Biodiversity & Conservation at the Sanctuary

Stand Up 4 Elephants

A Study of an Ecosystem in Nepal

STAND UP 4 ELEPHANTS
SU4E

Data collected by SU4E team over 3 years, report written by Chloé LOZANO

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Introduction

Nepal, with an area slightly over 147,000 km² and a population of more than 30 million, is home to over 60 different ethnic groups. Geographically, the country is divided into three very different climatic zones: the cold and dry Himalayan mountainous zone, the temperate hilly zone, and the subtropical region in the Teraï plains. This climatic and topographic diversity fosters a wide variety of biological and natural ecosystems. About 45% of its land is covered with forests.

The adoption of the National Parks and Wildlife Conservation Act 2029 BS in 1973 enabled Nepal to take measures for the management of national parks, conservation of wildlife and their habitats, regulation of hunting, as well as the preservation and development of sites of particular importance. In 1980, the Department of National Parks and Wildlife Conservation (DNPWC) was established to conserve and manage the country's wildlife and biodiversity. Since then, numerous national parks and reserves have been created to protect wildlife and their habitats.

Figure 1 : Protected Areas of Nepal (2) and Localization of Stand Up 4 Elephants

Its network of protected areas includes 12 national parks, 1 wildlife reserve, 1 hunting reserve, 6 conservation areas, 10 Ramsar sites, and 13 buffer zones, extending from the lowlands of the Teraï to the high mountains, covering more than 23.39% of the country's total area (*Figure 1*) (2). Nepal is a signatory to numerous international conventions, including the Convention on Biological Diversity (CBD), the Ramsar Convention on Wetlands, and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This contributes to the in situ conservation of ecosystems and biodiversity.

According to the Nepalese Center for Biodiversity Research and Conservation, Nepal ranks 49th in the world in terms of biodiversity, with more than 22,000 species recorded, representing 1.3% of global biodiversity. Additionally, the country is home to more than 11,000 recorded species of fauna (3).

The association Stand Up 4 Elephants (SU4E), dedicated to protecting captive elephants in Nepal, is located in the village of Bairiya, in the municipality of Khairahani. It is 500 meters from Chitwan National Park, in southern Nepal, in the Bagmati province of the Teraï region (*Figure 1*). Since 2014, it has been committed to a progressive and ethically responsible approach aimed at improving the conditions of captive elephants in Nepal. This report explores biodiversity through fauna and flora, highlighting the richness and diversity of life on Earth, while emphasizing the impact of the SU4E sanctuary initiative on creating a dynamic and diverse ecosystem. We will examine the diversity of mammals, birds, reptiles, amphibians, arachnids, insects, and plants on a global scale, then focus on their presence in Nepal, and finally within the SU4E sanctuary. By highlighting the variety of species that coexist with Asian elephants in this sanctuary, we aim to demonstrate the importance of preserving and protecting not only these majestic animals but also the diverse ecosystem that forms around them.

1# Mammals

Mammals of the World

Mammals are a class of vertebrates characterized by several distinctive traits. They typically have hair or fur on their bodies, which helps them regulate their body temperature and blend in with their surroundings. Mammals nourish their young with milk produced by mammary glands. Their hearts generally have four chambers, ensuring efficient oxygen circulation throughout the body. Mammals breathe through lungs and have a complex nervous system, contributing to their intelligence and adaptability. They reproduce through live births or, in some cases, by laying eggs, although the latter is rare. Mammals play various roles in ecosystems, from pollinating plants to regulating the populations of other species. They can be found in a wide variety of habitats, from deserts to oceans to tropical forests, making them one of the most diverse groups in the animal kingdom.

The IUCN lists 5,980 species across 27 orders (4), while over 6,611 species are recorded, including 17 domesticated ones, in the ASM Mammal Diversity Database, stemming from Arizona State University, with 107 recently extinct (5). According to a recent study on mammal biomass, these 17 domesticated species make up the predominant share, representing 62% of the total biomass, while humans account for 34%, and only 4% are attributed to wild mammals (*Figure 2*) (6).

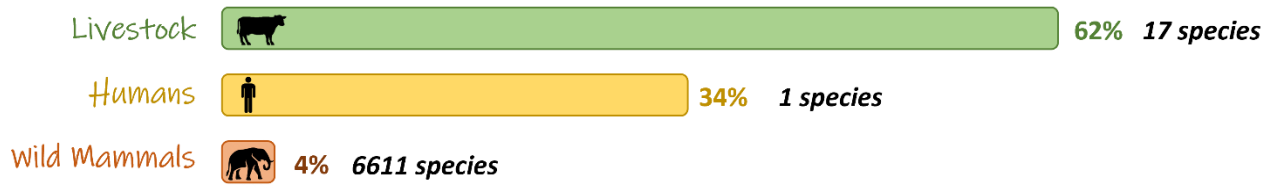


Figure 2 : Global Mammal Biomass

The IUCN has classified 1,339 species among the listed ones as threatened worldwide, which represents 22%, or nearly one in four mammals (*Figure 3*) (4).

Figure 3 : Number and percentage of species of Mammals in each IUCN Red List category

Mammals in Nepal

In 2011, the Nepalese government drafted a national red list of mammals called "Status of Nepal's Mammals", a report providing a comprehensive list of mammals found in Nepal, assessing the status of each species, identifying specific threats to the species, and making conservation recommendations (7). This list was updated in 2018 and lists 212 mammal species, with one quarter being bats, amounting to 53 species.

There are two endemic mammals in the region: the Csorba's Mouse-eared Myotis (*Myotis csorbai*) and the Himalayan Wood Mouse (*Apodemus gurkha*) (*Figure 4*). The mouse is classified as Least Concern (LC) by the IUCN but is considered endangered (EN) due to threats from human persecution, fragmentation, and degradation of grasslands and pastures. The bat, on the other hand, is critically endangered (CR) nationally but listed as Data Deficient (DD) internationally. It is threatened by subsistence hunting, fragmentation and degradation of forests, as well as diseases such as mange and white-nose syndrome (4,7).

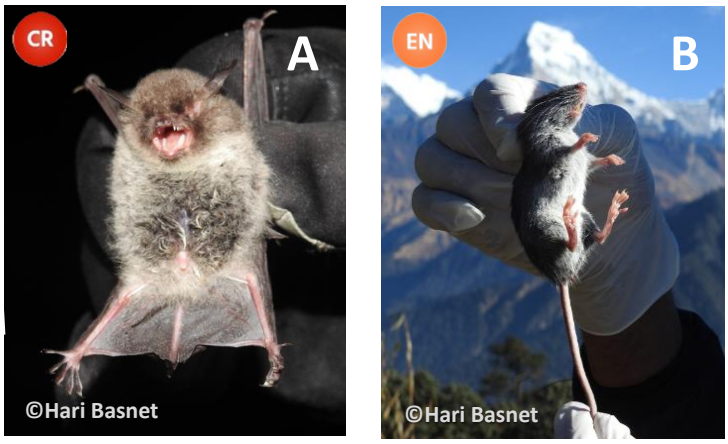


Figure 4 : The *Mammals Endemic in Nepal*

(A) Csorba's Mouse-eared Myotis (Myotis csorbai)
(B) Himalayan Wood Mouse (Apodemus gurkha)

There are 48 (23%) threatened species at the national level, including 8 species critically endangered, 26 species endangered, and 14 vulnerable species (*Figure 5*). One species, the Pygmy Hog (Porcula salvania), is considered regionally extinct.

