancement, the OECM framework could also serve as a vital instrument for engaging stakeholders from all sectors of society —including communities, social organizations, enterprises, and universities — in in-situ biodiversity conservation. This will steadily strengthen conservation management capacities and overall effectiveness, fostering standardized, orderly, and sustainable development of diverse conservation practices.

5) Strengthen conservation in productive landscapes and improve technical systems for agricultural biodiversity

This report's analysis indicates that semi-natural habitats such as farmland and agroforestry composite zones represent important critical conservation gaps with high biodiversity-supporting potential. To foster synergies between agricultural production and biodiversity conservation, technical guidelines for ecological farms and farmland ecological landscapes could be further improved, together with agricultural biodiversity monitoring indicators. Attention could also be directed to traditional agroforestry systems and agricultural heritage to strengthen technical support, as well as the evaluation and documentation of their biodiversity contributions.

6) Innovate diversified funding mechanisms and create pathways for ecological value realization

A long-term diversified funding mechanism could be built through government guidance, social participation, and market-based incentives. In areas with high ecosystem service value, OECM-based ecological product value realization models could be explored, including biodiversity credits and carbon credits. Community ecological compensation and benefit-sharing mechanisms could be strengthened to help convert conservation outcomes into economic returns.

Fiscal policy can act as a guiding instrument to offer incentives and support covering natural resource asset property rights, taxation and finance for social capital investment in OECMs. Channels linking corporate ESG, green finance and ecological value realization should be unlocked to encourage voluntary corporate participation in biodiversity conservation.

7) Strengthen international exchange and share localized OECM experience from China

International exchanges on OECM practices could be strengthened through platforms such as CBD COP sessions, international conferences, and online webinars. Typical OECM cases could be systematically summarized to support exchange and knowledge sharing between Chinese and international conservation practitioners. China's OECM model, which combines top-down policy control with bottom-up voluntary conservation, may provide useful experience for other

developing countries, especially in human-nature mosaic landscapes, contributing to not only national NBSAP targets, but also the global delivery of KM-GBF Target 3.

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Appendix: Comparison and Selection of Conservation Prioritization Method

1. Existing Protected Area Mask Scenario

To compare with the conservation priority analysis presented in the main report, which incorporates existing protected areas in the conservation priority analysis, this section presents the results of a scenario in which existing protected areas are included as a mask layer. In this scenario, existing protected areas are treated as the highest-level mask, meaning that all existing protected areas, covering about 18% of China's terrestrial area (17.47% in the dataset used in this report due to data accessibility), are assumed to be conservation priority areas. The model then identifies the remaining approximately 12% of high-priority areas.

Figure S1 shows the top 30% and 50% priority areas identified when incorporating protected areas as baseline conservation priority areas. Existing protected areas cover 58.3% of the top 30% priority areas and 34.9% of the top 50% priority areas, respectively. Conservation gaps outside protected areas are mainly located in southwestern Yunnan border areas, southeastern Xizang, the middle and lower Yangtze River plains, central and western Zhejiang, northern Bohai Rim, northern Xinjiang, as well as some agroforestry mosaic areas in Sichuan and Gansu.

Compared with the scenario without incorporating existing protected areas (Figure 2.5), southeastern Xizang, the middle and lower Yangtze River plain, Taiwan Island, and northern Xinjiang (including the Junggar Basin and Altai Mountains) continued to be identified as conservation gaps after applying the protected area mask. This indicates that these areas still have high supplementary conservation needs outside the existing protected area system. In contrast, conservation gaps in regions such as the mountains of southwest China and the Bohai Rim are substantially reduced.

