Article

Xinglongshan National Nature Reserve: Natural resources, tourism resources, and sustainable development

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Abstract
The Xinglongshan National Nature Reserve in Gansu Province is located within Yuzhong County, Lanzhou City, Gansu Province, situated at the transitional junction of three major geographical units: the Qinghai-Tibet Plateau, the Loess Plateau, and the Mongolian Plateau. It serves as an important ecological barrier and a biodiversity hotspot in China. Based on existing literature, this paper systematically reviews research progress concerning the natural geography, biodiversity, geological and mineral resources, tourism development, and ecological conservation of Mt. Xinglongshan. The reserve records 1,022 species of higher plants, including endemic species such as *Oxytropis xinglongshanica*; 160 species of wildlife, including 49 bird species and 11 mammal species (based on infrared camera surveys), with 13 species under national protection, and the alpine musk deer (*Moschus chrysogaster*) being a key protected species in the region. Geologically, the basic volcanic rocks of the Xinglongshan Group record important geological information regarding the Neoproterozoic breakup of the Rodinia supercontinent. Currently, the reserve is advancing its intelligent construction but still faces challenges such as human disturbance and disaster prevention and control.

Keywords Xinglongshan National Nature Reserve; biodiversity; *Oxytropis xinglongshanica*; *Moschus chrysogaster*; forest ecosystem; ecotourism.

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1 Introduction

The Xinglongshan (兴隆山) National Nature Reserve is a crucial forest ecosystem protection area in Northwest China. Its unique geographical location determines its irreplaceable ecological functions in biodiversity conservation, water conservation, and climate regulation. This region is not only a transitional zone between the Loess Plateau and the Qinghai-Tibet Plateau but also a geographical boundary for the distribution of many plant and animal species, holding high ecological research value (Baidu Baike, 2026).

Since Mt. Xinglongshan was approved as a national-level nature reserve in the 1980s, domestic and international researchers have conducted extensive research in fields such as geological structure, plant taxonomy, animal ecology, and forest management. Xu et al. (2008) systematically studied the geochronology and petrogenesis of the basic volcanic rocks of the Xinglongshan Group, revealing the Neoproterozoic geological evolution of the region. In their book, Li et al. (2020) included 420 species of vascular plants, laying a foundation for research on regional plant diversity. Mao et al. (2022) conducted a systematic two-year survey of bird and mammal diversity within the reserve using infrared camera technology, obtaining first-hand data on 60 wildlife species.

However, there is currently a lack of systematic integration of research results concerning various aspects of Mt. Xinglongshan, including its natural geography, biological resources, ecological environment, and tourism development. Based on existing literature, this paper provides a comprehensive review of the research status of Mt. Xinglongshan, aiming to offer a reference for subsequent research and conservation management.

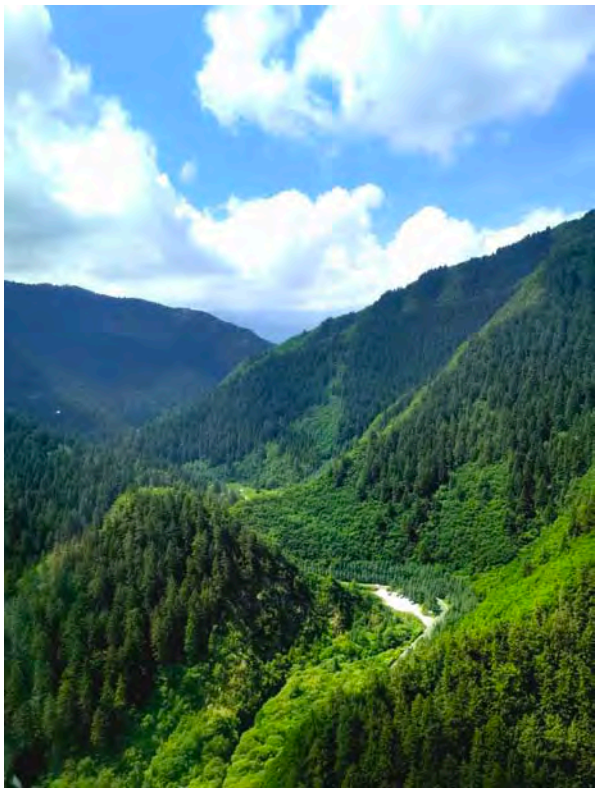
2 Overview of Mt. Xinglongshan

Xinglongshan National Nature Reserve is located in Yuzhong County, 60 km southeast of Lanzhou City, Gansu Province, with geographical coordinates between 103° 50′ –104° 10′ E and 35° 38′ –35° 58′ N (Travel China Guide, 2026). The reserve covers a total area of approximately 333 square kilom, with a forest coverage rate of over 80%, making it one of the best-preserved primitive forests in Gansu Province (Fig. 1).

Mt. Xinglongshan consists of two main peaks: the East Peak (Mt. Xinglongshan) at 2400 m above sea level, and the West Peak (Mt. Qiyun) at 2500 m above sea level. The two mountains are separated by Xinglong Gorge, spanned by the Yunlong Bridge, forming a unique mountain gorge landscape (Nature Exploration, 2018; Longxigong, 2025; Travel China Guide, 2026). The terrain is high in the south and low in the north, with the highest peak reaching 3021 m above sea level and a relative elevation difference of over 1000 m, resulting in complex and diverse topography.

According to historical records, Mt. Xinglongshan has a long-standing Taoist culture dating back to the Western Zhou Dynasty. In the Qing Dynasty, the renowned Taoist Liu Yiming practiced here for over 40 years, constructing 62 Taoist temples and writing 22 books, making significant contributions to the development of religious culture in Mt. Xinglongshan (Travel China Guide, 2026). In 1227, Genghis Khan died in Mt. Xinglongshan during his campaign against the Western Xia. His clothing tomb was once preserved here, and later, from 1939 to 1949, his coffin was also secretly stored in the Great Buddha Hall. This history brought great fame to Mt. Xinglongshan (Travel China Guide, 2026). In August 1943, Chiang Kai-shek resided in a villa at the foot of this mountain for six days, holding a military conference. This building remains well-preserved today.

In 1988, Mt. Xinglongshan was approved by the State Council as a national-level nature reserve (Wu et al., 2012; Dou et al., 2023), primarily protecting the original forest ecosystem and rare and endangered wildlife such as the alpine musk deer. To date, 1,022 species of higher plants and 160 species of wild vertebrates have been recorded in the reserve, making it an important biodiversity center in Northwest China (Nature Exploration, 2018; Longxigong, 2025; Baidu Baike, 2026; Travel China Guide, 2026).



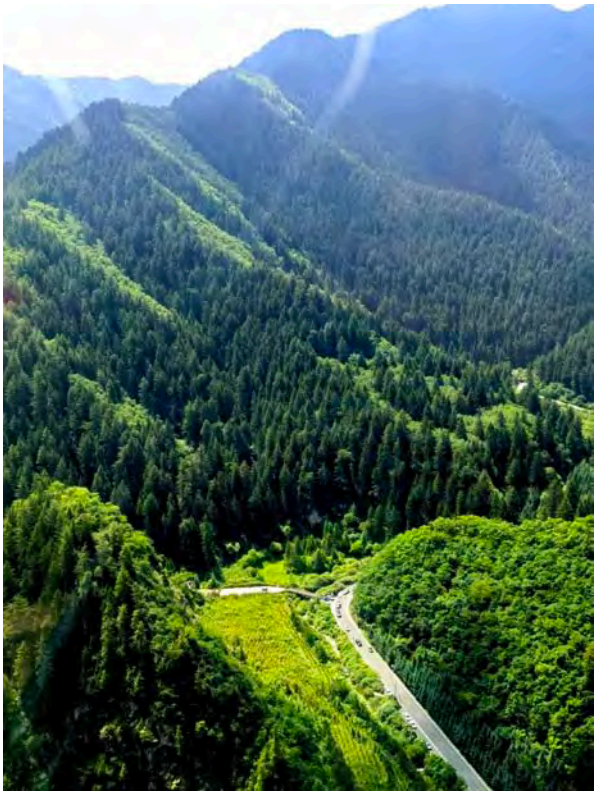


Fig. 1 Mt. Xinglongshan.