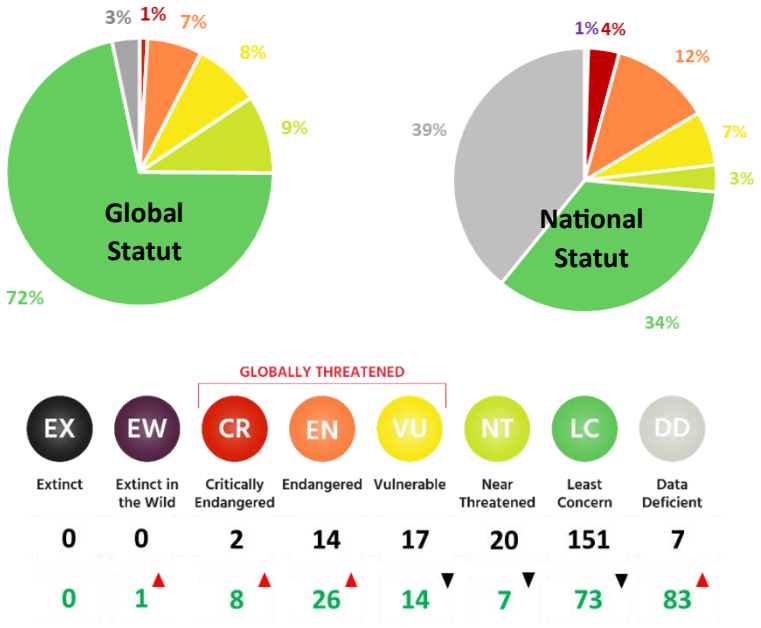


Figure 5 : Number and percentage of species of Mammals in Nepal in each Red List category according to Glabal Status (Black) and National Status (Green)

According to Wildlife Conservation Nepal, 27 mammal species benefit from protection measures, including the Asian Elephant, itself classified as endangered (8). By crossing the list of protected species with those threatened by the National List (8CR - 26EN - 14VU), we find that only 22 threatened species benefit from protection measures, leaving 26 species unprotected (12 EN, 4 CR, 10 VU). This is partly explained by the fact that the list of protected species is established under the "National Parks and Wildlife Conservation Act," dating back to 1973, which unfortunately has not been updated to reflect new data and newly identified threatened species to date. Thus, despite advances in our understanding of conservation and threats to wildlife, legal provisions have not been updated to provide adequate protection for all endangered species.

Mammals at SU4E

Within the sanctuary itself, we observed 11 different species (*Figure 6*), out of the 75 mammals documented in Chitwan National Park (9). Thanks to cameras installed inside the elephant enclosure, it was possible to observe during the monsoon period a wild elephant (*Elephas maximus*), an Indian Civet (*Viverricula malaccensis*), and several felines, including an Indian Leopard (*Panthera pardus fusca*), a Fishing cat (*Prionailurus viverrinus*), as well as a female Jungle Cat (*Felis chaus*) accompanied by her offspring. The other mammals listed in this account, such as Golden Jackals (*Canis aureus*), Gray Indian Mongoose (*Urva edwardsii*), Asian House Shrew (*Suncus murinus*), as well as Asian House Rats (*Rattus tanezumi*), are permanent residents of the sanctuary (*Figure 7D, 7E, 7F*). It is noteworthy that the Asian House Rat, although very common in houses, is neither listed in the National List nor in the Chitwan National Park checklist. Some scientists have mentioned its presence in Nepal, but they have not provided sufficient evidence to justify it. However, a morphological and molecular study from 2018 attests to its presence in the territory (10). We also observed the presence of bats belonging to the order Chiroptera but precise identification would require their capture.

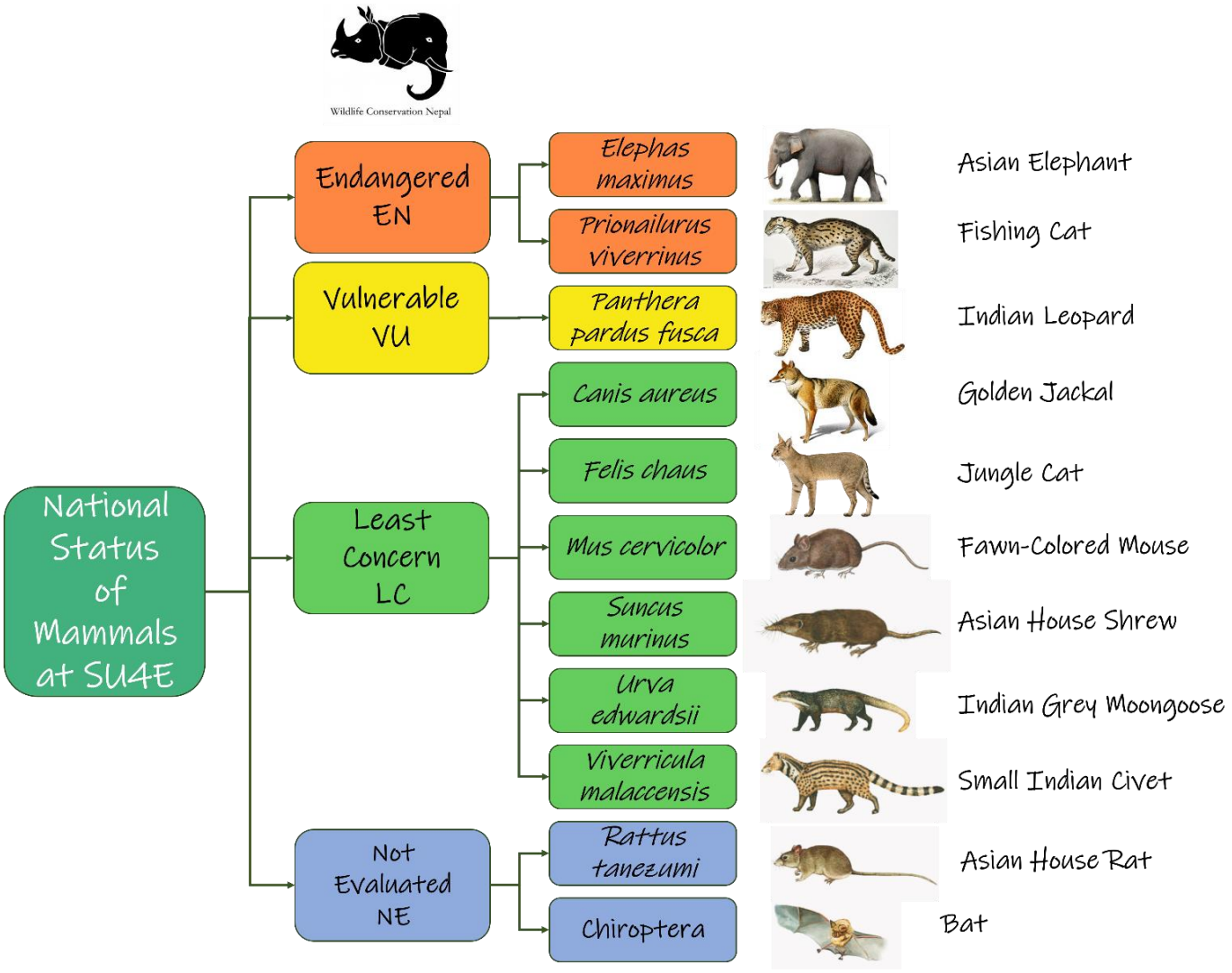


Figure 6 : National Status of Mammals at SU4E

Among these species, three are classified as threatened. The Fishing Cat has been reclassified as an endangered species by the Nepalese government, while it is still classified as vulnerable by the IUCN (*Figure 7A*). Its main threat comes from habitat degradation, particularly deforestation and water pollution, followed by the decline of its resources and thirdly, poaching for the wildlife trade. Regarding the Indian Leopard, classified as vulnerable, its main threat lies in persecution, retaliatory killing by humans, and poaching. Depletion of its resources adds additional pressure, as well as the fragmentation of its environment as a last measure (*Figure 7B*). For elephants, classified as an endangered species, the primary threat is the fragmentation and degradation of their environment, followed by conflicts with humans due to crop raiding, property damage, and attacks on humans. Tuberculosis also represents a threat to the species (*Figure 7C*).

