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Biodiversity of Bitahai Nature Reserve in Yunnan Province, China

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Abstract. Bitahai Nature Reserve is located in Northwest Yunnan and is the highest elevation and the highest latitude wetland nature reserve in Yunnan Province. Bitahai Nature Reserve is a typical wetland nature reserve in very low latitude and high elevation with large areas of coniferous forest around the alpine till lakes, wetland and water area ecosystem while compared with natural reserves distributed same latitude in the world. The area of the reserve distribution is the key area of Transverse Mountain Region. It was a refuge for plant and wildlife because Transverse Mountains were not covered by ice in the Tertiary. And the area is now regarded as a center of forming new species and preserving ancient species. Species biodiversity is high and the distribution of some endemic animals and plants are limited in Transverse Mountains area. In the nature reserve, there are many first and second grade protected plants and animals listed in Lists of China National Priority Protection Fauna and Flora. All of these are precious materials of genetic diversity. The diversities of the plant community and vegetation contribute to ecosystem diversity. Thus, Bitahai Nature Reserve holds with high conservation value. However, its biodiversity is threatened by different factors and its conservation should be paid great attention.

Background

Bitahai Nature Reserve is located in Shangrila County (named as Zhongdian County before December 2001) and belongs to Diqing Tibetan Autonomous Prefecture in Northwestern Yunnan, China. Bitahai Nature Reserve includes two parts – Napahai and Bitahai–Shuduhu. They were local reserves and separately called Bitahai Nature Reserve and Napahai Nature Reserve when they were built in 1981. And they were promoted as provincial-level natural reserves by Yunnan province government in 1984. Their territories were originally 14,181 and 2400 ha. The business of two reserves always had been controlled uniformly by the Bitahai Nature Reserve. Two reserves are being planned to combine and called Bitahai Nature Reserve to applying National Nature Reserve. Their total land area is enlarged to 33,000 ha. Bitahai–Shuduhu part lies between 27°46′35″–27°57′25″N and 99°54′23″–100°08′59″E, its area is 26,869.2 ha and accounts for 81.2% in the total area; Napahai part locates between 27°47′58″–27°55′00″N and 99°35′43″–99 °40′56″, its area is 6201.1 ha and accounts for 18.8% (Figure 1).

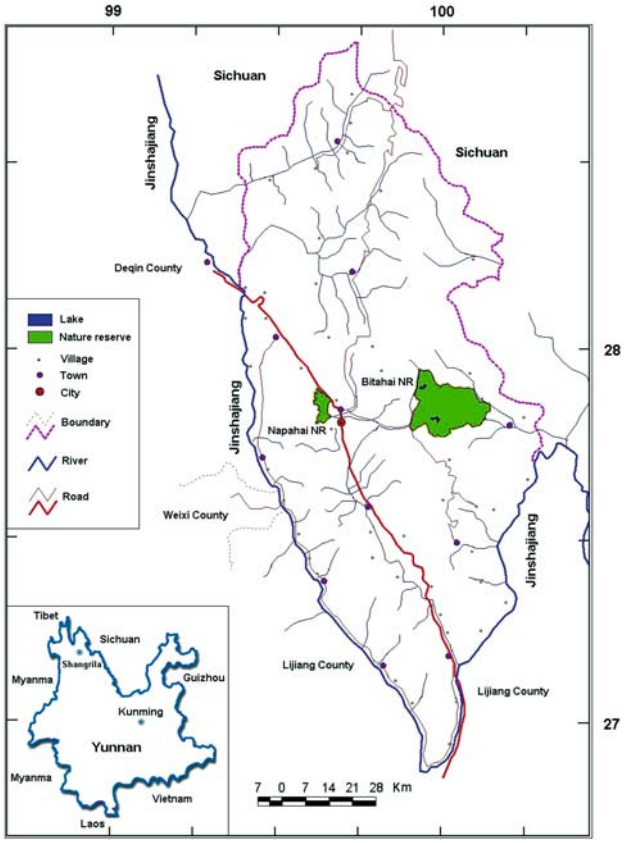

Figure 1. The Location of Bitahai Nature Reserve.