3 Geography and Topography of Mt. Xinglongshan

3.1 Geographical Location and Administrative Division

Xinglongshan National Nature Reserve is located in the central part of Gansu Province, south of Chengguan Town, Yuzhong County. Its geographical coordinates are between 103° 50′ –104° 10′ E and 35° 38′ – 35° 58′ N. The reserve borders Anding District of Dingxi City to the east, Lintao County to the south, Qilihe District to the west, and Chengguan Town, Yuzhong County, to the north (Baidu Baike, 2026). Administratively, the entire reserve is located within Yuzhong County and is directly managed by the Xinglongshan National Nature Reserve Management Center. It has several protection stations under its jurisdiction, including Majiasi, Guantan'gou, Xinglongshan, Mapo, and Yinshan.

3.2 Geomorphological Features and Terrain Units

Mt. Xinglongshan is located in the eastern extension of the Qilian Mountains, representing a hilly area transitioning from the Longzhong Loess Plateau to the Qinghai-Tibet Plateau. The geomorphology of the region is complex, mainly comprising various landform units such as medium mountains, low mountains, hills, valleys, and piedmont alluvial fans (Baidu Baike, 2026).

Medium Mountain Landform: Ranging from 2500 to 3021 m above sea level, mainly distributed in the southern and central parts of the reserve, accounting for about 40% of its total area. This area features steep

terrain with slopes typically between 25° and 40°, locally exceeding 50°. Bedrock is exposed with strong weathering, and gullies are deeply incised.

Low Mountain Landform: Ranging from 2000 to 2500 m above sea level, mainly distributed in the northern part and the eastern and western flanks of the reserve, serving as a transition zone from medium mountains to loess hills. The terrain is relatively gentle, with slopes generally between 15° and 25°. Soil cover is thicker, and forest vegetation is well-developed.

Loess Hills: Ranging from 1800 to 2000 m above sea level, mainly distributed in the northern marginal areas of the reserve, with loess thickness reaching 50-100 m. The terrain exhibits typical loess ridges, mounds, and gully landforms, with severe soil erosion.

Valley Landform: Xinglong Gorge and its tributaries run through the reserve, forming valleys of varying widths. Valley widths are generally 50-200 m, with steep riverbed gradients and fast-flowing water. Riverbanks are flanked by floodplains and terraces, which are the main distribution areas for farmland and settlements.

3.3 Geological Structural Background

The Mt. Xinglongshan area is tectonically located in the eastern segment of the Middle Qilian Mountains block, a transitional zone between the Qilian Orogenic Belt and the North China Craton. The regional geological evolution is complex, having undergone multiple phases of tectonic and magmatic activity (Nature Exploration, 2018; Longxigong, 2025; Baidu Baike, 2026)).

Research by Xu et al. (2008) on the basic volcanic rocks of the Xinglongshan Group indicates that the exposed Xinglongshan Group in this area primarily comprises a suite of low-grade metamorphic clastic rocks and basic volcanic formations. It can be divided into three formations: lower, middle, and upper. The basic lava in the lower formation is basalt or basaltic andesite with higher SiO_2 content (50.97% -54.70%), formed in a continental intraplate extensional setting. The basic volcanic lava in the middle and upper formations is spilite-porphyry or spilite, with lower SiO_2 content (45.71%-49.58%) and N-MORB-type geochemical characteristics, representing the emergence of oceanic crust.

Zircon U-Pb dating results show that the youngest magmatic zircon age from the basic lava in the upper formation of the Xinglongshan Group is 713±53 Ma, indicating that the formation age of this group is most likely Neoproterozoic (Xu et al., 2008). Zircon ages with distinct magmatic crystallization characteristics form a maximum peak between 1.0-1.2 Ga, considered a response to magmatic events related to the formation of the Rodinia supercontinent in this region. The Xinglongshan Group provides an incomplete geological record of the stage from continental extension to oceanic crust development following the formation of the Rodinia supercontinent, holding significant scientific value for studying the breakup of the Neoproterozoic supercontinent.

3.4 Soil Types and Distribution

The soil types in the Xinglongshan National Nature Reserve exhibit a clear vertical differentiation pattern with altitude (Wei et al., 2013; Baidu Baike, 2026):

Mountain Gray-Cinnamon Soil: Distributed in the loess hilly areas at altitudes of 1800-2200 m. Organic matter content is low (0.5%-1.5%), slightly alkaline (pH 7.5-8.0), loose in texture, and susceptible to erosion.

Mountain Cinnamon Soil: Distributed in the mid-low mountain zones at altitudes of 2200-2600 m. This is the primary forest soil type in the reserve. Organic matter content is moderate (2%-5%), neutral to slightly acidic (pH 6.5-7.5), with good soil structure and high fertility.

Mountain Dark Brown Soil: Distributed in the medium mountain zones at altitudes of 2600-3000 m. Organic matter content is rich (5%-10%), acidic (pH 5.5-6.5), moist soil with a deep humus layer.

Mountain Meadow Soil: Distributed in alpine meadows and valley areas above 2800 m. Organic matter content is extremely high (10%-15%), soil moisture is abundant, and the root mat layer is well-developed.

4 Climate of Mt. Xinglongshan

4.1 Climate Type and Characteristics

Mt. Xinglongshan is located at the convergence of the eastern monsoon region of China, the northwestern arid region, and the Qinghai-Tibet alpine region, belonging to a temperate semi-arid continental monsoon climate. The main climate characteristics are: distinct four seasons, dry and windy in winter and spring, cool and rainy in summer and autumn, ample sunshine, strong evaporation, and significant annual and diurnal temperature ranges (Baidu Baike, 2026).

4.2 Temperature Characteristics

The annual average temperature in the reserve varies significantly with altitude. According to data from the Yuzhong County Meteorological Station (1874 m), the annual average temperature in the piedmont area is 6.7°C; at the Mt. Xinglongshan scenic area (2400 m), it is 4.5°C; in the medium mountain areas above 2800 m, the annual average temperature drops to around 2°C. The average temperature in the coldest month (January) is -8°C to -10°C, and in the hottest month (July), it is 16°C to 20°C. Extreme minimum temperatures can reach -25°C, and extreme maximum temperatures can reach 32°C. The frost-free period is 140-160 days in the piedmont area and less than 120 days in the alpine areas (Baidu Baike, 2026).

The diurnal temperature variation is also significant, especially in spring and autumn, with temperature differences between day and night reaching 15-20°C. This strong diurnal temperature range facilitates the accumulation of organic matter in plants, making the tree rings in Mt. Xinglongshan distinct, providing good material for dendrochronological studies.

4.3 Precipitation Characteristics

The annual precipitation in the Xinglongshan National Nature Reserve is approximately 450-600 millim, increasing with altitude. The piedmont area receives about 400 mm annually, while the medium mountain zone receives 550-600mm, and the alpine areas exceed 600 mm. Precipitation is unevenly distributed seasonally, mainly concentrated from July to September, accounting for 55%-65% of the annual total. Winter (December-February) precipitation is minimal, less than 5% of the annual total. Interannual precipitation variability is significant, with differences of more than double between wet and dry year (Baidu Baike, 2026).