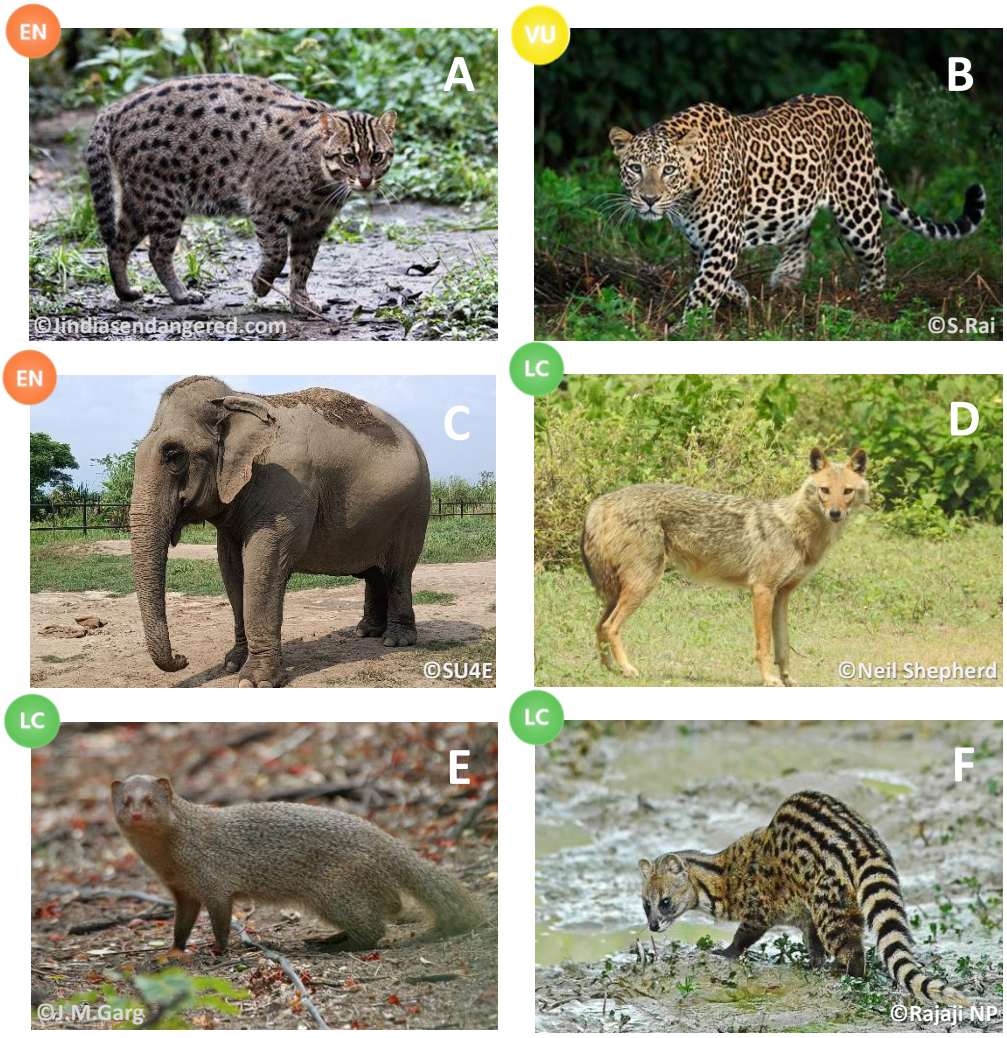


Figure 7 : Six of the mamal species observed in SU4E

(A) Fishing Cat (Prionailurus viverrinus)
(B) Indian Leopard (Panthera pardus fusca)
(C) Asian Elephant (Elephas maximus)
(D) Golden Jackal (Canis aureus)
(E) Indian Grey Mongoose (Urva edwardsii)
(F) Small Indian Civet (Viverricula malaccensis)

2# Birds

Birds of the world

Birds are a class of tetrapod vertebrates characterized by their ability to fly, although not all species do so. Their main features include a body covered in feathers, hollow bones that reduce their weight to facilitate flight, and a highly efficient respiratory system including air sacs. Birds generally reproduce through hard-shelled eggs, and they often exhibit complex social behaviors such as singing and migration. Their digestive system is adapted to their diet, with a stomach composed of multiple parts. Birds have a four-chambered heart, allowing for efficient oxygen circulation. They also serve as important indicators of ecosystem health, playing various roles in food chains and natural cycles.

In 2021, a study documented 9,700 species of wild birds, representing 92% of the total species, while domestic species make up the remaining 8% (9). On the other hand, a biomass analysis reveals that wild birds account for only 29%, while farmed birds constitute 71% of the total bird population (6).

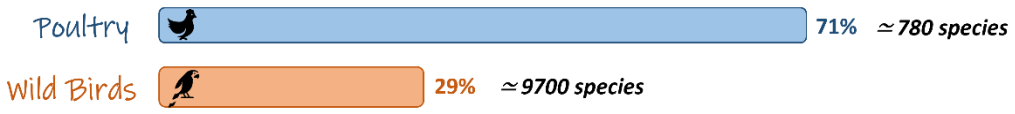


Figure 8 : Global Birds Biomass

The IUCN estimates the total number of bird species recorded worldwide at 11,197, distributed among 36 orders (4). BirdLife International, the official authority for the Red List for birds, is responsible for assessing and documenting the risk of extinction globally. Their 2023 assessment revealed that 1,354 species are threatened (12%), representing approximately 1 in 8 species (*Figure 9*) (10).

Figure 9 : Number of species of Birds in each IUCN Red List category

Birds in Nepal

Nepal has developed its own National Red List of Birds to better target its conservation efforts and uphold its commitments to biodiversity. Founded in 2000, Himalayan Nature is a research institute dedicated to development and conservation, focusing on promoting sustainable livelihoods for Himalayan communities while conducting scientific research on Himalayan biodiversity and its global environment (11). In connection with species preservation efforts, this institute contributes to the assessment of the 'National Red List of Birds,' an initiative undertaken for the first time in January 2016 and regularly updated since then.