When the nature reserve was established in 1981, a preliminary investigation for biological resources had been conducted and a planning for the nature reserve construction had been finished. Henceforth, more survey and investigation for biological resources have been launched in northwest Yunnan by some institutes of Chinese Academy of Sciences, universities and colleges of Yunnan or the other provinces in China. Some publishing monograph or works reported or recorded the biodiversity of this area have been published (Chu 1989; Chu et al. 1989, 1990; Yang 1991; Yang et al. 1995). A comprehensive and systematic integrated investigation (including many subjects, such as insects, freshwater fishes, amphibians and reptiles, birds, mammals, fungi, fern, gymnosperm, angiosperm and so on) for the Hengduan Mountains Region (i.e. the Transverse Mountains Region) was carried out by the teams of comprehensive scientific expedition to the Qinghai-Xizang Plateau, Chinese Academy of Sciences during 1981–1985. The series of the scientific expedition to the Hengduan Mountains of the Qinghai-Xizang Plateau have been published in succession (Chen 1992, 1993, 1998;

Tang 1996; Zhao and Yang 1997). These materials are helpful and have high reference value for understanding the biodiversity of Bitahai Nature Reserve. Although the investigation for the Hengduan Mountains Region entirely covered the area of Bitahai Nature Reserve, subjects stated above were impossible to investigate details in the nature reserve because the scope Hengduan Mountains Region is extensive. Furthermore, investigations have been completed for a long time and the resources conditions have already changed deeply.

Southwest Forestry College (SWFC) initiated 'Bitahai Nature Reserve Comprehensive Scientific Inventory and Survey' in 2001. The program was entrusted by Yunnan Province Forestry Department and Shangrila County Government. The scientific expedition team was composed of experts focusing on 20 thematic topics. Investigation content was involved: geological conditions and landscape features, waters and climate, soil, flora, vegetation types, wetland plants, rare and endangered protected plants, cash plants, ferns, mammals, birds, amphibians and reptiles, fishes, insects, biodiversity, social economy, social forestry, tourism development, etc.

The team studied thoroughly the whole Nature Reserve. Some thematic groups of the team went into the nature reserve for several times and the scientific research lasted as late as the end of 2001. According to the characters of different subjects and methods used in the field, thematic topics collected specimens, made samples in the field or visited communities in and out of the nature reserve.

A lot of first-hand information, specimen, photo and video files have come out of the expedition. The expedition makes clearly biological resources, the tourism resources, key protected wildlife and plants with their population and the present status. With the hard work of the team and the data and information collected previously, the team accomplished 'The Report about Bitahai Nature Reserve Comprehensive Scientific Inventory and Survey'. The report comprehensively and objectively reflects the natural resources status of the nature reserve. It provides scientific foundation for the planning, construction and management of the nature reserve, and also paves way for the reasonable development of biological and tourism resources of the nature reserve in the future.

This article was picked out and condensed from the 'The Report about Bitahai Nature Reserve Comprehensive Scientific Inventory and Survey'. It may give an outline of Bitahai Nature Reserve.

The biodiversity of the nature reserve

Near the nature reserve, there are more than 244 rivers and creeks and 298 lakes, all run into the Jinsha River (the Upper Yangtze River). Most lakes in the area are scattered in the mountainous plateau with elevation of 3000–4500 m, making the area of an important region with alpine lakes in Northwestern Yunnan. Napahai, Bitahai and Shudu Lake are the biggest of these

alpine lakes and the area around these lakes enjoys picturesque nature beauty. Around these lakes, large area of wetlands and swamps have been formed over millions of years, with one of these wetlands lies in an elevation of 3900 m, thus making Bitahai Nature Reserve the highest elevation and highest latitude wetland nature reserve in Yunnan Province. Bitahai Nature Reserve and the lakes are just like pearls perching on the Northwestern Yunnan Plateau. The key objectives of the Nature Reserve are to protect alpine and mid-alpine marshland, wetlands, lakes and the wild species having these areas as habitats. The protected targets are including rare alpine fish species, waterfowls spending the winter in the waters and their habitats, alpine coniferous forests and mammals living in these forests.

Species diversity

Richness of the species

Seed plants. The present comprehensive inventory made a thorough catalogue about the plant resources, based on the data of the previous researches. As the new catalogue shows, there are 140 families, 568 genera and 2275 species of wild seed plants. Of these, there are 4 families, 9 genera and 20 species of gymnosperm and 136 families, 559 genus and 2255 species of angiosperm (Table 1).