Mountainous terrain significantly influences precipitation distribution. Windward slopes (south, southwest) receive more precipitation than leeward slopes (north, northeast). Ridges and upper slopes receive more precipitation than lower slopes and valleys. This topographic variation in precipitation directly affects the distribution pattern of vegetation.

4.4 Evaporation and Humidity

The annual evaporation in the reserve is approximately 1300-1600 millim, 2-3 times the precipitation amount. Evaporation is highest in May-June and lowest in December-January. Relative humidity increases with altitude: the piedmont area averages about 55% annually, the medium mountain zone reaches 65%-70%, and the alpine areas exceed 70%. Relative humidity is highest in summer, reaching 75%-85%, and lowest in winter, only 40%-50% (Baidu Baike, 2026).

4.5 Wind Conditions and Sunshine

The dominant wind directions throughout the year in the reserve are southeast and northwest, with wind speeds typically between 2-4 m per second. Strong winds occur frequently in spring, with maximum wind speeds exceeding 20 m per second. Annual sunshine duration is 2400-2600 hours, with a sunshine percentage of 55%-

60%. The total solar radiation is 120-130 kcal/cm²·yr, providing ample photosynthetically active radiation favorable for plant growth.

5 Animal Diversity and Distribution in Mt. Xinglongshan

5.1 Overview of Animal Diversity Research

Research on animal diversity in the Xinglongshan National Nature Reserve dates back to the 1980s. Early surveys focused mainly on large mammals and birds, with relatively weak research on small mammals, amphibians, reptiles, and insects (Shao et al., 2005; Baidu Baike, 2026). In recent years, with the widespread application of infrared camera technology, significant progress has been made in the investigation of terrestrial birds and mammals.

Mao et al. (2022) deployed 60 infrared cameras in the Xinglongshan National Nature Reserve from September 2018 to August 2020, accumulating 33,521 camera-days and obtaining 7,877 independent valid photographs. A total of 60 wildlife species were identified, including 49 bird species from 8 orders and 18 families, and 11 mammal species from 4 orders and 8 families. This represents the most systematic survey of bird and mammal diversity in the Xinglongshan National Nature Reserve to date, providing crucial foundational data for subsequent conservation management.

5.2 Mammal Diversity

Based on infrared camera surveys and previous historical records, the Xinglongshan National Nature Reserve records a total of 11 mammal species from 4 orders and 8 families. They are detailed by taxonomic group as follows:

I. Carnivora

1. Canidae

- Red Fox (*Vulpes vulpes*) – Relative Abundance Index (RAI) of 2.36, mainly distributed in mid-low altitude shrublands and forest edges.

2. Mustelidae

- Asian Badger (*Meles leucurus*) – RAI of 13.99, grid occupancy of 80.00%, one of the most common large mammals in the reserve (Mao et al., 2022).
- Siberian Weasel (*Mustela sibirica*) – Low RAI, mainly distributed in forest edges and near farmland.
- Beech Marten (*Martes foina*) – RAI of 1.77, mainly distributed in high-altitude rocky mountainous areas.

3. Felidae

- Leopard Cat (*Prionailurus bengalensis)* – RAI of 7.56, grid occupancy of 80.00%, the only wild felid species in the reserve (Mao et al., 2022).

II. Artiodactyla

4. Cervidae

- Alpine Musk Deer (*Moschus chrysogaster*) – RAI of 13.99, a Class I National Key Protected Wild Animal and the flagship species of the Xinglongshan National Nature Reserve. Assessed as Endangered (EN) on the IUCN Red List (Mao et al., 2022).
- Siberian Roe Deer (*Capreolus pygargus*) – RAI of 1.05, mainly distributed in forest and shrubland areas.

5. Suidae

- Wild Boar (*Sus scrofa*) – RAI of 2.33, with population numbers recovering in recent years.

III. Rodentia

6. Sciuridae

- Pere David's Rock Squirrel (*Sciurotamias davidianus*) – Commonly found in forest edges and rocky areas.

- Siberian Chipmunk (*Tamias sibiricus*) – Mainly distributed in coniferous and broad-leaved mixed forests.

7. Muridae

- Confucian White-bellied Rat (*Niviventer confucianus*) – Mainly distributed in understory shrubs.

IV. Lagomorpha

8. Leporidae

- Cape Hare (*Lepus capensis*) – RAI of 0.99, mainly distributed in forest-edge shrublands and grassy slopes.

5.3 Bird Diversity

Based on infrared camera surveys combined with historical data, a total of 49 bird species from 8 orders and 18 families have been recorded in the Xinglongshan National Nature Reserve. They are detailed by major groups as follows (Mao et al., 2022):

I. Galliformes

1. Phasianidae

- Common Pheasant (*Phasianus colchicus*) – RAI of 24.88, grid occupancy of 95.00%, the bird species with the highest relative abundance in the reserve (Mao et al., 2022).

- Daurian Partridge (*Perdix dauuricae*) – RAI of 1.23, mainly distributed in grassy slopes and shrubland areas.

- Blood Pheasant (*Ithaginis cruentus*) – Class II National Protected Animal, mainly distributed in high-altitude coniferous forests.

II. Columbiformes

2. Columbidae

- Oriental Turtle Dove (*Streptopelia orientalis*) – Commonly found in forest edges and near farmland.

- Eurasian Collared Dove (*Streptopelia decaocto*) – Mainly distributed in low mountain and hilly areas.

III. Cuculiformes

3. Cuculidae

- Common Cuckoo (*Cuculus canorus*) – Summer visitor, commonly found in forest edge areas.

IV. Strigiformes

4. Strigidae

- Long-eared Owl (*Asio otus*) – Class II National Protected Animal, nocturnal bird of prey.

V. Accipitriformes

5. Accipitridae

- Northern Goshawk (*Accipiter gentilis*) – New record for the reserve, Class II National Protected Animal (Mao et al., 2022).

- Common Buzzard (*Buteo buteo*) – Commonly found in open woodlands and farmland.

VI. Coraciiformes

6. Alcedinidae

- Common Kingfisher (*Alcedo atthis*) – Mainly distributed in stream and river valley areas.

VII. Piciformes

7. Picidae

- Great Spotted Woodpecker (*Dendrocopos major*) – Commonly found in broad-leaved and mixed forests.

- Grey-headed Woodpecker (*Picus canus*) – Mainly distributed in mature forests.

VIII. Passeriformes

Passeriformes is the most diverse bird order in the reserve, with over 40 species recorded. Main families include:

- Corvidae: Common Magpie (*Pica pica*), Red-billed Blue Magpie (*Urocissa erythroryncha*), Eurasian Jay (*Garrulus glandarius*)
- Paridae: Great Tit (*Parus major*), Green-backed Tit (*Parus monticolus*)
- Pycnonotidae: Collared Finchbill (*Spizixos semitorques*)
- Sylviidae: Various Leaf Warblers (*Phylloscopus* spp.)
- Muscicapidae: Red-flanked Bluetail (*Tarsiger cyanurus*), Daurian Redstart (*Phoenicurus auroreus*)
- Passeridae: Eurasian Tree Sparrow (*Passer montanus*)
- Fringillidae: Grey-capped Greenfinch (*Chloris sinica*)
- Prunellidae: Maroon-backed Accentor (*Prunella immaculate*) – New record for the reserve (Mao et al., 2022).