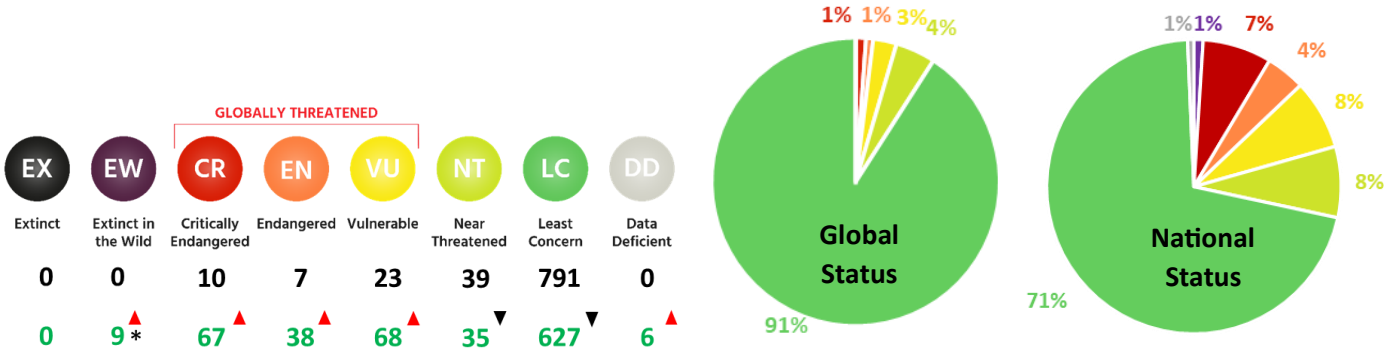


Figure 10 : Number and percentage of species of Birds in Nepal each Red List category according to Glabal Status (Black) and National Status (Green)

To date, Nepal lists 884 bird species, of which 19% are classified as threatened, totaling 173 endangered species (11). In comparison, the IUCN lists 870 species, with only 5% of species threatened, totaling 40 species (4). On the National Red List, 9 (1%) species are classified as extinct in the region, 67 (7%) are critically endangered, 38 (4%) are endangered, and 68 (8%) birds are classified as vulnerable (*Figure 10*).

Nepal is home to a unique endemic species, the Spiny Babbler of Nepal (*Turdoides nipalensis*). This sedentary, territorial bird mainly inhabits the mid-hills of Nepal. Unfortunately, its existence is threatened by bush clearing due to agriculture, urbanization, and hunting in some regions. It is classified as least concern both nationally and internationally (*Figure 11*) (11).

Figure 11 : Spiny Babbler of Nepal (Turdoides nipalensis)

In Nepal, only 9 bird species are protected by the National Parks and Wildlife Act (*Figure 12*) (1). Among them, two are classified as critically endangered, two others are endangered, three are vulnerable, one is near threatened, and the last is considered to be of least concern (4). It can be observed that 101 threatened bird species do not benefit from any protective measures.

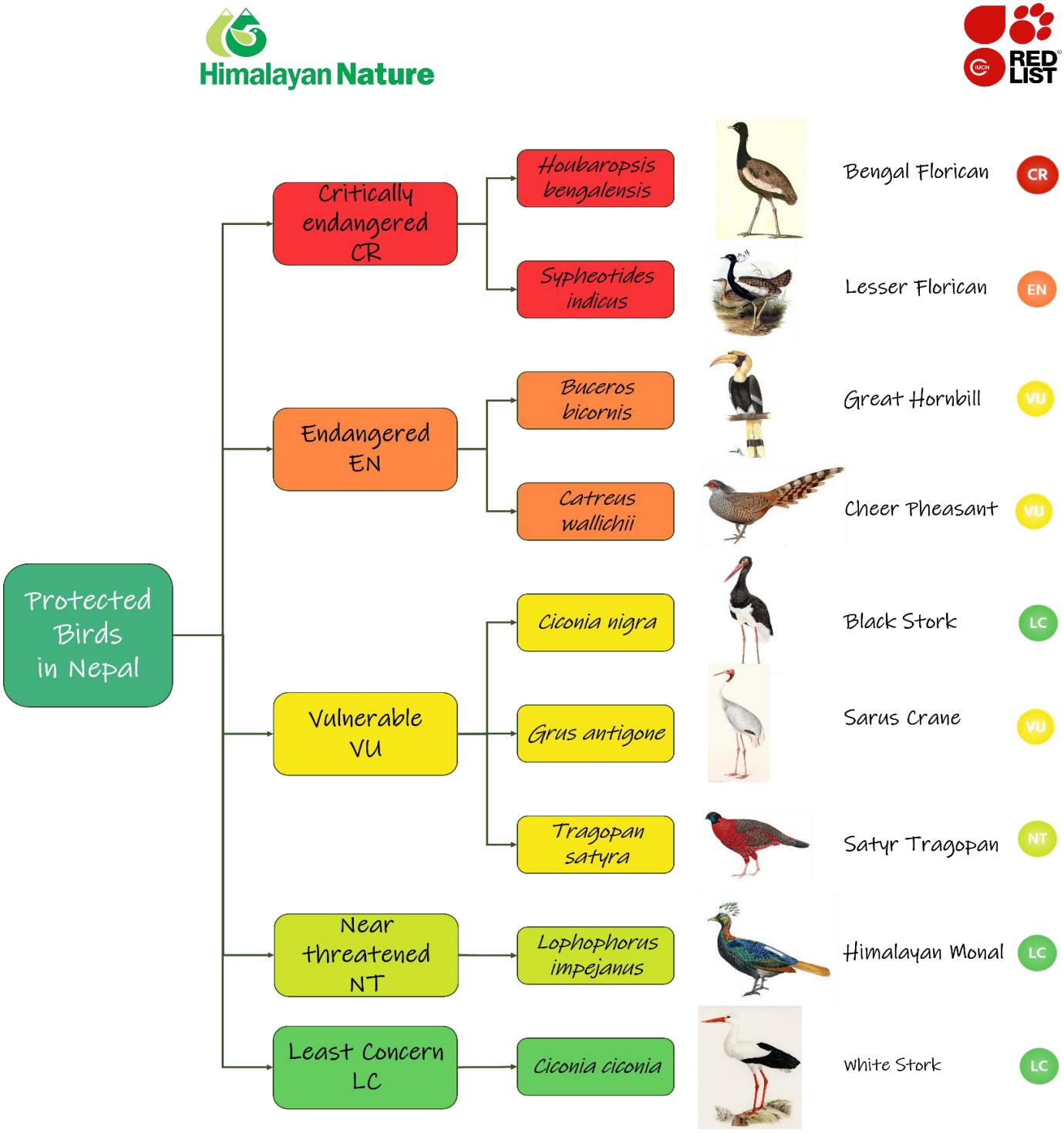


Figure 12 : Protected Birds in Nepal with their National Status and Global Status

Birds at SU4E

The bird census at the sanctuary was conducted visually, but also through vocal identification using the BirNET and Merlin Bird ID apps, both of which utilize the eBird database. Among the 673 species present in Chitwan National Park, we identified 32 different bird species (*Figure 13*) (12).