Three angiosperm families have more than 100 species, respectively. They are Compositae (64 genera 324 species), Rosaceae (26 genera 107 species) and Ranunculaceae (19 genera 104 species). Families between 50 and 100 species are as follows: Gramineae (34 genera 99 species), Umbelliferae (31 genera 85 species), Papilionaceae (8 genera 76 species), Labiatae (18 genera 74 species), Scrophulariaceae (11 genera 70 species), Gentianaceae (10 genera 66 species), Orchidaceae(24 genera 64 species), Saxifragaceae (9 genera 63 species), Liliaceae (16 genera 62 species), Cruciferae (9 genera 62 species), Cyperaceae (14 genera 61 species), Primulaceae (3 genera 57 species) and Cruciferae (20 genera 50 species).

The total species of families with more than 50 species are 1424 species, 62.6% of the total seed plants of the NR.

Table 1. Comparison of Seed Plants of Bitahai NR, Yunnan and China.

	Gymnosperm					Angiosperm				
	Bitahai	Yunnan		China		Bitahai	Yunnan		China	
		No.	%	No.	%		No.	%	No.	%
Family	4	10	40.0	11	36.4	136	230	59.1	291	46.7
Genus	9	32	28.1	32	28.1	559	1953	28.6	3116	17.9
Species	20	92	21.7	200	10.0	2255	14000	16.1	25000	9.0

According to the *List of National Key Protected Plants* issued by the State Council of China in 1999, *Taxus yunnanensis* is first grade protected species, *Torreya yunnanensis*, *Picea bracluytyla*, *Fagopyrum dibotrys*, *Psammosilene tunicodes*, *Tricholoma matsutake* and *Cordyceps sinensis* are second grade national protected species. Although the number of species being protected is not big, all these species have conspicuous regional characteristics. *Cordyceps sinensis*, *Tricholoma matsutake*, *Taxus yunnanensis*, *Fagopyrum dibotrys* are endemic species in this bio-geographical region and they have great protecting value.

Initiative statistics show that in the NR there are some plants enjoying great economic potentials. Of these plants, 463 are ornamental plants, 363 are medicinal herbs and 60 are edible wild plants, 8 are starch plants and 22 are fiber plants, 22 are fragrant oil plants, 25 are tanning material, 11 are gum and resin plants.

Vertebrates and insects. Altogether 28 orders, 70 families and 280 species of vertebrates are recorded in the Bitahai NR (Table 2). There are 68 species of mammals, belonging to 7 orders and 23 families. Of these, *Neofelis nebulosa* and *Panthera pardus* are first grade national protected animals listed in Lists of China National Priority Protection Fauna (1989). There are other 14 species of second grade national protected species. They are as follows: *Macaca mulatta*, *Cuon alpinus*, *Selenarctos thibetanus*, *Ursus arctos*, *Ailurus fulgens*, *Martes foina*, *Martes flavigula*, *Lutra lutra*, *Viverra zibetha*, *Viverra indica*, *Felis temmincki*, *Lynx lynx*, *Moschus sifanieus*, *Moschus berezovskii*, *Capricornis sumatraensis*, and *Naemorhaedus caudatus*.

Around 171 species of birds are recorded in the investigated area, belonging to 16 orders 38 families. If classified according to the migrating habits, there are 120 species of resident birds, 70.1% of the total and six species of summer migratory birds or summer residents, 3.5% of the total, and 126 species of birds are reproduction birds (including resident and summer migratory birds), 73.6%. About 36 species are winter residents birds (not including birds passing through this territory in winter), 21.1% of the total. Eighteen species are stop-by birds or rarely-seen birds, 10.5% of the total. Six species – *Grus nigricollis*, *Ciconia nigra*, *Gypaetus barbatus*, *Tetrastes sewerzowi*, *Haliaeetus albicilla*,

Table 2. Vertebrates in Bitahai Nature Reserve and those in Yunnan and other places in China[a].

Wildlife	Bitahai NR	Yunnan	Percentage of Bitahai in Yunnan (%)	China	Percentage of Bitahai in China (%)
Mammals	68	304	22.4	597	11.4
Birds	171	808	21.2	1253	13.6
Reptiles	11	152	7.2	391	2.8
Amphibians	13	112	11.6	278	4.7
Fishes	17	432	3.9	1023	1.7

[a]Data from The Report of Wild Life Resources Investigation in Yunnan (Yunnan Province Forestry Department, 2001).