5.4 Insect Diversity

Mt. Xinglongshan boasts abundant insect resources, particularly its Lepidoptera butterflies. Early surveys revealed 53 species of butterflies belonging to 2 superfamilies, 4 families, and 30 genera within the Xinglongshan National Nature Reserve. Of these, 21 species from 9 genera were discovered for the first time, and 8 species from 4 genera were newly recorded in Gansu Province. These butterflies include various types such as Swallowtails, Nymphalids, and Satyridae. Furthermore, another specialized survey on the Nymphaloidea recorded 40 species from 3 families and 33 genera, including 1 species from 1 genus of Rhizophoraceae, 14 species from 13 genera of Satyridae, and 25 species from 19 genera of Nymphalids. One family with 7 genera and 8 species were discovered for the first time within the Xinglongshan National Nature Reserve.

5.5 Spatial Distribution Patterns of Species

The study by Mao et al. (2022) revealed the spatial distribution patterns of bird and mammal diversity within the Xinglongshan National Nature Reserve:

Altitudinal Distribution: Species diversity index was highest at mid-elevations (2635-2835 m, H=2.74), with relatively lower diversity at high and low altitudes. This pattern aligns with the "mid-elevation bulge" hypothesis, where species from both lower and higher altitudes overlap at mid-elevations, creating a peak in species diversity (Mao et al., 2022).

Habitat Types: Shrubland habitats had the highest species diversity index (H=2.69), followed by coniferous-broadleaf mixed forests and coniferous forests. Diversity was relatively lower in meadows and farmland habitats. Shrubland habitats provide abundant food resources and cover, serving as important habitats for many species (Mao et al., 2022).

Temporal Dynamics: Monthly relative abundance index analysis showed two peaks in wildlife activity, occurring in May and September. May is the spring breeding season when animal activity is frequent; September is the autumn foraging and migration season, leading to increased activity again.

5.6 Rare and Endangered Species and Conservation Status

The Xinglongshan National Nature Reserve records 13 species of nationally protected wild animals, including:

Class I National Protected Animals:

- Alpine Musk Deer (*Moschus chrysogaster*) – Flagship species of the reserve, IUCN Endangered (EN) status. The musk deer population is declining, with major threats from illegal poaching and habitat destruction.

Class II National Protected Animals:

- Blood Pheasant (*Ithaginis cruentus*)
- Northern Goshawk (*Accipiter gentilis*)
- Long-eared Owl (*Asio otus*)
- Leopard Cat (*Prionailurus bengalensis*)
- Beech Marten (*Martes foina*)

IUCN Red List assessments: 1 species Endangered (EN) (Alpine Musk Deer), 1 species Vulnerable (VU), 2 species Near Threatened (NT) (Mao et al., 2022).

5.7 Current Status of Human Disturbance

Infrared camera monitoring data indicate that the Relative Abundance Index for domestic animal activity within the reserve is 32.99, with a grid occupancy rate of 67.00%; the RAI for human activity is 19.60, with a grid occupancy rate of 73.00% (Mao et al., 2022). These figures suggest that despite the establishment of a nature reserve, significant human disturbance persists in the area. Main types of disturbance include:

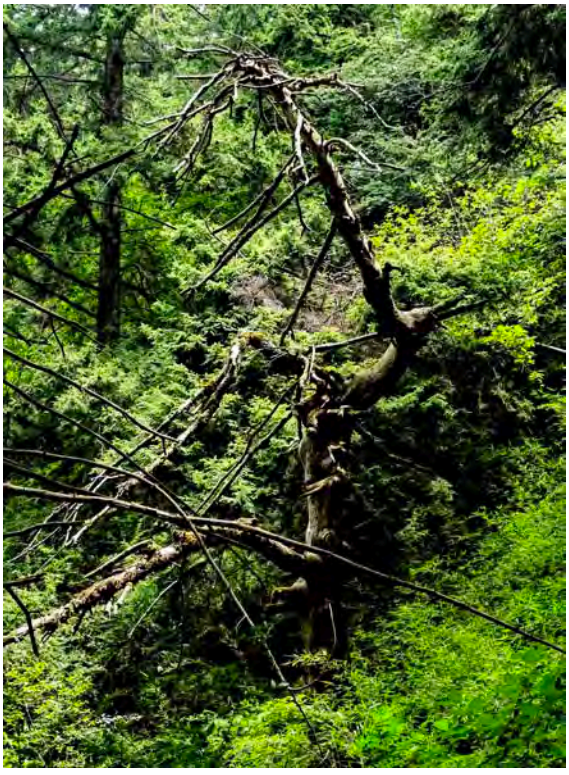
- Grazing: Domestic animals (mainly cattle and goats) enter forests and shrublands for grazing and trampling, competing with wild ungulates for food resources and affecting vegetation regeneration.
- Collecting: Villagers enter forest areas to collect wild medicinal materials, fungi, and wild vegetables, causing habitat disturbance.
- Tourism: Noise, litter, and road barriers caused by tourist activities disrupt the normal activities of wildlife.
- Traffic: Roads passing through the reserve create barrier effects for wildlife, and roadkill incidents occur periodically.

6 Plant Diversity and Distribution in Mt. Xinglongshan

6.1 Overview of Plant Diversity

Xinglongshan National Nature Reserve is rich in plant resources (Baidu Baike, 2026; Fig. 2). According to existing data statistics, 1,022 species of higher plants are distributed in the reserve, belonging to 130 families and 420 genera. Among these, there are about 40 species of ferns (15 families, 25 genera), 12 species of gymnosperms (3 families, 6 genera), and 970 species of angiosperms (112 families, 389 genera). In their book, Li et al. (2020) include 420 common vascular plant species in the reserve, accompanied by high-quality color photos and detailed morphological descriptions.

The flora composition of the reserve is complex, dominated by North China elements, mixed with Mongolian elements, Qinghai-Tibet elements, and Chinese endemic elements. This convergence and transitional nature of the flora makes Mt. Xinglongshan an important area for phytogeographical research (Li et al., 2024; Baidu Baike, 2026).



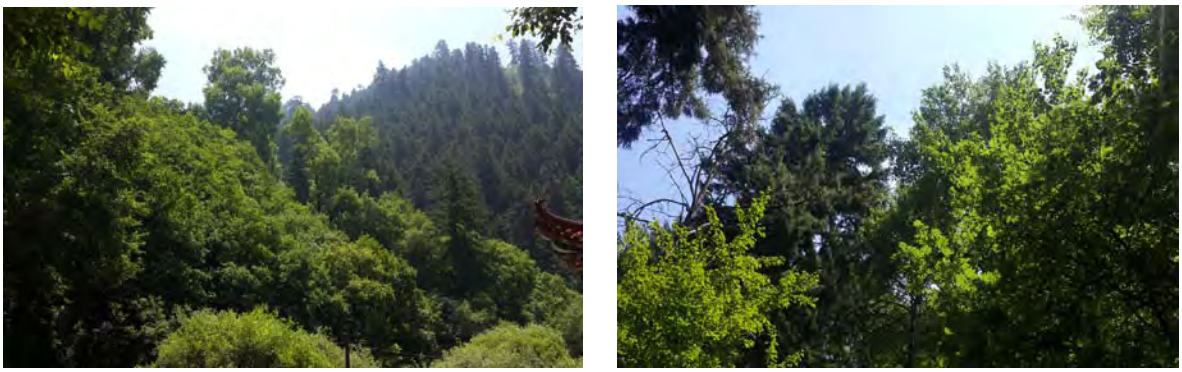


Fig. 2 Plant diversity in Mt. Xinglongshan.