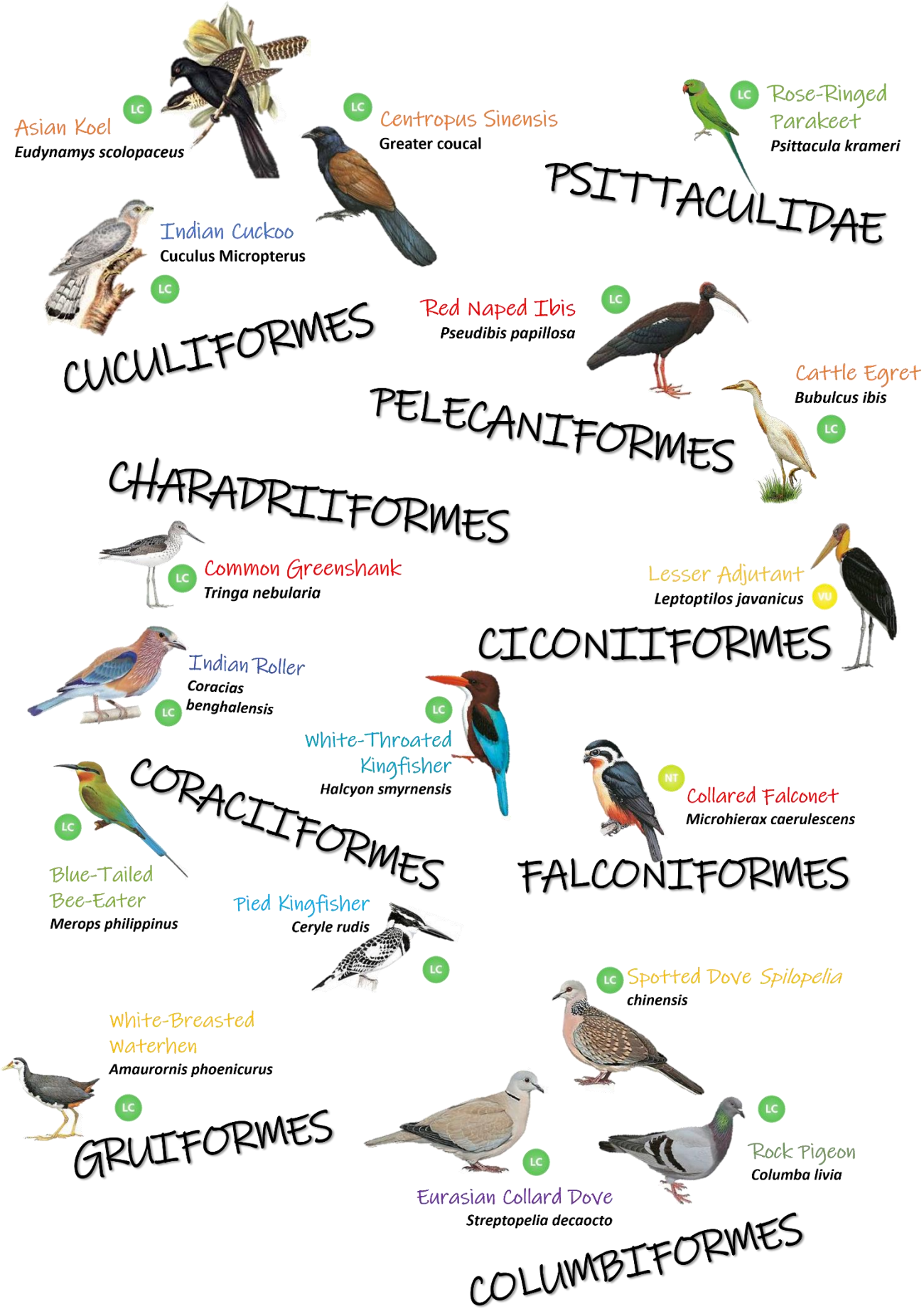


Figure 13 : Bird species observed at SU4E

Some of the birds present at the camp are classified as nationally threatened. Among them, we find the Streaker Weaver (*Ploceus manyar*), classified as critically endangered, primarily threatened by habitat fragmentation and loss as well as the degradation of wetlands (*Figure 14A*). The Lesser Adjutant (*Leptoptilos javanicus*) is classified as vulnerable, threatened by habitat fragmentation, poisoning of wetlands, water pollution, and the invasive spread of water hyacinth, pesticides, disturbances to breeding, resting, and feeding areas, as well as hunting and trapping for food and medicinal purposes (*Figure 14B*). Two other species are classified as near threatened: the Collared Falconet (*Microhierax caerulescens*), threatened by the degradation of broadleaf tropical forests and habitat fragmentation (*Figure 14C*), and the Baya Weaver (*Ploceus philippinus*), threatened by pesticides, hunting, trapping, and intensification of agriculture, leading to the disappearance of bushes and trees (*Figure 14D*) (11).

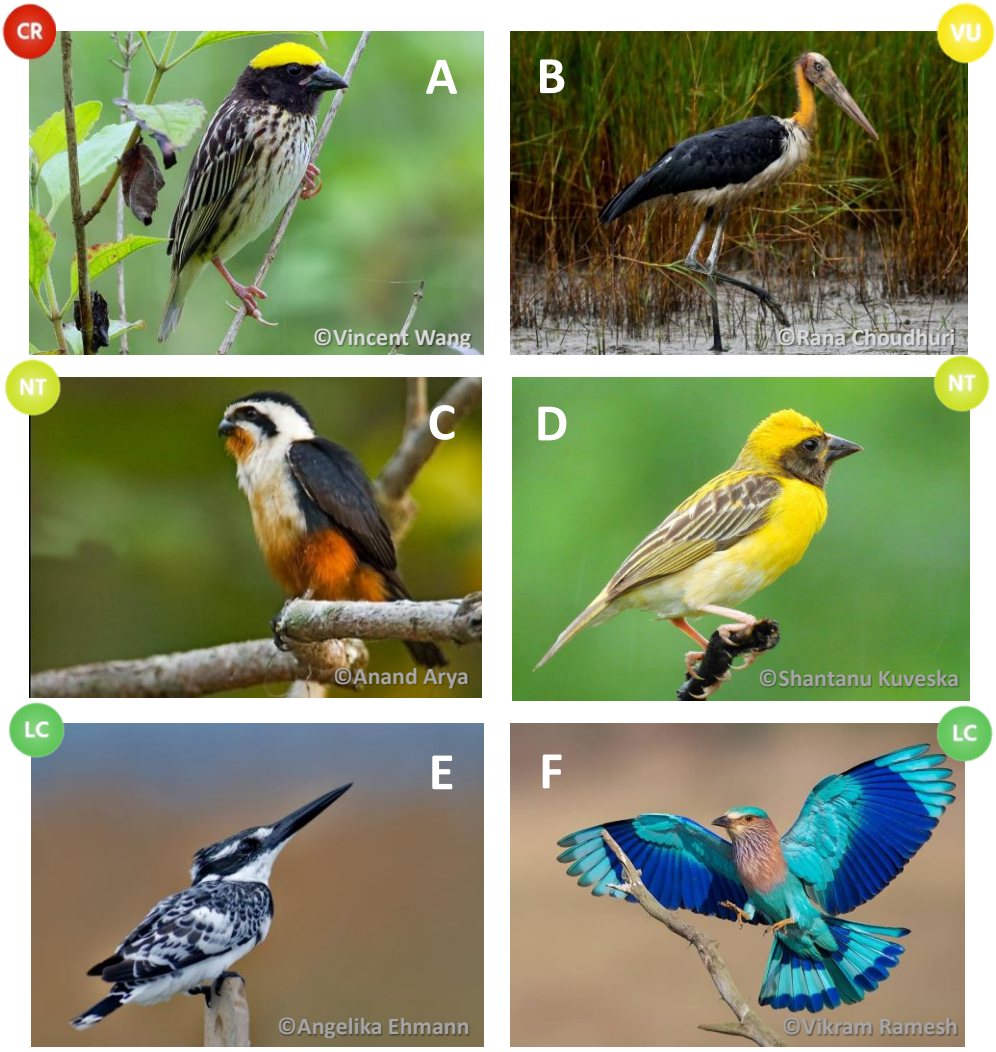


Figure 14 : Six Bird species observed at Su4E

(A) Streaked Weaver (Ploceus manyar) *(B) Lesser Adjutant (*Leptoptilos javanicus*)*
(C) Collared Falconet (Microhierax caerulescens) *(D) Baya Weaver (Ploceus philippinus)*
(E) Pied Kingfisher (Ceryle rudis) *(F) Indian Roller (Coracias benghalensis)*

3#Reptiles

Reptiles in the World

Reptiles are a class of tetrapod vertebrates characterised by their scaly, waterproof skin, which protects them from dehydration. They breathe exclusively through their lungs and are mainly adapted to life on land. Reptiles reproduce on land, often with hard-shelled eggs. Their skeletons are well developed to support their bodies on land, and they generally have a heart with three or four chambers, depending on the species. These cold-blooded animals with variable temperatures (ectotherms) are efficient predators in their habitat and play a crucial role in food chains.