*Tetraogallus szechenyii*are are first grade national protected birds and the other 18 species are second grade national protected, including *Podiceps cristatus*, *Platalea leucorodia*, *Cygnus cygnus*, *Accipiter virgatus*, *Circus cyaneus*, *Buteo buteo*, *Pandion haliaetus*, *Gyps fulvus*, *Gyps himalayensis*, *Falco tinnunculus*, *Ithaginis cruentus*, *Tragopan temminckii*, *Grossoptilon crossoptilon*, *Pucrasia macrolopha*, *Grus grus*, *Psittacula derbiana*, *Bubo bubo*, *Strix aluco*.

In the nature reserve, there are 11 species and sub-species of reptiles, belonging to 1 order and 2 sub-orders and 5 genera. The number of species of amphibians are 13, belonging to 2 orders and 5 families. There are 17 species of native fishes, belonging to 2 orders, 4 families and 12 genera.

Altogether 493 species of insects are recorded in the Zhongdian Area. Field trip investigations detected 12 orders and 51 families. Sixty-three species of insects have been identified and classified, belonging to 8 orders and 25 families. Orders Coleoptera and Lepidoptera hold plenty species and locusts of Coleoptera have the largest population. This investigation also discovered that *Coccinella geminopunctata* and other 9 species are new records in Yunnan Province.

Peculiar taxonomic category

Two indicators – number of species and peculiar taxonomic category are used to measure the biodiversity in a region. Let us take a look at the peculiar taxonomic category of the biological communities.

Seed plants. The three distribution centers of Chinese Special Plant Biome are: Western Hubei–Eastern Sichuan, Hengduan Mountains and Southeastern Yunnan–Southwestern Guangxi ((Ying and Zhang 1994). Bitahai NR lies in the heartland of the Hengduan Mountain Special Plant Biome. In the NR, 31 genera of unique Chinese plants (means distributed only in China) are recorded, 12.8% of the total 243 unique genera in China. This kind of high concentration of endemic plants is a rare site anywhere in the world. Certain plants found in the NR are the only genera in the Hengduan Mountains. These genera are *Caulokaempferia*, *Xanthopappus*, *Anemoclema*, *Souliea*, *Spenceria*, *Haplospharea*, *Sinolimprichtia*, *Cyclorhiza* and *Physospermopsis*. These genera are formed by relative advanced plant families, such as Compositae, Umbelliferae and Labiatae, composing one and only new and rare plant center in China. The biodiversity in the region plays a vital role in China and the world.

The number of peculiar seed plants species is quite amazing too. Altogether 1322 species of such plants are recorded in the NR, 60% of the total plant species in the NR. Of these, 514 species are endemic in the Hengduan Mountains, more than one-fifth of the total seed plants in the NR. Beside this, 292 species are Chinese endemic plants, 171 species are southwest China endemic plants, 32 species are Yunnan endemic plants and 218 species are northwest Yunnan endemic plants and 95 are native plants in the NR.

Vertebrates and insects. Six species of mammals – *Petaurista xanthipes*, *Eozapus setchuanus*, *Sicista concolor*, *Lepus oiostolus*, *Moschus sifanieus* and *Ailurus fulgens*, are species of only located in the Hengduan Mountains, Himalayans, and Qinghai-Tibetan Plateau, 14.6% of the total 40 major mammals in the NR. Forty-two bird species find their hatching places only in the Hengduan Mountains, 33.3% of the total 126 hatching species found in the NR. This means about one-third of the bird species are peculiar species in the region. *Oreolalax*, *Atympanophrys*, *Nanorana* are three endemic genera of tailless amphibians in China. Except a few species of *Oreolala* also can be found in Eastern Sichuan, Western Hubei and Northern Guizhou, most Chinese endemic genera and their species are found only in the Hengduan Mountains. Two other genera – *Scutiger* and *Batrachuperus* are also mainly found in the Hengduan Mountains. They are the result of the rising movements of the Hengduan Mountains. Of the 11 species of reptiles found in the region, 9 are endemic in the Henghduan Mountains. Of the 17 species of native fishes, 11 species are only found in Jinshajiang River System. *Ptychobarbus chungtienensis chungtienensis* and *Ptychobarbus chungtienensis gezaensis* are only found in Bitahai NR and the nearby creeks.

In China, three insects only found in Yunnan are recorded in the NR. They are *Hippodamia variegata* (Goeze), *Psiloreta pulchrepes* (Butlter) and *Rheumaptera diochoticha* (Xue).