6.2 Major Plant Groups and Species

6.2.1 Ferns (Pteridophyta)

Fern species in the Xinglongshan National Nature Reserve are relatively few, mainly distributed in humid understory and valley areas. Representative species include:

- Chinese Lady Fern (*Athyrium sinense*)
- Bracken (*Pteridium aquilinum* var. *latiusculum*)
- Peking Spleenwort (*Asplenium pekinense*)
- Silver Cloak Fern (*Aleuritopteris argentea*)
- Oak Fern (*Gymnocarpium oyamense*)

6.2.2 Gymnosperms (Gymnospermae)

Gymnosperms are the constructive and dominant species of the forest vegetation in Mt. Xinglongshan, forming the main body of the forest landscape (Fig. 2). Main species include:

- Pinaceae
  - Chinese Pine (*Pinus tabuliformis*) – Representative of warm-temperate coniferous forests, distributed at 1600-2200 m.
  - Wilson's Spruce (*Picea wilsonii*) – Representative of cold-temperate coniferous forests, distributed at 2200-2800 m.
  - Qinghai Spruce (*Picea crassifolia*) – Distributed in high-altitude areas above 2600 m.
  - Prince Rupprecht's Larch (*Larix principis-rupprechtii*) – Scattered distribution, mostly planted forests.
- Cupressaceae
  - Chinese Arborvitae (*Platycladus orientalis*) – Distributed on low mountain rocky slopes.
- Taxaceae
  - Chinese Yew (*Taxus chinensis*) – Class I National Protected Plant, scattered in shaded valley slopes.

6.2.3 Angiosperms (Angiospermae)

Angiosperms constitute the main body of the Mt. Xinglongshan flora, with a wide variety. They are detailed by major families as follows:

Salicaceae

- David's Poplar (*Populus davidiana*) – Representative of deciduous broad-leaved forests, distributed at 1800-2500 m.
- Cathay Poplar (*Populus cathayana*) – Mainly distributed in valley areas.
- Chinese Willow (*Salix matsudana*) – Common riverside tree.

- Various willows (*Salix* spp.), such as *Salix sinica*, *Salix gracilior*, etc.

Betulaceae

- Asian White Birch (*Betula platyphylla*) – Important component species of deciduous broad-leaved forests.
- Red Birch (*Betula albosinensis*) – Mainly distributed on high-altitude slopes.
- Himalayan Birch (*Betula utilis*) – Distributed in areas above 2500 m.
- Siberian Filbert (*Corylus heterophylla*) – Understory shrub.

Fagaceae

- Liaodong Oak (*Quercus wutaishanica*) – Constructive species of deciduous broad-leaved forests, distributed at 1800-2400 m.

Rosaceae

Rosaceae is the most species-rich family in the reserve, including numerous woody and herbaceous plants:

- Siberian Crab Apple (*Malus baccata*)
- Gansu Hawthorn (*Crataegus kansuensis*)
- Peking Cotoneaster (*Cotoneaster acutifolius*)
- Zabel's Cotoneaster (*Cotoneaster zabelii*)
- Gansu Peach (*Amygdalus kansuensis*)
- Spiraea (*Spiraea* spp.) – multiple species
- Rose (*Rosa* spp.) – multiple species
- Strawberry (*Fragaria* spp.)
- Hairy Agrimony (*Agrimonia pilosa*)

Leguminosae

- Xinglongshan Crazyweed (*Oxytropis xinglongshanica* C. W. Chang) – Endemic to Mt. Xinglongshan, distributed on mountain slopes at 1800-2600 m ().
- Russian Fenugreek (*Medicago ruthenica*)
- Sweetclover-like Milkvetch (*Astragalus melilotoides*)
- Many-flower Bushclover (*Lespedeza floribunda*)

Oxytropis xinglongshanica is a new plant species published in 1987, with the type specimen collected from Mt. Xinglongshan, Yuzhong County, Gansu. This species is a perennial herb, 20-50 cm tall, with pinnate leaves 6-20 cm long. Corolla purple or blue-purple. Legume sub-leathery, oblong, inflated. It differs from related species *Oxytropis giraldii* in having stipules connate at the middle, more leaflets, and longer bracts (iflora. 2026).

Aceraceae

- Amur Maple (*Acer ginnala*)
- Mono Maple (*Acer pictum* subsp. *mono*)

Oleaceae

- Weeping Forsythia (*Forsythia suspensa*)
- Lilac (*Syringa oblata*)

Caprifoliaceae

- Amur Honeysuckle (*Lonicera maackii*)
- Red-flowered Honeysuckle (*Lonicera rupicola* var. *syringantha*)

Asteraceae

Asteraceae is the most species-rich herbaceous family in the reserve, including:

- Aster (*Aster* spp.)
- Saw-wort (*Saussurea* spp.)

- Wormwood (*Artemisia* spp.)
- Mongolian Dandelion (*Taraxacum mongolicum*)

Poaceae

As the most popular family around the world (Zhang, 2012, 2014, 2016, 2018; Zhang et al., 2014), Poaceae is also one of the most abundant herbaceous families in the reserve (Fig. 2), including:

- Needle grass (*Stipa* spp.)
- Dahurian Wild Rye (*Elymus dahuricus*)
- Sheep Fescue (*Festuca ovina*)
- Fountain Bamboo (*Fargesia nitida*)

Orchidaceae

- Monorchis (*Herminium monorchis*)
- Chinese Spiranthes (*Spiranthes sinensis*)

6.3 Forest Vegetation Types and Distribution

Based on the study by Ma et al. (2022) using GIS technology to analyze the forest landscape of the Xinglongshan National Nature Reserve, the forest landscape can be divided into 10 types. Forested land landscape dominates, with shrubland landscape accounting for over 41% of the total forest ecological landscape area in the study area (Fig. 2).

According to the altitudinal gradient and community characteristics, the vegetation vertical zone spectrum of Mt. Xinglongshan can be divided into the following types:

(1) Piedmont Loess Hill Shrub-Grass Zone (1800-2000 m)

Located in the northern edge of the reserve, vegetation consists mainly of shrubs and grasslands. Main constructive species include: Littleleaf Peashrub (*Caragana microphylla*), Chinese Date (*Ziziphus jujuba* var. *spinosa*), and Bunchgrass (*Bothriochloa ischaemum*). This zone has severe soil erosion and relatively low vegetation coverage.

(2) Deciduous Broad-leaved Forest Zone (2000-2300 m)

Mainly distributed in low mountain areas, dominated by Liaodong Oak (*Quercus wutaishanica*) forests, mixed with David's Poplar (*Populus davidiana*), Asian White Birch (*Betula platyphylla*), etc. Understory shrubs are abundant, mainly including Siberian Filbert (*Corylus heterophylla*), Bicolor Lespedeza (*Lespedeza bicolor*), and Spiraea (*Spiraea* spp.). Herbaceous plants include Sedge (*Carex* spp.) and Fragrant Solomon's Seal (*Polygonatum odoratum*). This zone is the most typical distribution area of warm-temperate deciduous broad-leaved forests in the reserve.

(3) Coniferous-Broadleaf Mixed Forest Zone (2200-2500 m)

Transitional zone between deciduous broad-leaved forests and cold-temperate coniferous forests. Main constructive species are Chinese Pine (*Pinus tabuliformis*) mixed with Liaodong Oak, David's Poplar, Asian White Birch, etc. Chinese Pine is most concentrated in this zone, forming pure stands in some areas. In their study on soil respiration of typical forest stands in Mt. Xinglongshan, Ling et al. (2024) selected Chinese Pine forests, Liaodong Oak forests, and David's Poplar-Asian White Birch mixed forests as main research objects, revealing the spatiotemporal dynamics of soil carbon respiration in different forest stands.