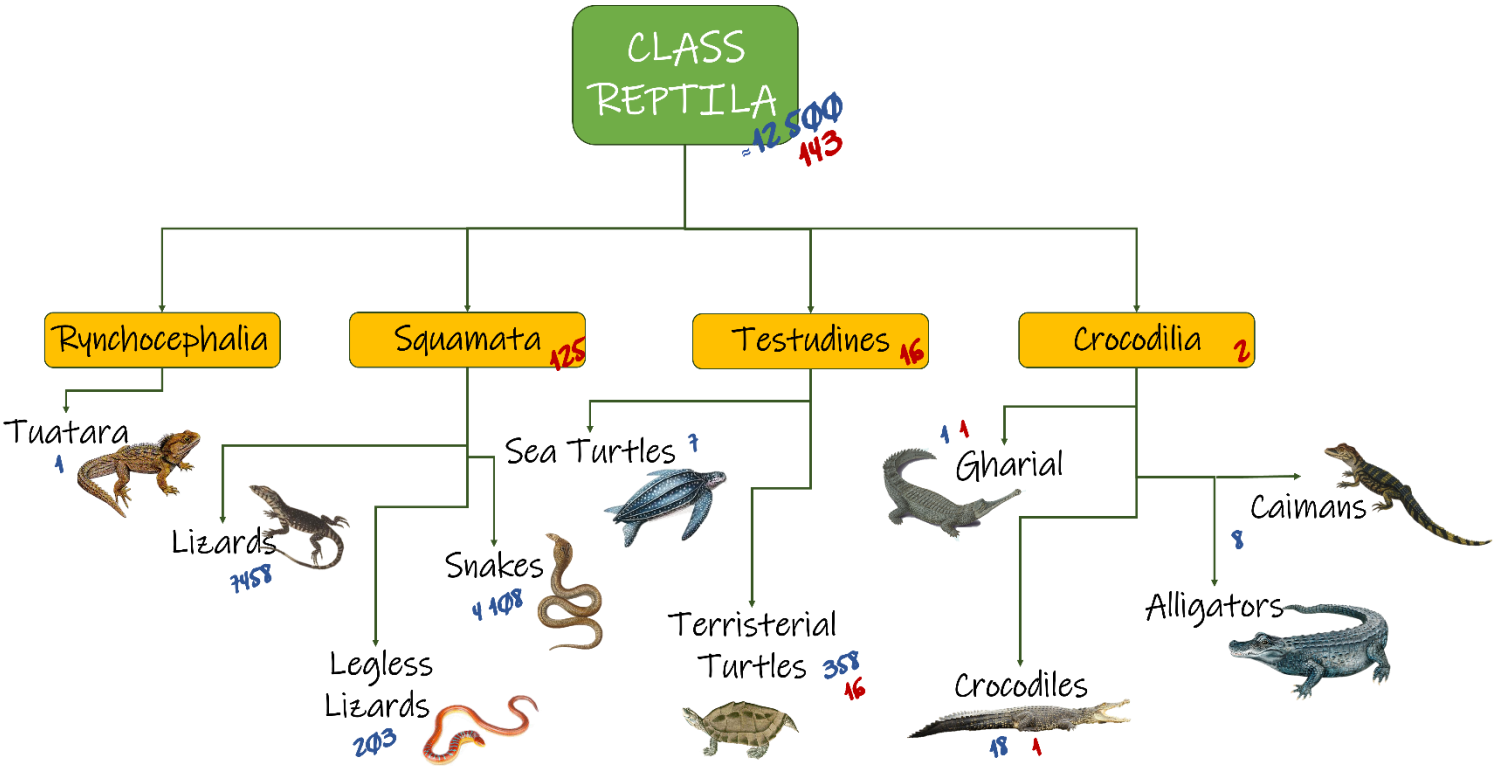


Figure 15 : Reptilie Classification (Blue : Number of species in the World ; Red : number of species in Nepal)

They are divided into four main orders. According to The Reptile Database, a database created in 1995 by P. Uetz of the EMBL (European Molecular Laboratory) in Germany, crocodilians have 27 representatives in 3 families, including crocodiles (18 species), gharials (1 species), caimans, and alligators (8 species). Rhynchocephalians, with a single representative, the tuatara (*Sphenodon punctatus*), are endemic to New Zealand. Testudines, on the other hand, include 365 species of turtles, distributed across 14 families, with only 7 marine specimens, while squamates encompass 12,162 species, including lizards (7,458 species), snakes (4,108 species), and amphisbaenians, also known as worm lizards (203 species) (*Figure 15*) (13).

The IUCN has recorded 10,254 reptile species, representing approximately 82% of identified reptiles. Among these, 1,848 species, or about 18%, are considered threatened. This is equivalent to about one in five reptiles (*Figure 16*) (4).

Figure 16 : Number and percentage of species of Reptile in each IUCN Red List category

In 2022, researchers from the University of Nepal, at the Mechi Multiple Campus in Bhadrapur, documented 143 species of reptiles distributed across 3 orders. In the order of crocodilians, we find the Marsh Mugger Crocodile (*Crocodylus palustris*) classified as vulnerable and the Gharial (*Gavialis gangeticus*) classified as critically endangered. There are 16 species of turtles and 125 species among the squamates, including lizards, snakes, and amphisbaenians (*Figure 15*) (14). The IUCN identifies a total of 134 reptile species in Nepal, of which 20 are threatened (*Figure 17*) (3).

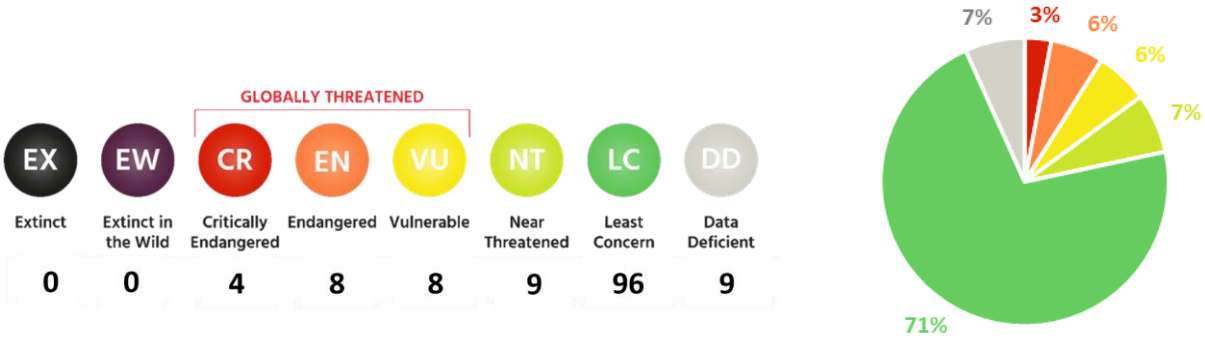


Figure 17 : Number and percentage of species of Reptile in Nepal in each IUCN Red List category

There are 19 endemic species in Nepal, of which only 3 reptiles are protected in Nepal (1,14). The Gharial (*Gavialis gangeticus*), classified as critically endangered (CR); the Indian Python or Indian Rock Python (*Python molurus*), near threatened (NT); and the Yellow Monitor Lizard (*Varanus flavescens*), considered endangered (EN) (*Figure 18*) (1,4). These species are protected due to habitat loss and the trade of their skins at national and international levels. For the Gharial, an additional threat comes from water pollution and egg poaching.