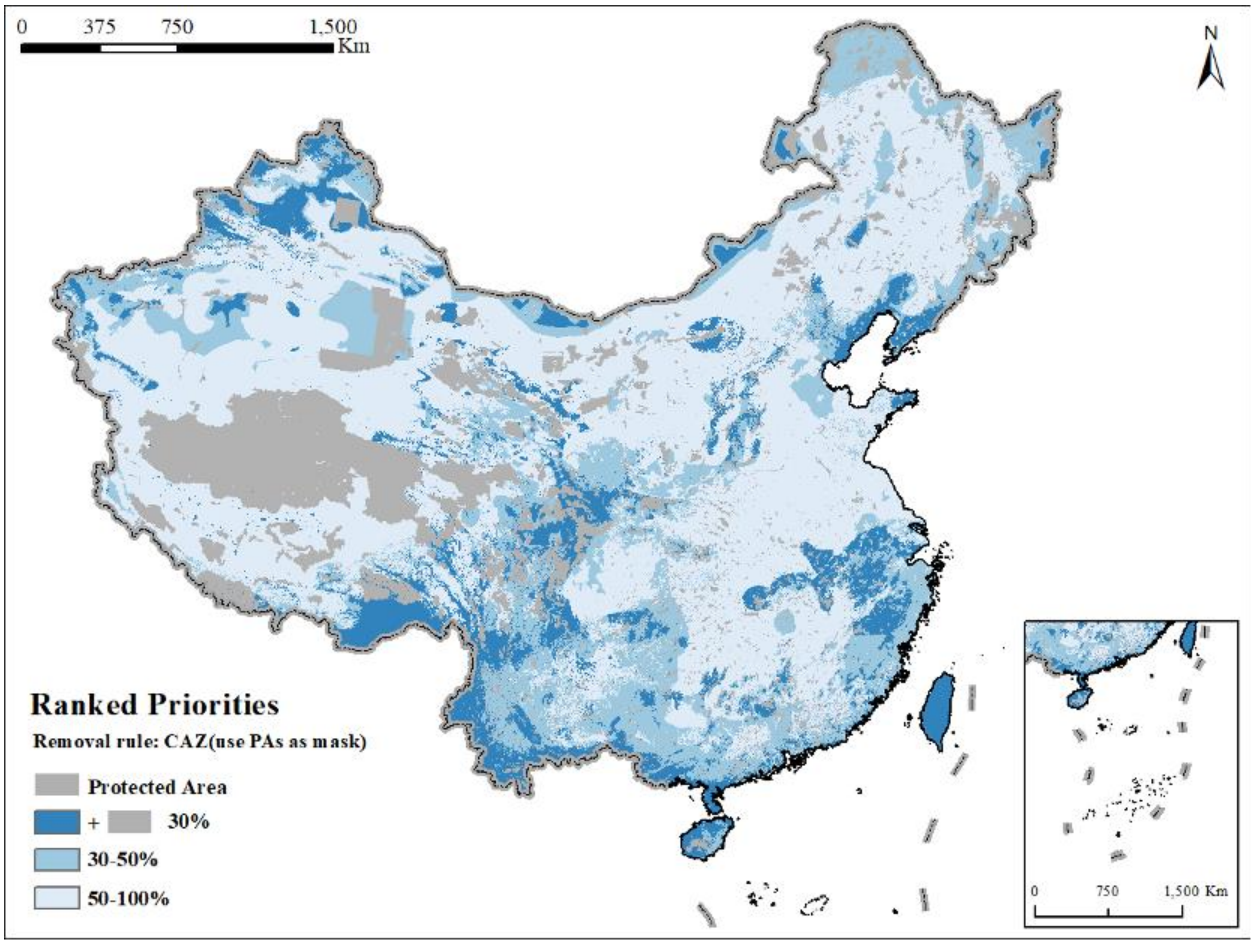


Figure S1: Top 30% and 50% conservation priority areas when incorporating existing protected areas, based on the CAZ algorithm

2. Spatial Planning Algorithm Comparison: Core Area Zoning (CAZ) and Additive Benefit Function (ABF)

The spatial pattern of system protection planning is strongly influenced by algorithm selection. In Zonation, the Core Area Zoning (CAZ) and the Additive Benefit Function (ABF) represent two distinct conservation logics: the former prioritizes protecting core habitats of narrowly distributed rare and endangered endemic species, while the latter focuses on safeguarding broad distribution areas with high species richness. This report compares the spatial intersections and unions of priority areas generated by the two algorithms to assess algorithm-driven differences in spatial patterns (Figure 2.7).