Genetic diversity

On the average, the more the genetic patterns are diversified, the better adaptability the wildlife species have. If genetic diversity is poor, the wildlife species will have poor adaptability for the changed environment, so is the adaptability in the process of evolution. And for this reason, the genetic diversity within a community reflects the potential of evolution of a certain species. To sum up, to measure the genetic diversity in a given region, we should not only focus on diversity within a species and between species, we should lay more attention to the richness of genetic resources and endemic characteristics of these genetic resources in that region.

Bitahai NR has very rich genetic resources and this can be shown from the following aspects:

Seed plants, vertebrates and insects have very large population and species in the NR. The gene diversity carried by each species constitutes of enormous gene bank.

In the area, there are some endemic and special wildlife and plant species. The gene resources conveyed by these species are valuable and special gene resources found nowhere in the world.

The area lies in the meeting place of Southwest region, Oriental realm and Qinghai-Tibet region, Palearctic realm. Certain species once widely distributed in these two realms (regions) are now become marginal communities. In order

to adapt to the harsh environment, these species have developed a lot of physical and physiological changes, which in turn will bring about positive accumulation in genetic diversity. The gene information carried by these species is a valuable genetic resource. If this kind of gene accumulation reaches a certain quantity, new unique and endemic species or subspecies will surely evolve.

Of the seed plants, vertebrates and insects found in the NR, certain species are widely distributed in the world. In order to adapt to the harsh environment, these species living in the high elevation in the NR will make more or less macro changes both in structure and genetic composition, which bring about a valuable genetic resource as a result.

Ecosystem diversity

Plant community diversity

Bitahai Nature Reserve lies in the northwestern most region of Yunnan Province with the highest latitude and elevation within the province. And it is one part of the Tibetan-Qinghai Plateau and is in the highest ladder of the Chinese landscape system. In terms of the vegetation system in Yunnan, the region belongs to alpine cold coniferous forest in southeastern Tibetan-Qinghai Plateau, specifically speaking, it is alpine forests and marshlands region in Zhongdian and Deqing County (Wu and Zhu 1987).

The highest point in the NR is 4159 m and the lowest point is 2380 m, with an elevation difference of 1815 m. The northern part of the NR is dominated by high mountains while the southern part is traversed by deep valleys. Because of the distinctive height difference within the NR, different vegetation types can be found in the NR. According to the Yunnan vegetation classification system (Wu and Zhu 1987), there are six major vegetation types in the NR, namely, hard leaf evergreen broadleaf forest, deciduous broadleaf forest, temperate coniferous forest, grooves, alpine meadow vegetation and water vegetation in alpine lakes. Eleven sub-vegetation types have been classified in the NR, namely, cold temperate hard leaf alpine evergreen broadleaf forest, birch forest, warm temperate coniferous forest, cool temperate coniferous forest, cold temperate coniferous forest, cold temperate grooves, middle-alpine meadow, middle-alpine marshlands, water plants community, floating leave plant community, underwater plant community, etc. altogether 34 flora types and 49 communities have been found in the NR.

Forest ecosystem in the alpine and middle alpine cold temperate
Virgin coniferous forest

The forest with the largest area is the cold temperate coniferous fir forest, distributing in the area with elevation between 3200 and 4000 m. Because of high elevation and inaccessibility, this area sees very few human activities and most forest is still in a natural state. In these forests, some trees with DBH more than 100 cm, with the biggest being 130 cm and some trees are as tall as

42 m. This area is one of regions best-kept natural spruce and fir forest in Yunnan Province.

The hard leaf evergreen broadleaf forest is of cold temperate alpine hard leaf evergreen broadleaf type and its distribution is below spruce and fir forest in elevation at 3000–3700 m. It usually grows in the sun-facing slopes with barren soil or gravel soil, and dots in the spruce and fir forest.

Within the NR, there is no large area of deciduous broadleaf forest, usually found in the boundary region of the NR and near the villages. Most of this forest is secondary forest, formed after spruce and fir forest is destroyed as a transitional vegetation type with birch and poplar tree as the main species. Spruce and fir grows very slow because of high elevation in the NR, while the birch and poplar trees grow very fast and this kind of stand can last for a rather long period of time. This increases the forest landscapes and vegetation types in the NR, which is positive in maintaining the biodiversity in the NR.