(4) Cold-temperate Coniferous Forest Zone (2500-2800 m)

Mainly distributed in medium mountain areas, dominated by Wilson's Spruce (*Picea wilsonii*) forests, accompanied by Qinghai Spruce (*Picea crassifolia*) and a small amount of Prince Rupprecht's Larch (*Larix principis-rupprechtii*). Understory shrubs are sparse, mainly including Peking Cotoneaster (*Cotoneaster acutifolius*), Glabrous Potentilla (*Dasiphora glabra*), etc. The ground layer has well-developed bryophytes, and soil organic matter content is high.

(5) Subalpine Shrub-Meadow Zone (above 2800 m)

Distributed in the high-altitude areas in the southern part of the reserve, dominated by alpine shrubs such as Rhododendron (*Rhododendron* spp.), Willow (Salix spp.), and meadows of Sedge (*Carex* spp.), Kobresia (*Kobresia* spp.). This zone has a cold climate, short growing season, low and dwarfed vegetation, with relatively high coverage.

6.4 Rare and Endangered Plants

The Xinglongshan National Nature Reserve is home to over 10 species of nationally protected wild plants, mainly including:

- Chinese Yew (*Taxus chinensis*) – Class I National Protected, scattered distribution.
- Wild Soybean (*Glycine soja*) – Class II National Protected, distributed in valley wetlands.
- Manchurian Ash (*Fraxinus mandshurica*) – Class II National Protected, rare in number.
- Xinglongshan Crazyweed (*Oxytropis xinglongshanica*) – Regionally endemic, with important conservation value (iflora， 2026).

Additionally, several orchid species are listed in the appendices of the Convention on International Trade in Endangered Species (CITES), such as Monorchis (*Herminium monorchis*) and Chinese Spiranthes (*Spiranthes sinensis*).

7 Mineral Resources and Distribution in Mt. Xinglongshan

7.1 Regional Geological and Mineral Background

The Mt. Xinglongshan area is located in the eastern segment of the Middle Qilian metallogenic belt, with favorable regional metallogenic geological conditions (Baidu Baike, 2026). From a tectonic perspective, this area lies at the junction of the southwestern margin of the North China Craton and the Qilian Orogenic Belt, having undergone multiple phases of tectonic-magmatic activity, providing favorable conditions for mineralization.

7.2 Xinglongshan Group Volcanic Series and Mineralization

The Xinglongshan Group is an important ore-bearing rock series in the region. Research by Xu et al. (2008) on the basic volcanic rocks of the Xinglongshan Group indicates that this group is primarily composed of low-grade metamorphic clastic rocks and basic volcanic formations. The basic lava in the lower formation formed in a continental intraplate extensional environment, while the basic lava in the middle and upper formations exhibits N-MORB-type geochemical characteristics. Such volcanic-sedimentary formations are important host strata for copper, lead, zinc, and other polymetallic deposits (Xu et al., 2008).

7.3 Known Mineral Occurrences and Mineralization Shows

According to regional geological survey data from the Gansu Provincial Bureau of Geology and Mineral Exploration and Development, known mineral occurrences and mineralization shows in and around the Xinglongshan National Nature Reserve mainly include:

(1) Yuzhong County Xinglongshan Lead-Zinc Mineralization Occurrence

Located in the eastern part of the reserve, mineralization occurs in the spilite of the upper formation of the Xinglongshan Group. Ore minerals are mainly galena and sphalerite, accompanied by pyrite and chalcopyrite. Mineralization occurs as veinlets and disseminated patterns with low grades, not forming industrial ore bodies.

(2) Yuzhong County Majiasi Copper Mineralization Occurrence

Located in the northwestern part of the reserve near Majiasi, mineralization occurs in the basalt of the middle formation of the Xinglongshan Group. Ore minerals are mainly chalcopyrite, with secondary malachite and azurite, occurring as veinlets and disseminated patterns. Copper grades are generally 0.2%-0.5%, locally reaching over 1.0%.

(3) Building Material Non-metallic Minerals

The Mt. Xinglongshan area has relatively abundant building material non-metallic minerals, mainly including:

- Limestone: Mainly distributed in the western and southern parts of the reserve, can be used for cement raw materials and building stone.
- Granite: Distributed in the northern part of the reserve, hard texture, beautiful color, can be used as building stone.
- Clay: Thick loess deposits in the loess hilly areas can be used as brick and tile raw materials.

7.4 Relationship with Adjacent Mining Areas

It is worth noting that there is a similarly named "Xinglongshan Ore Block" in Balinzuoqi, Chifeng City, Inner Mongolia Autonomous Region, which is part of the Shuangjianzishan super-large silver polymetallic deposit. This ore block is a completely different geographical entity from the Xinglongshan National Nature Reserve in Gansu. Research by Jiang et al. (2024) shows that large-scale copper mineralization has been exposed at depth in the Shuangjianzishan Xinglongshan Ore Block, with a chalcopyrite Re-Os isochron age of (237.7±7.4) Ma, belonging to the Early Indosinian mineralization period. This discovery has significant guiding importance for exploration in the Greater Khingan Range area but has no direct relevance to the Xinglongshan National Nature Reserve in Gansu discussed in this paper, mentioned here only for clarification to avoid confusion.

7.5 Mineral Resource Protection

As a national-level nature reserve, any form of mineral resource exploration and mining activities is strictly prohibited in the core zone and buffer zone of Mt. Xinglongshan. Activities in the experimental zone require strict adherence to environmental impact assessment procedures and approval processes. Currently, there are no active mines within the reserve, and all historical small-scale mining sites have been closed and undergone ecological restoration.

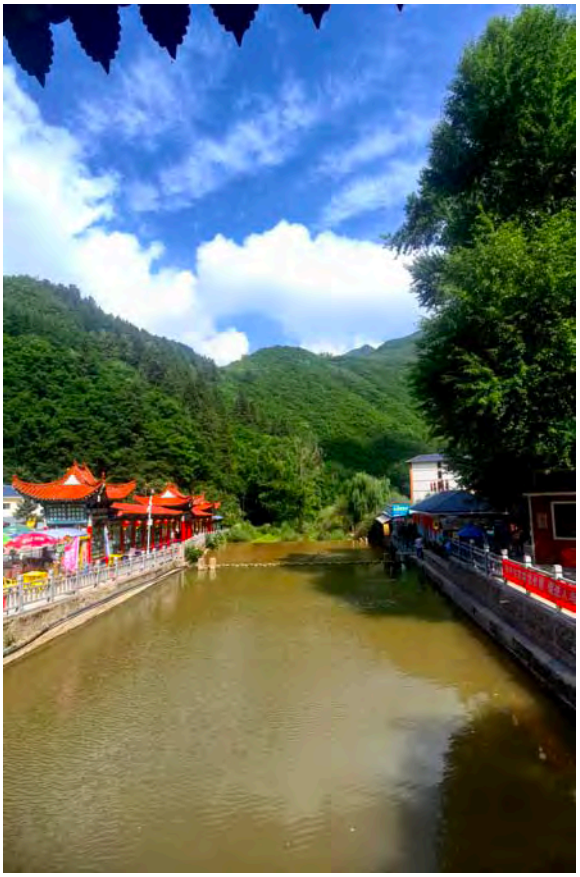
8 Tourism Resources and Distribution in Mt. Xinglongshan

8.1 Tourism Resource Types and Evaluation

Mt. Xinglongshan is a famous scenic spot and tourist summer resort in Gansu Province, with rich and diverse tourism resources (Baidu Baike, 2026; Fig. 3), which can be categorized by type as:

(1) Natural Landscape Resources

- Mountain Landscape: East Peak (Mt. Xinglongshan) at 2400 m, West Peak (Mt. Qiyun) at 2500 m, with two mountains facing each other and a deep gorge. The East Peak is known for its elegance, while the West Peak is renowned for its steepness.
- Forest Landscape: Primitive forest coverage exceeds 80%, with Chinese Pine forests, Wilson's Spruce forests, Liaodong Oak forests, etc., forming distinct seasonal forest landscapes. The autumn foliage presents a spectacular view.
- Hydrological Landscape: Xinglong Gorge features babbling streams and cascading waterfalls, with the Yunlong Bridge spanning the gorge, forming the classic scene of "a bridge linking two mountains, a rainbow reflecting in clear water."
- Meteorological Landscape: Scenic features such as post-rain cloud seas, sunrise and sunset, and winter snow rime offer high ornamental value.