The intersection of the two algorithms represents highly stable core conservation zones concentrated in the southern Hengduan Mountains, Xishuangbanna, the central and southern parts of Hainan Island, and the Wuyi Mountains, exhibiting both species richness and endemic species aggregation. The union reveals spatial discrepancies between the two algorithms: the ABF

algorithm tends to prioritize areas with many widespread species, such as the southeastern China hills, where favorable climatic conditions have nurtured numerous generalist forest birds and mammals of the Oriental Realm; whereas the CAZ algorithm gives greater weight to arid regions of northwestern China, the Qinghai-Xizang Plateau, and northern Xinjiang—high-altitude, cold habitats characterized by stringent conditions and relatively low species diversity but serving as critical habitats for drought-and cold-resistant rare species of the Palearctic Realm.

Overall, CAZ helps address the limitation of ABF, which may overemphasize species-rich areas and underrepresent rare species, thereby improving overall species representation.

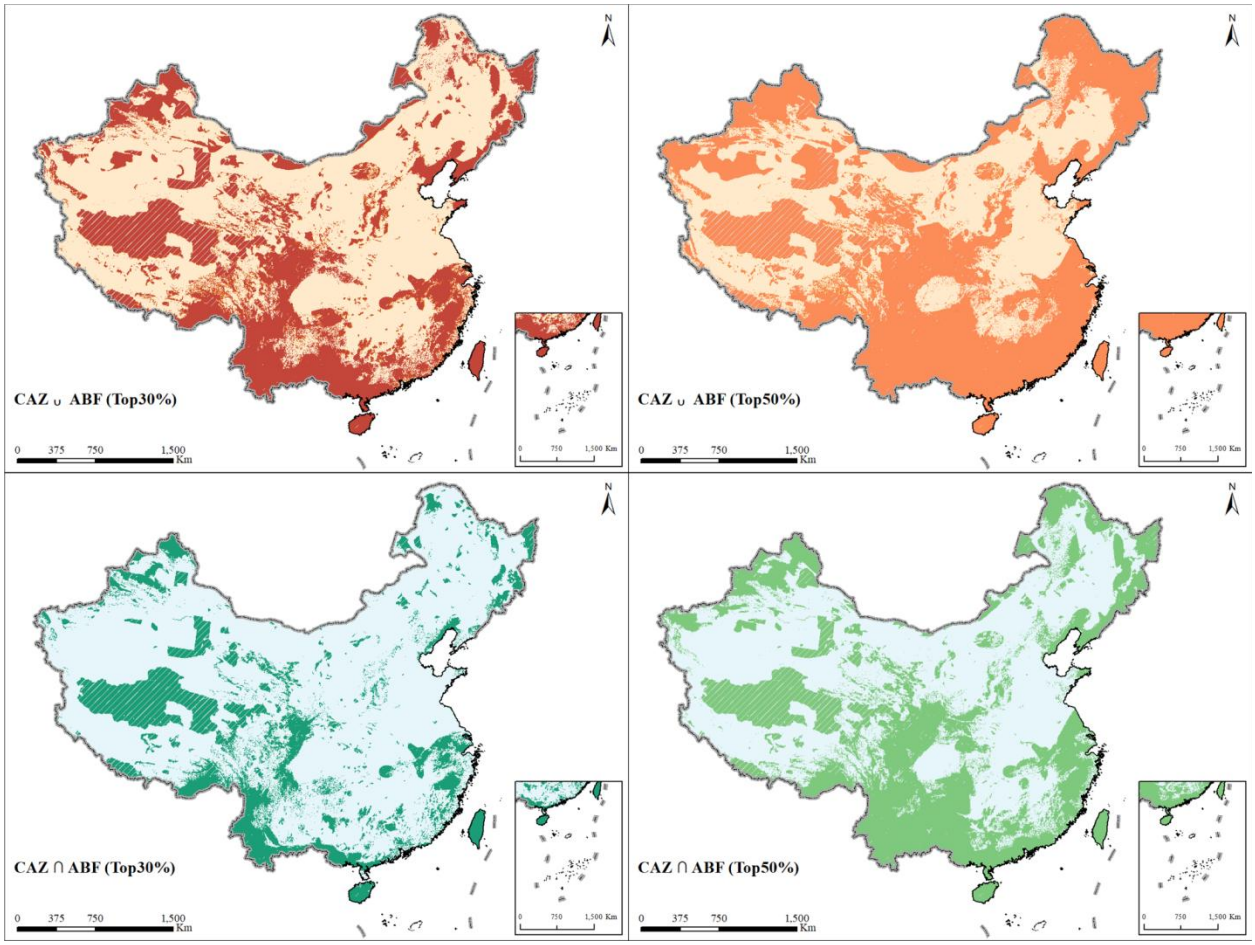


Figure S2 Comparison of the top 30% conservation priority areas identified by CAZ algorithm and ABF algorithm

3. Conservation Cost Minimization Scenario

Practical conservation planning must balance competing land-use demands. This report introduced human activity footprint index to represent marginal conservation costs and developed a cost-minimization scenario to identify lower-cost priority areas while meeting species

conservation targets.

After cost constraints are included, the spatial pattern of CAZ priority areas changes substantially (Figure S3). Many high-value cells in the eastern coast and the middle and lower Yangtze River plain are removed because these areas have high development intensity and high land protection costs. Priority areas shift toward less developed regions with lower opportunity costs, including central and western mountains (Schröter et al., 2014), sparsely populated plateaus, and remote areas, such as the northern Greater Khingan Mountains, Yinshan Mountains, Qilian Mountains, Qinling Mountains, Daba Mountains, and mid- to high-elevation forest belts of the Hengduan Mountains. The model compensates for the loss of eastern habitats by selecting analogous habitat patches elsewhere. This spatial restructuring reflects the tendency of strict conservation to shift toward remote areas with lower opportunity costs under implementation-cost and funding constraints.