Most mammals take this part of forest as their habitats. The major species are *Macaca mulatta*, *Selenarctos thibetanus*, *Ailurus fulgens*, *Moschus berezovshi*, *Muntiacus muntjak*, *Elaphodus cephalophus*, *Felis* spp. and *Vulpes vulpes*. In the low valleys, wild boar can be found. The major rare and endemic bird species are *Crossoptilon crossoptilon*, *Columba hodgsonii*, *Zoothera dixoni, Yuhina diademata, Tetraogallus szechenyii, Tetrastes sewerzowi*, *Aquila chrysaetos*, *Nucifraga caryocatactes*, *Certhia himalayana*, *Tragopan temminckii*, *Bubo bubo*, *Babax lanceolatus*, *Accipiter virgatus*, *Pucrasia macrolopha*, *Cuculus canorus* and so on.

Ecosystem of alpine and mid-alpine marshlands and lakes

Marshlands and wetlands are the most conspicuous feature of the NR. The core area of the NR is Napahai Lake, Shuduhu Lake and Bitahai Lake, constituting the highest elevation and latitude wetlands nature reserve in Yunnan Province. The elevation of the three lakes is around 3268–3610 m and around the lakes, large areas of marshlands and swamps have developed. Certain parts of the marshlands are in the elevation of 3900 m.

The major bird species found in the groove marshlands and meadows are *Tetraogallus szechenyii*, *Tetrastes sewerzowi*, *Columba leuconotaa*, *Columba rupestris*, *Columba rupestris*, *Anthus hodgsoni*, *Pyrrhocorax pyrrhocorax*, *Phylloscopus affinis*, *Phylloscopus reguloides*, *Anthus roseatus*, *Ptyonoprogne rupestris*, *Alauda gulgula*, *Troglofytes troglodytes* and so on.

The alpine lakes and the wetlands are ideal food sources and places to spend harsh winter for the birds in their migration endeavors and they are also hatching places for some species of waterfowls. The most common birds spending winter in these lakes and wetlands are *Ciconia nigra*, *Anser indicus*, *Anas platyrhynchos*, *Mergus merganser*, *Haliaeetus albicilla*, *Grus nigricollis*, *Tadorna ferruginea* and the less common birds are *Cygnus cygnus*, *Platalea leucorodia*, *Anser anser*, *Ardea cinerea*, *Egretta garzetta*. The common migrating bird stopping over the area is red-feet sandpiper.

The richest amphibians and reptile species are those living in the meadows and marshlands at the edge of forests. The freshwater fishes of *Ptychobarbus chungtienensis chuntienensis* and *Ptychobarbus chungtienensis gezaensis* are only restricted in a narrow area in Bitahai Lake and the creeks near the lake.

Characteristics of biodiversity and its formed background in Bitahai NR

The reason Bitahai enjoys such rich biodiversity and world attention lies in the its ideal natural conditions and geographical location.

Background of biodiversity formation

In terms of geological formation, the area belongs to the northern part of 'Ancient Kang-Dian Landmass' and it is a major constituent of the world-famous Hengduan Mountains.

In its history rising up, the Qinghai-Tibetan Plateau underwent several fierce fold movements, forming the Hengduan Mountains on its eastern edge. During the Ice Age, there was no large area of ice cover in north–south direction deep-cut Hengduan Mountains and the landscape was similar to what is today. During the Ice Age, however, glaciers came and went frequently, making the climate zone moving south and north from time to time. At the same time, it brought about vertical changes on the natural zones. This kind of changes is not like that in the plain regions, where the changes on the natural zones can be several kilometers long. In the valleys of lower elevation, the influence of Ice Age climate was very weak and the major landscape never disappeared. The evolution of such landscape was rather stable. The landscape patterns in the area are good for northern wildlife seeking shelter in the region, thus preserving many ancient and primitive species in the area and making the area of major center preserving primitive and ancient wildlife species in China. At the same time, wildlife in the adjacent areas migrated into the area and polarized into different habitats and became basic elements of fauna system in the region.

The rise of the Hengduan Mountains brought about differences in geography, landscape and climate compared with the adjacent regions. A conspicuous vertical climate belt was formed as a result. The complicated climate patterns and vertical vegetation distribution provide the wildlife with diversified habitats. The paralleled valleys and high peaks form separate habitats for plants and wildlife. These habitats are beneficial for preserving species and contribute a lot in their evolution and development. And this, the basic conditions for producing unique species in the area are formed. This is the reason that the wildlife and plant species in the Hengduan Mountains are highly developed and enjoy unique characteristics.