照無量渡人
有求必應

Fig. 3 Tourism resources in Mt. Xinglongshan.

(2) Cultural Landscape Resources

- Taoist Cultural Heritage: Mt. Xinglongshan has a long-standing Taoist culture. Qing Dynasty Taoist Liu Yiming practiced here for over 40 years, constructing 62 Taoist temples. Existing ancient buildings include Hunyuan Pavilion, Zhaoyun Pavilion, Great Buddha Hall, Bodhisattva Hall, Taibai Spring, Erxian Terrace, Xisong Pavilion, Dilei Pavilion, Kuixing Pavilion, etc (Fig. 3).
- Genghis Khan Relics: The Great Buddha Hall enshrines a statue of Genghis Khan, with three tall spruces in front of the hall. According to records, Genghis Khan died in Mt. Xinglongshan in 1227, and his clothing tomb was once preserved here. From 1939 to 1949, his coffin was also secretly stored in the Great Buddha Hall (Travel China Guide, 2026; Fig. 3).
- Chiang Kai-shek's Villa: In August 1943, Chiang Kai-shek stayed here for six days and held a military conference. This two-story building includes a living room, waiting room, staff room, and conference room on the first floor, and a conference room, communications room, bedroom, dressing room, and bathroom on the second floor (Fig. 3).
- Liu Yiming's Tomb: The tomb of Qing Dynasty Taoist Liu Yiming is located here, with a stone tablet erected in front.

(3) Scientific Research and Education Resources

As a national-level nature reserve, Mt. Xinglongshan is an ideal location for field practice and science education in disciplines such as ecology, forestry, geology, and botany. The reserve features the Xinglongshan National Natural History Museum, displaying regional animal, plant, and geological specimens (Travel China Guide, 2026).

8.2 Major Scenic Area and Attraction Distribution

East Peak Scenic Area (Mt. Xinglongshan):

- Yunlong Bridge: A 155-meter-long colorful arch bridge supported by 16 red pillars and topped with a colored glazed tile roof, with pavilions at each end, resembling a rainbow connecting the two mountains (Fig. 3).
- Great Buddha Hall: Dominated by blue, red, and green colors, consisting of three central main halls and two small side halls (Travel China Guide, 2026).
- Erxian Terrace, Taibai Spring, Xisong Pavilion, Dilei Pavilion, Kuixing Pavilion, etc.

West Peak Scenic Area (Qiyun Mountain; Fig. 3):

- Hunyuan Pavilion, Zhaoyun Pavilion
- Yuhuang Hall, Longwang Hall, Tudi Shrine
- Heavenly Ladder: Steep mountain stone steps, offering a challenging climb (Travel China Guide, 2026).

Foothill Scenic Area:

- Chiang Kai-shek's Villa
- Xinglongshan Natural History Museum

8.3 Tourism Service Facilities and Transportation

Transportation: Mt. Xinglongshan is located 60 km from Lanzhou city center, with convenient transportation. Visitors can take a bus from Lanzhou Tianshui Road Bus Station to Yuzhong County (about 1 hour), then transfer to bus No. 6 or take a taxi to the scenic area (about 15 minutes) (Travel China Guide, 2026). Reception Facilities: The scenic area features visitor service centers, parking lots, dining points, and accommodation facilities, basically meeting visitor needs.

8.4 Ecological Impacts of Tourism Development

While tourism development brings economic benefits, it also has certain impacts on the ecological environment of the reserve. Main issues include:

- Habitat Disturbance: Visitor activities cause wildlife to avoid core tourism areas, shrinking their activity ranges.
- Litter Pollution: During peak tourist seasons, large amounts of waste are generated, exceeding disposal capacity.
- Road Barriers: Tourism roads create barrier effects for wildlife.
- Noise Pollution: Visitor noise and tourist vehicle noise disturb normal wildlife activities.

According to infrared camera monitoring, the grid occupancy rate for human activity within the reserve is as high as 73.00%, with tourism being a major source.

9 Eco-Environment Protection and Ecotourism Development in Mt. Xinglongshan

9.1 History of Nature Reserve Development

The development process of Gansu Xinglongshan National Nature Reserve can be divided into the following stages:

- 1982: Approved by the Gansu Provincial People's Government as a provincial-level nature reserve.
- 1988: Approved by the State Council and upgraded to a national-level nature reserve.
- 2000: Listed by the State Forestry Administration as a national demonstration nature reserve.
-2015: The Gansu Xinglongshan Forest Ecosystem National Positioning Observation and Research Station was approved for construction, providing a platform for long-term ecological monitoring.

9.2 Ecosystem Monitoring and Research

The establishment of the Gansu Xinglongshan Forest Ecosystem National Positioning Observation and Research Station marks the systematic and standardized development of scientific research monitoring in the reserve. This station relies on the Gansu Academy of Forestry Sciences, in collaboration with Lanzhou University and other research institutions, to carry out long-term positioning observation studies on forest ecosystem structure and function, biodiversity maintenance mechanisms, carbon cycling processes, and other aspects.

Based on observation data from this station, Ling et al. (2024) conducted continuous observations of soil respiration rates in typical forest stands in Mt. Xinglongshan (Liaodong Oak forest, David's Poplar-Asian White Birch mixed forest, Chinese Pine forest, and Wilson's Spruce forest). The study showed significant spatial heterogeneity in soil respiration rates among different forest stands, with soil temperature (T5) and soil water content (W5) being key factors regulating soil respiration. Such research provides important data support for assessing the carbon sink function of forest ecosystems.

Ma et al. (2022) systematically analyzed the forest landscape pattern of the reserve using GIS technology and secondary resource survey data. The study identified 10 types of forest landscape elements and revealed the quantitative relationships between various forest landscape types and topographic factors (elevation, slope, aspect). Such research provides a scientific basis for forest landscape optimization and management.

9.3 Biodiversity Conservation Measures

(1) Flagship Species Conservation

The alpine musk deer is the flagship species of the Xinglongshan National Nature Reserve, assessed as Endangered (EN) on the IUCN Red List. Main conservation measures taken by the reserve include:

- Establishing a dedicated monitoring network for musk deer, conducting regular population surveys.
- Strengthening anti-poaching patrols, removing illegally set snares and traps.
- Protecting and restoring musk deer habitat, controlling grazing and human disturbance.

(2) Habitat Protection and Restoration

- Strictly protecting primary forests in the core zone, prohibiting any form of logging or development.

- Carrying out degraded forest restoration and plantation forest tending in experimental zones to improve forest quality and ecological functions.
- Implementing natural forest protection projects, closing hillsides for afforestation, promoting natural vegetation recovery.

(3) Wildlife Monitoring

From 2018 to 2020, Mao et al. (2022) conducted a two-year systematic survey of bird and mammal diversity in the reserve using 60 infrared cameras, obtaining 7,877 independent valid photographs and identifying 60 wildlife species, providing crucial foundational data for conservation management. This non-invasive monitoring technology will continue to be applied in the reserve, establishing a long-term dynamic monitoring system.