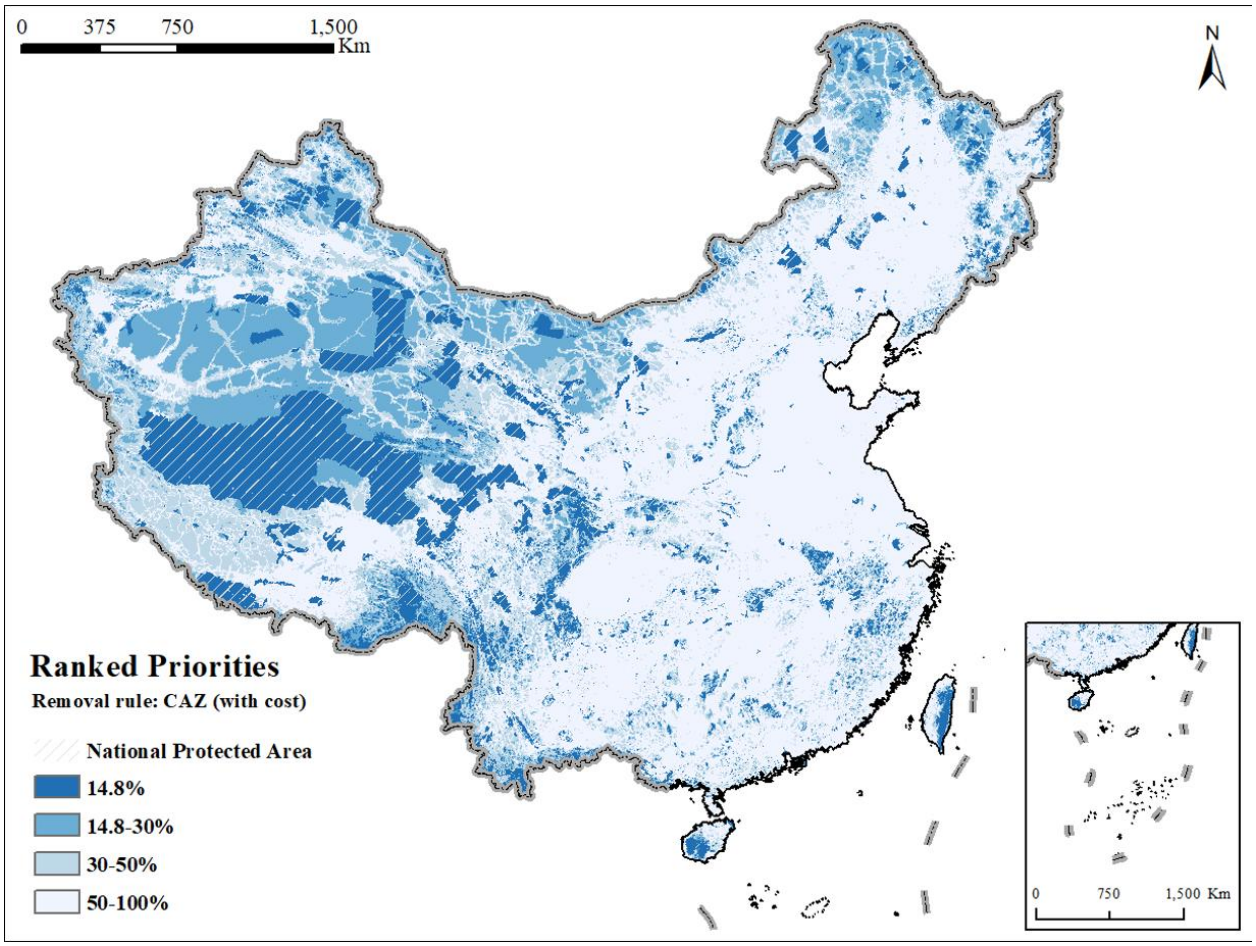


Figure S3 Conservation priority areas under marginal cost minimization, based on the CAZ algorithm

The ABF algorithm is even more sensitive to cost constraints (Figure S4). The original ABF

results favored species-rich tropical and subtropical low-altitude regions; however, these areas generally possess prominent economic development potential and long histories of human utilization. Under cost constraints, many high-biodiversity hotspots in the hills and basins of southern and central China were excluded, shifting the priority significantly toward mountainous areas such as the Yunnan-Guizhou Plateau and the eastern edge of the Qinghai-Xizang Plateau—regions characterized by low development pressure, large available area, and moderate species richness.