Characteristics of biodiversity in Bitahai NR

Diversified fauna and flora

(1) Flora is dominated by temperate zone characteristics with tropical plant features. Viewed from the distribution of seed plants in the area, the flora of the region is of temperate zone characteristics. There are altogether 362 genera of temperate plants, 70.2% of the total 568 genera in the NR. Of these temperate plants, most are northern temperate zone plants, 126 genera, 24.4% of the total. The second is China-Himalayan plants, 46 genera, 9% of the total. This clearly shows the close relationship between the plants in the region and those in the Himalayans.

Tropical plants are not uncommon in the region. There are altogether 175 genera with tropical characteristics, 33.9% of the total. Of these tropical plants, most are pan-tropical plants, 58 genera, 11.2% of the total. Yet there are not many species of these tropical plants and they mainly grow in the river valleys at lower elevation, usually with very small population and they are not the major element in the communities. This reflected the temperate zone characteristics of the nature reserve flora as well its tropical characteristics affiliation.

(2) Fauna is dominated by oriental characteristics with conspicuous southwest China features. Studies and researches on birds, mammals, amphibians, reptiles and insects show that, in terms of fauna, most wildlife in the region is composed by the species of oriental realm. Yet, in certain high elevation areas, some palearctic realm species distribute southward along the mountain ridges. And there are also some tropical species distribute northward along the valleys in the region. The wildlife species from different zones co-exist in a vertical distribution pattern. In terms of population, most wildlife species in the region belongs to southwestern region of oriental realm.

Diversity of species

Relatively speaking, the Hengduan Mountains are quite young, so are the fauna and flora composition in the region. However, the fauna and flora of the region is originated from the fauna and flora before the rise of the Mountains. Because the area was very little influenced by the Ice Age and glaciers, certain primitive and ancient species could survive, thus making the fauna and flora of the region have some ancient characteristics.

Vertical distribution

The vegetation types change vertically as elevation changes. In the lower elevation areas, the plants are of tropical characteristics while in the high elevation area, the plants are of cold region characteristics.

The area is a meeting place of wildlife species from the south and north. Most of them distribute in vertical patterns. In the high elevation, the dominant species of Qinghai-Tibetan species of the paleo-arctic zone while at the lower elevation, oriental species distribute. Studies on fishes subfamily

Schizothroacinae in Cyprinidae show that since the Tertiary Period, Schizothroacinae species experienced three major differentiation or polarization as the Qinghai-Tibetan Plateau rose and stabilized. As a result, adaptive groups were preserved and distributed at different altitude. Non-adaptive groups were extincted and this is the case with other fish groups too.

State of biodiversity in Bitahai NR

Appraisal on biodiversity of Bitahai NR

Unique bio-geographical location
The unique bio-geographical location of the Bitahai NR strongly secures its place concerning biodiversity in Yunnan, China and in the world.

Geological history of the Hengduan Mountains. The Hengduan Mountains were not all covered by ice in the Ice Age, making it a refugee for plants and wildlife and the area is now regarded as a center preserving and forming new species. In recent years, this area has become a hot spot to preserve biodiversity in the world.

Meeting place of the bio-geographical zones. In terms of fauna, the Hengduan Mountains region is transitional place of oriental and paleo-arctic zones (Zhang 1999). In the flora classification system of Yunnan, the area lies in the heartland of the 'western Yunnan and Hengduan Mountains' and in meeting area of the southern edge of the pan-arctic zone and ancient tropical zone (Wu and Zhu 1987).

Landscape transitional zone. Viewed from latitude and elevation conditions, the area is a landscape transitional zone. To its south or in the areas with lower elevation, the vegetation is mainly subtropical coniferous forest and secondary shrubbery and meadow. To the north or in the areas with higher elevation, the vegetation is mainly alpine meadow and alpine tundra.

Important corridor for birds migration. The Hengduan Mountains Range is an important corridor for birds' migration in Asia and in western China. Bitahai NR is right in the middle of this corridor. Its alpine lakes, marshlands and wetlands are the best food sources for the birds migrating southward and an ideal places to overcome the harsh winter.

Richness of biodiversity in Bitahai NR
Richness of biodiversity. As previously elaborated, the NR is rich in wildlife and plant species, ecosystems and hereditary patterns. It is an area which calls for special attention and protection.

Uniqueness of biodiversity in Bitahai NR. Some unique plant, vertebrates and insects species have developed in the NR, making it an area with uniqueness of biodiversity. The uniqueness not only reflects the regional background of species, but also tells the connections and differences of a given region with the adjacent regions. In this sense, uniqueness of biodiversity, to some extent, elaborates the bio-geographical importance of a certain region and the value of establishing nature reserves is right here in this fact.