Figure 18 : Nepal's Protected Reptiles and their National Status

(A) Gharial (Gavialis gangeticus)
*(B) Indian Python(*Python molurus*)*
(C) Yellow Monitor (Varanus flavescens)

Reptiles at SU4E

There are 46 identified reptiles in Chitwan National Park, of which 8 were observed at the sanctuary (12). We note the absence of reptiles in winter, between October and February (*Figure 19*).

The 3 species of geckos (*Hemidactylus platyurus, Hemidactylus frenatus, Hemidactylus garnotii*) are commonly found in our dwellings (*Figure 19A, 19B, 19C*). The Oriental Garden Lizard (*Calotes versicolor*) is found in our hedges and bushes. It exhibits sexual dimorphism and changes color for camouflage, thermoregulation, and communication with its conspecifics. Males are recognizable by their red heads during the breeding season (*Figure 19D*) (15).

Five snakes of different species were observed at the sanctuary. The Burmese Python (*Python bivittatus*), classified as vulnerable and without government protection, was caught and released into Chitwan National Park for the benefit of all (*Figure 19F*). The Trinket Snake (*Coelognathus helena*), the Asian Glass Lizard, and 2 other unidentified species were spotted only once at SU4E (*Figure 19E, 19G*). However, the Indian Rat Snake (*Ptyas mucosa*), a semi-arboreal and territorial diurnal species, returns to the sanctuary every year during the monsoon season (*Figure 19H*).

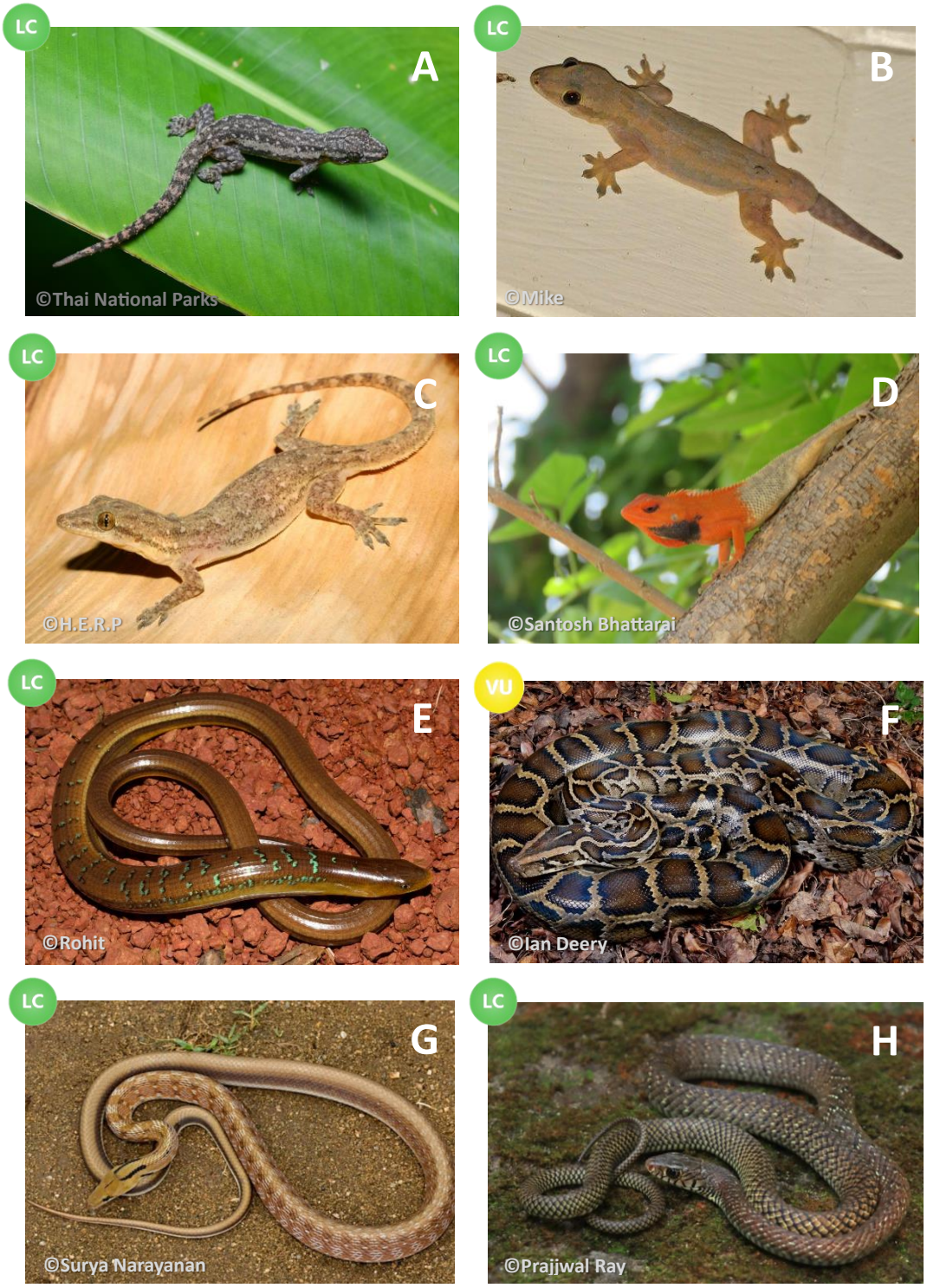


Figure 19 : Six Reptile species observed at SU4E

(A) Asian House Gecko (Hemidactylus frenatus)
(B) Flat-tailed house gecko (Hemidactylus platyurus)
(C) Indo-Pacific Gecko (Hemidactylus garnotiii)
(D) Oriental Garden Lizard (Calotes versicolor)
(E) Asian Glass Lizard (Dopasia gracilis)
(F) Burmese Python (Python bivittatus)
(G) Trinket Snake (Coelognathus helena helena)
(H) Indian Rat Snake (Ptyas mucosa)

4# Amphibians

Amphibians around the world

Amphibians are a class of tetrapod vertebrates characterized by their life cycle, which typically includes both an aquatic and a terrestrial phase. Their thin and permeable skin allows them to absorb water and nutrients from their environment, while their respiration can occur through both lungs and skin. Amphibians often inhabit amphibious habitats, where they typically reproduce in water. Their skeleton and muscles are adapted for both swimming and jumping, and they have a three-chambered heart. Sensitive to environmental changes, they are important indicators of ecosystem health.

AmphibiaWeb, created by the University of California, Berkeley, catalogs 8,737 species of amphibians, classified into three distinct orders: 222 Gymnophiona, also known as apods, caecilians, or gymnophiones, 816 Caudata, which include salamanders and newts, and finally 7,699 Anura, commonly known as frogs (*Figure 20*) (16).