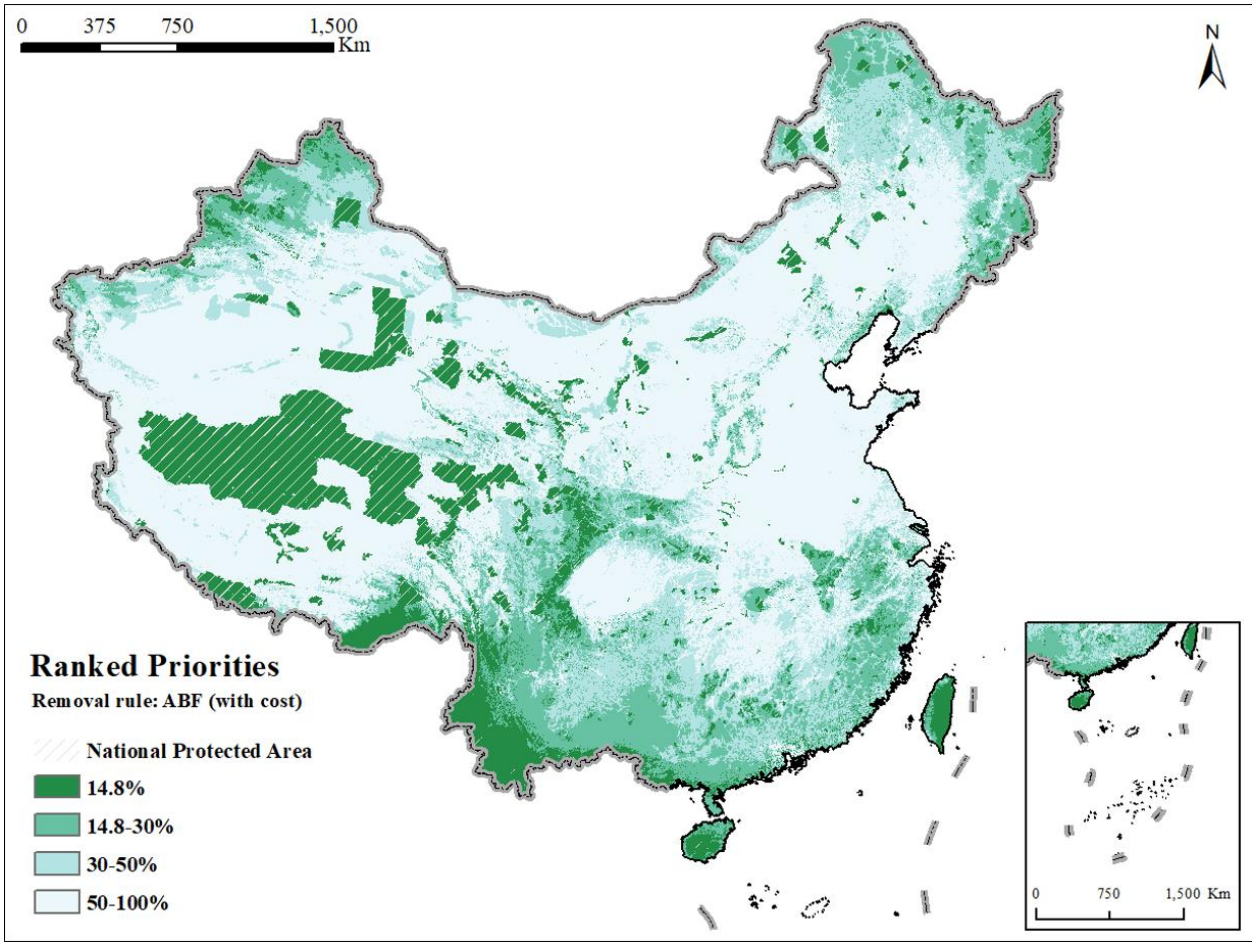


Figure S4 Conservation priority areas under marginal cost minimization, based on the ABF algorithm

In summary, while the optimal allocation based on marginal cost minimization reduces conservation investments, it has clear ecological shortcomings. The cost-constrained model systematically overlooks specific threatened species found exclusively in high-intensity human activity areas — for example, endangered migratory waterbirds dependent on eastern coastal mudflats and endemic amphibians and reptiles inhabiting low-elevation karst habitats of southern China—whose habitats cannot be adequately replaced by similar habitats in remote mountainous

regions. Prioritizing conservation areas with a strong focus on costs is therefore not conducive to the persistence of rare and range-restricted species and deviates from the conservation goal of preventing species extinction (Polasky et al., 2001).