Uniqueness of the wetland ecosystem

Compared to the wetlands in northwest, central and east China, the wetlands in the Bitahai NR has two distinctive features. First, the wetlands of Bitahai NR lie in very high elevation and, second, there are large areas of coniferous forest around the wetlands. The well-kept alpine and mid-alpine coniferous forest is a natural reservoir to conserve rainwater and a major source of underground water, which is a sure guarantee to form and maintain wetlands and lakes. Different from this, the wetlands in inland China have their water sources from the rivers in the upper reaches. Special wetlands as Bitahai nourish unique wetland vegetation types and special wetland wildlife species and thus it enjoys great value as a nature reserve. What's more, this area is one of the headwaters of the Changjiang River (Yangtze River). For these reasons, the conservation of alpine and mid-alpine wetlands and lakes holds with a deep ecological significance.

The wetlands ecosystem has a direct and intimate relationship with the birds having them as habitats. Of the 171 species of birds recorded, 31 are species wetlands-specific, 18.1% of the total number. Most of these 31 species have very large population living in the area. One example is wild geese and ducks with a population of about 10,000 in Napahai area. In summary, the conservation of the waters and wetlands in the NR is the key issue to protect the birds spending water in the region.

Biodiversity conservation

Threats to biodiversity

Water level in wetlands. The water in Napahai Lake flows into the Jinshajiang (the upper Yangtze River) through an underground river from a hole in the northwestern bank. Over the years, the hole has been enlarged by people and the water level of the lake fluctuates greatly as season changes. Each year, after November, the area of open water drastically declines. As the water level falls, the habitats for waterfowls shrinks and so does the food of the birds. If this continues, the birds cannot find enough food to eat and they will surely migrate to other places.

Habitats destruction. The local people have the habit of letting their pigs grow in the field. When looking for food, the pigs usually dig the ground, destroying the

vegetation and water plants in the ponds and near the wetlands. This may be beneficial for the birds spending winter in the region, but there is always a competition for food between the local waterfowls and the birds spending winter there. In the long run, the habitats and vegetation of the NR is seriously affected.

Fuel wood consumption. Besides cooking meals and preparing food for livestock, the local people also burn a lot of fuel wood to warm themselves for half a year each year. Investigation shows that each household consumes about 15–20 m^3 fuel wood. Fuel wood consumption has become a major threat to forest resources.

Tourism development. At present, tourism development in the NR is beginning to encroach onto the core area. The use and exploitation of tourism resources in the NR is unreasonable and unscientific, which in turn greatly affects the ecosystem in the region.

Introduction of alien fishes. In Shuduhu Lake, the native fish has already become extinct. If the introduction activities of carp and crucian carp species in other lakes continues, the rare and endemic native fishes such as *Ptychobarbus chungtienensis chuntienensis* in those lakes will be eliminated in the competition.

Biodiversity conservation
Protecting the biome and habitats. Protecting biome and habitats is considered to the only effective way to conserve biodiversity. To achieve this goal, the following work needs to be done. First, determine the elevation and water level of the lake through investigation and deduction and maintain a large area of open water. Second, conduct pilot project to raise livestock in barns, dens and encircled places, reducing the destruction on the vegetation of the wetlands near the lakes.

Developing the community economy. Help the local communities to plan economic development projects. Introduce community development programs. These programs may include kitchen stove improvement, energy replacement and livestock feed planting. These measures will reduce the dependence of human being on natural resources and promote the local economy. Only when the local communities participate into the conservation can the resources and NR be preserved.

Planning the functional zones. Core zone, buffer zone and experiment zone have their respective functions. In the buffer zone and experiment zone, certain suitable projects such as ecotourism can be developed.

Strengthening the capacity construction of the NR. The first thing to do in this part is to construct the capacity of the management staff. Second, it is urgent to compile a management plan with clear objectives. The management plan

should include: prioritized listed of the protected targets, researches and monitoring objectives and feasible field work management activities such as patrolling routes planning and implementation.

Strengthening policy, law and regulation construction. The introduction of alien species should be strictly controlled by law and regulations. Alien fishes are not allowed to be introduced into the lakes in the NR. According to the regulations of nature reserve management and wildlife conservation, a complete mechanism of awarding and punishing system should be established and the local villagers should be banned from logging and hunting in the forests in the NR.

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