9.4 Status of Ecotourism Development

Mt. Xinglongshan is a well-developed and highly recognized ecotourism area in Gansu Province. In recent years, the reserve has carried out the following work in ecotourism development (Administration of Gansu Xinglongshan National Nature Reserve. 2025):

(1) Infrastructure Construction

- Improving scenic area roads, trails, viewing platforms, parking lots, and other infrastructure.
- Building cable cars to facilitate visitor access to mountain peaks.
- Renovating ancient buildings to protect cultural heritage.

(2) Science Education and Outreach

- Constructing the Xinglongshan Natural History Museum to showcase regional natural resources and ecological protection achievements.
- Setting up interpretive signage to educate visitors on ecological protection.
- Conducting nature education activities to enhance public environmental awareness.

(3) Intelligent Development

In September 2025, the reserve's management center held a lecture on exploring the path of intelligent development, proposing a strategic concept for building a new model of "intelligent protection, scientific management." This system uses "Xiaolin Smart Brain" as its core, integrating data from resource management, disaster warning, scientific research monitoring, etc., to achieve "unified overview on one screen, unified management on one network." The five major business systems cover biodiversity protection, disaster prevention and control, ecological engineering, government affairs and tourism, and data governance. Through technologies such as AI species identification, 3D plot modeling, and drone patrols, a "space-air-ground" three-dimensional monitoring network is being constructed. Intelligent development will push the reserve's management from "passive response" to "active prevention and control," providing technical support for the coordinated development of ecological protection and tourism.

9.5 Community Co-management and Public Participation

Several towns and villages are located around the reserve, and the production and livelihood activities of local residents are closely related to resource utilization in the reserve. In recent years, the reserve has actively explored community co-management models:

- Establishing coordination mechanisms with surrounding communities to jointly address issues such as human-wildlife conflict and resource utilization.
- Conducting alternative livelihood training, guiding villagers to develop green industries such as ecological agriculture and agritourism.
- Involving local villagers in forest fire protection, ecological patrols, and other work, increasing employment opportunities.

However, infrared camera monitoring shows that domestic animal activity (RAI=32.99) and human activity (RAI=19.60) remain relatively frequent within the reserve, indicating that community co-management work still needs to be deepened (Mao et al., 2022).

10 Problems and Measures for Mt. Xinglongshan

10.1 Main Problems

(1) Severe Human Disturbance

Infrared camera monitoring data show that the Relative Abundance Index for domestic animal activity (32.99) within the reserve is higher than for most wild mammals, and the grid occupancy rate for human activity is as high as 73.00%. Overgrazing leads to understory vegetation degradation, with domestic animals competing with wild ungulates for food resources. Village activities like collecting medicinal herbs and fungi disturb wildlife habitats. Tourist numbers during peak seasons exceed environmental carrying capacity (Mao et al., 2022).

(2) Prominent Conflict Between Conservation and Development

Surrounding communities heavily rely on resources such as land, water, and forest products. Traditional resource use patterns conflict with conservation goals. The ecological compensation mechanism is imperfect, and local residents benefit little from conservation efforts, affecting their motivation to support conservation.

(3) Weak Disaster Prevention and Control System

Located in the transitional zone between the Loess Plateau and the Qinghai-Tibet Plateau, the reserve has complex geological conditions, with frequent natural disasters such as flash floods, landslides, and debris flows. As noted in the 2025 lecture, the monitoring blind spots and lagging emergency response exposed by flash flood disasters highlight the limitations of traditional management models (Administration of Gansu Xinglongshan National Nature Reserve. 2025).

(4) Need for Strengthened Scientific Research and Monitoring

Although a forest ecosystem national positioning observation and research station has been established, long-term monitoring data lacks continuity and comprehensiveness. Environmental element monitoring for soil, water bodies, and atmosphere is insufficiently covered, and quantitative assessments of ecosystem service functions need to be deepened.

(5) Aging Infrastructure

Some protection stations have outdated infrastructure, with conditions needing improvement for patrol roads, communication networks, etc. Ecotourism facilities, though having some foundation, still lag behind growing visitor demands.

10.2 Measures

Based on the past studies, the following measures can be adopted:

(1) Strengthen Human Disturbance Control

- Clearly define functional zones (core, buffer, experimental) and strictly implement zoning management.
- Increase law enforcement against illegal grazing, poaching, and collecting.
- Guide visitors to travel during off-peak periods and control visitor capacity in core scenic areas.
- Optimize tourist route design to reduce disturbance to wildlife habitats.

(2) Improve Ecological Compensation Mechanisms

- Secure national and provincial ecological compensation funds and raise compensation standards.
- Explore establishing horizontal ecological compensation mechanisms where beneficiary areas compensate the reserve.

- Develop eco-friendly industries such as under-forest economy, ecotourism, and carbon trading to broaden community income sources.

(3) Enhance Disaster Prevention and Control Capabilities

- Accelerate intelligent development to build a "space-air-ground" three-dimensional monitoring network.
- Improve geological disaster monitoring and early warning systems, enhancing emergency response capacity.
- Implement flash flood gully management projects to reduce disaster risks (Administration of Gansu Xinglongshan National Nature Reserve. 2025).

(4) Deepen Scientific Research and Monitoring

- Continue long-term positioning observations of forest ecosystems to accumulate foundational data.
- Strengthen population dynamics and ecological research on rare and endangered species like the alpine musk deer.
- Conduct ecosystem service value assessments to quantify conservation effectiveness.

(5) Promote Intelligent Reserve Construction

- Accelerate the construction of the "Xiaolin Smart Brain" central platform to achieve data integration and sharing.
- Promote the application of new technologies such as AI species identification and drone patrols.
- Utilize technologies like solar power supply and Beidou communication to address monitoring blind spots in complex terrain.

11 Future Prospects

Looking ahead, the development of Xinglongshan National Nature Reserve should follow the principle of prioritizing conservation while exploring new paths for coordinating ecological protection and green development.

In ecological conservation, the goal is to create a nationally first-class nature reserve by continuously improving the conservation management system. Through intelligent development, achieve a transition from "human-based" to "technology-based" protection, enhancing the precision and effectiveness of conservation management. Strengthen the protection of flagship species like the alpine musk deer, striving for stable or increasing populations. Promote the restoration of degraded ecosystems to enhance the stability and service functions of the forest ecosystem.

In scientific research, fully leverage the platform of the Gansu Xinglongshan Forest Ecosystem National Positioning Observation and Research Station to attract more research institutions, conducting comprehensive multi-disciplinary, multi-scale research. Focus on cutting-edge scientific issues such as forest carbon sinks, biodiversity maintenance mechanisms, and ecosystem responses to climate change, aiming for high-level research outputs.

In ecotourism, adhere to the principle of "protection first, rational utilization," strictly controlling development intensity. Enhance tourism service quality and develop new ecotourism formats such as science education and forest wellness tourism. Deeply explore cultural resources including Taoist culture and Genghis Khan culture to enrich the cultural connotation of the scenic area.

In community development, establish more robust community co-management mechanisms to promote the green transformation of surrounding communities. Through measures such as ecological compensation, alternative livelihoods, and employment support, enable community residents to become stakeholders and active participants in ecological protection, achieving harmonious coexistence between humans and nature.

As an important ecological barrier and biodiversity center in central Gansu, the conservation and development of Mt. Xinglongshan hold great significance for maintaining regional ecological security and

promoting ecological civilization construction. Guided by the concept that "lucid waters and lush mountains are invaluable assets," Xinglongshan National Nature Reserve is poised to forge a new path prioritizing ecological protection while pursuing green development, contributing a "Xinglongshan model" to the construction of a beautiful China where humans and nature coexist in harmony.

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