4. Rationale for Selecting the Conservation Prioritization Method

Based on the aforementioned analysis, this report used the CAZ algorithm, without incorporating existing protected areas as a mask layer or applying cost constraints, as the final method for identifying conservation priority areas and existing conservation gaps.

From an ecological perspective, the CAZ algorithm is highly responsive to species irreplaceability and is well suited to China's current species conservation needs. As one of the global centers for biodiversity evolution, China harbors a vast pool of endemic species. These species, such as the giant panda lineage, snub-nosed monkeys, and several endemic pheasants, often have highly restricted ranges. Using the CAZ algorithm to identify conservation priority areas better retains core habitats of rare and range-restricted species while avoiding the preferential allocation of conservation priority to widespread species at the expense of endemic species. It is therefore better aligned with the need to prioritize threatened species conservation (Lehtomäki & Moilanen, 2013).

From the perspective of evaluation principles, not using existing protected areas as a mask is necessary for measuring baseline biodiversity value. This report chooses not to incorporate existing protected areas into the mask, so that the natural distribution pattern of species can be assessed directly and gaps in the existing conservation system can be identified more objectively (Gaston et al., 2008).

Regarding the applicability of spatial policy tools, the unconstrained baseline planning results provide practical application scenarios for implementing OECMs. As discussed above, while cost minimization aligns with the economic rationale for establishing exclusive protected areas, it inevitably sacrifices critical habitats in eastern developed regions and high-value agricultural zones. By preserving the original usufruct of land and implementing mild management adjustments, OECMs can achieve biodiversity conservation within production and living spaces without incurring substantial land coordination cost (Jonas et al., 2021). Therefore, areas with high human footprint that are identified as high value in the unconstrained model but excluded in the cost-constrained model are precisely where OECMs may have the greatest marginal benefit. Using the top 30% CAZ result without cost constraints as the baseline can both secure ecological conservation priorities and support flexible implementation through diverse conservation approaches, contributing to the 30×30 target.

5. Comparison Between Conservation Priority Areas and Terrestrial Biodiversity Conservation Priority Areas

This report overlays the top 30% conservation priority areas identified based on species conservation needs with the terrestrial biodiversity conservation priority areas designated by the former Ministry of Environmental Protection, which cover 28.8% of China's terrestrial area. The overlap covers 1.22 million km² , accounting for 42.2% of the top 30% priority areas and 44.2% of the official terrestrial biodiversity conservation priority areas.

The overlap is relatively high in southern China and the Hengduan Mountains, including central-southern Hainan Island, the mountains of southwestern Guangxi, Xishuangbanna, Minshan-Hengduan Mountains, and the southern Hengduan Mountains. These areas are also key regions for conserving rare and threatened species. Dongting Lake and Poyang Lake in the middle and lower Yangtze River region, two key waterbird habitats along the East Asian-Australasian Flyway, also show high overlap between the two priority systems. In northwestern and northeastern China, large overlaps occur in areas such as the Altai Mountains, Sanjiang Plain, and Greater Khingan Mountains. In contrast, areas such as the Xilingol Grassland, western Ordos-Helan Mountains-Yinshan Mountains, Liupan Mountains-Ziwuling Mountains, Songnen Plain, Tianshan-Junggar region, Tarim River, and Qilian Mountains exhibit relatively low overlap between the two systems, despite the presence of top 30% conservation priority areas nearby.

Official biodiversity conservation priority areas consider not only species richness and threat status, but also ecosystem representation and endemism, special ecological functions, ecosystem threat level, regional representativeness, economic use, scientific research value, and data availability. Therefore, their spatial scope overlaps with, but also differs from, the top 30% priority areas identified in this report based solely on species conservation needs. This report does not aim to replace the officially designated priority areas. Instead, it provides a complementary perspective based on terrestrial vertebrate conservation needs, supporting finer-scale identification of species conservation gaps and improvement of regional conservation planning.

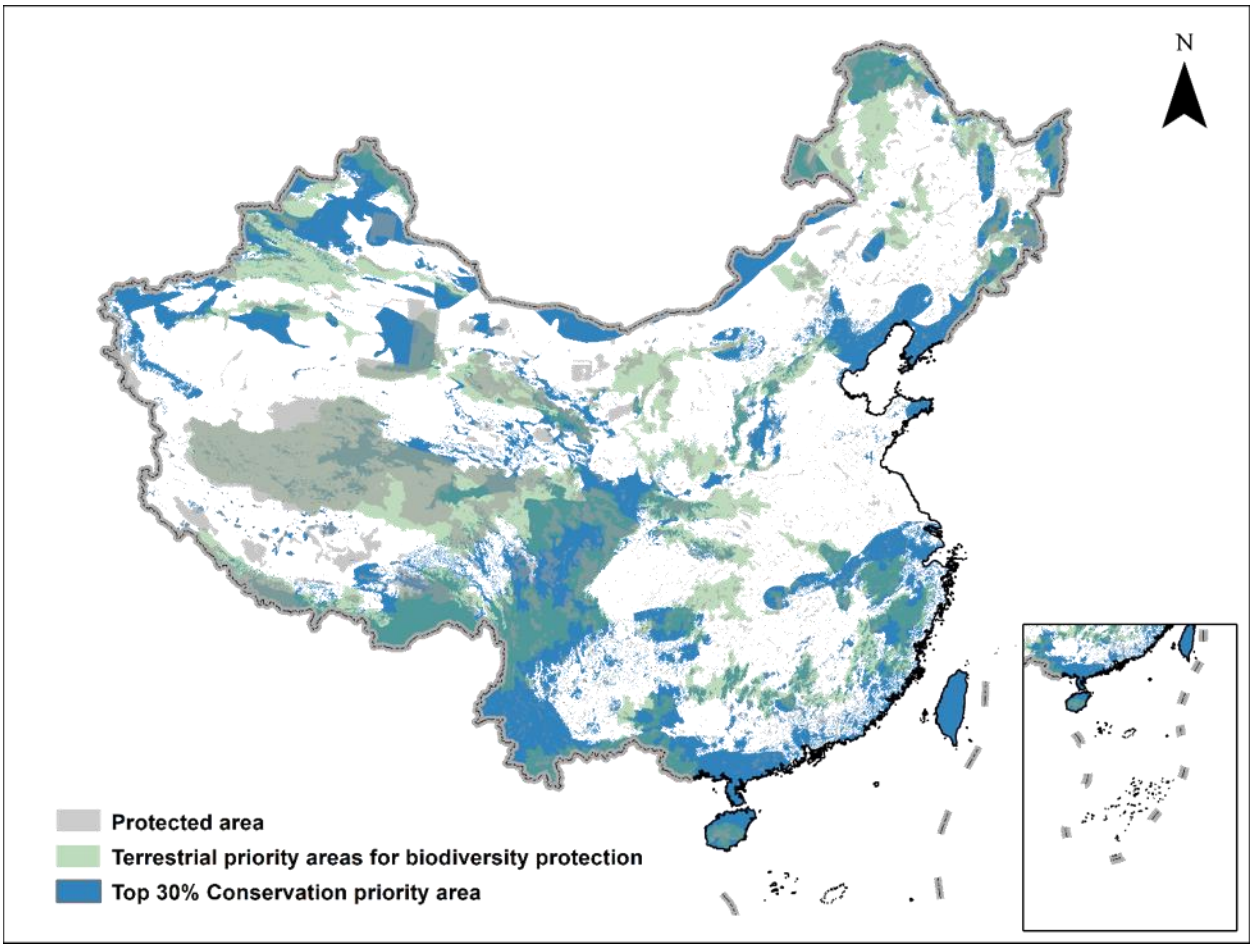


Figure S5 Terrestrial biodiversity conservation priority areas and top 30% conservation priority areas identified in this report