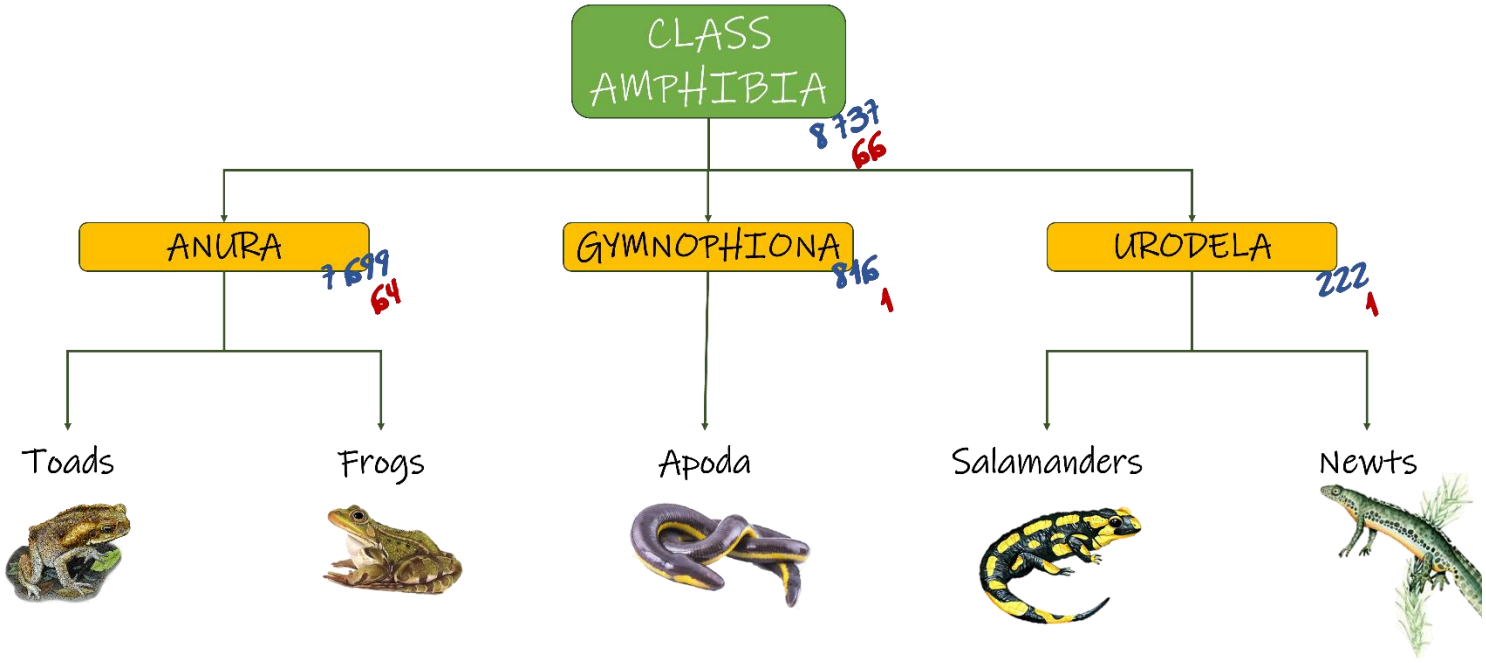


Figure 20 : Classification of Amphibians (Blue : Number of species in the world ; Red : Number of species in Nepal)

The IUCN, on the other hand, has listed a total of 8,020 species of amphibians, which corresponds to approximately 87% of the described species. Among these, 2,876 are considered threatened, representing around 36% of the total. This is roughly one in three amphibians (*Figure 21*) (4).

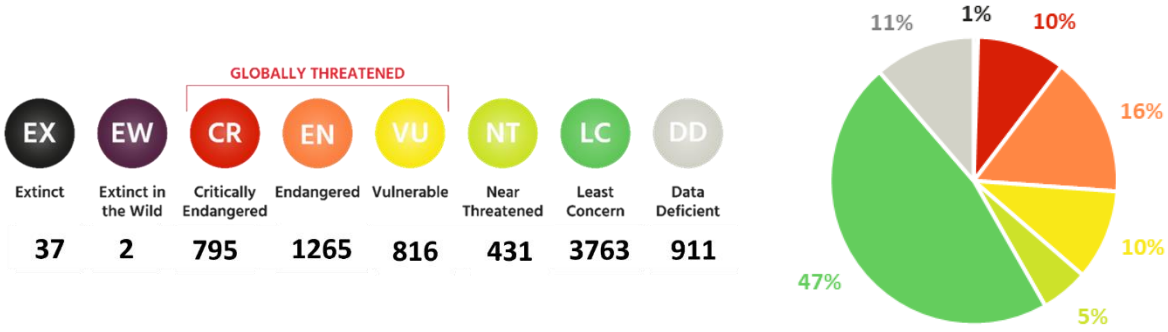


Figure 21 : Number and percentage of species of Amphibians in each IUCN Red List category

Amphibians in Nepal

Among the 66 species listed by the IUCN, five are currently threatened in Nepal, and no specific protection measures are in place by the government (*Figure 22*).

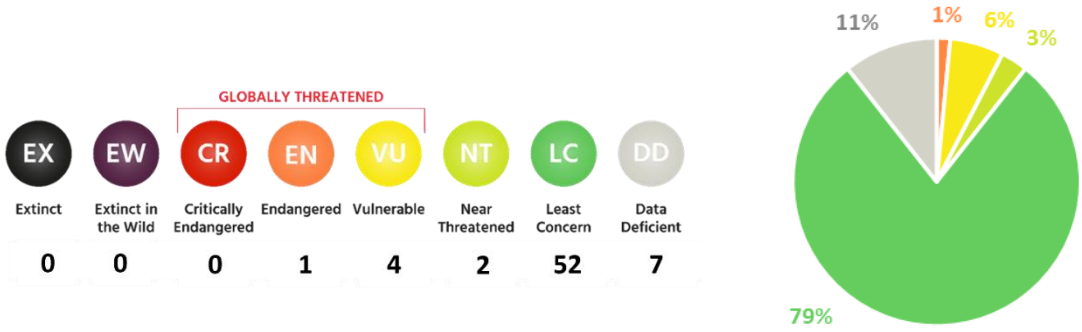


Figure 22 : Number and percentage of species of Amphibians in Nepal each IUCN Red List category

Among these, the Mountain Cascade Frog (*Amolops monticola*) is classified as endangered, while the other four, the Himalayan Salamander (*Tylototriton himalayanus*), the Kerala Warty Frog (*Minervarya keralensis*), the Dudhwa Tree Frog (*Chirixalus dudhwaensis*), and the Mahabharat Torrent Frog (*Amolops mahabharatensis*), are classified as vulnerable (*Figure 23*).

The threats facing these species include residential and commercial development, urban area expansion, agriculture and aquaculture, hunting and trapping of terrestrial animals, as well as pollution from agricultural and forest effluents. Additionally, they are confronted with challenges related to climate change and extreme weather conditions. The Mountain Cascade Frog is also threatened by deforestation and timber harvesting, while the Himalayan Salamander must deal with dams and water management. The Kerala Warty Frog is also affected by the cultivation of non-woody annual and perennial plants, while the Dudhwa Tree Frog faces threats related to transport and service corridors such as roads and railways. Finally, the Mahabharat Torrent Frog shares similar threats to the mountain frog, including deforestation and timber harvesting, as well as the impacts of pollution and climate change. These combined threats underscore the importance of effective conservation measures to protect these fragile species and their natural habitat (4).

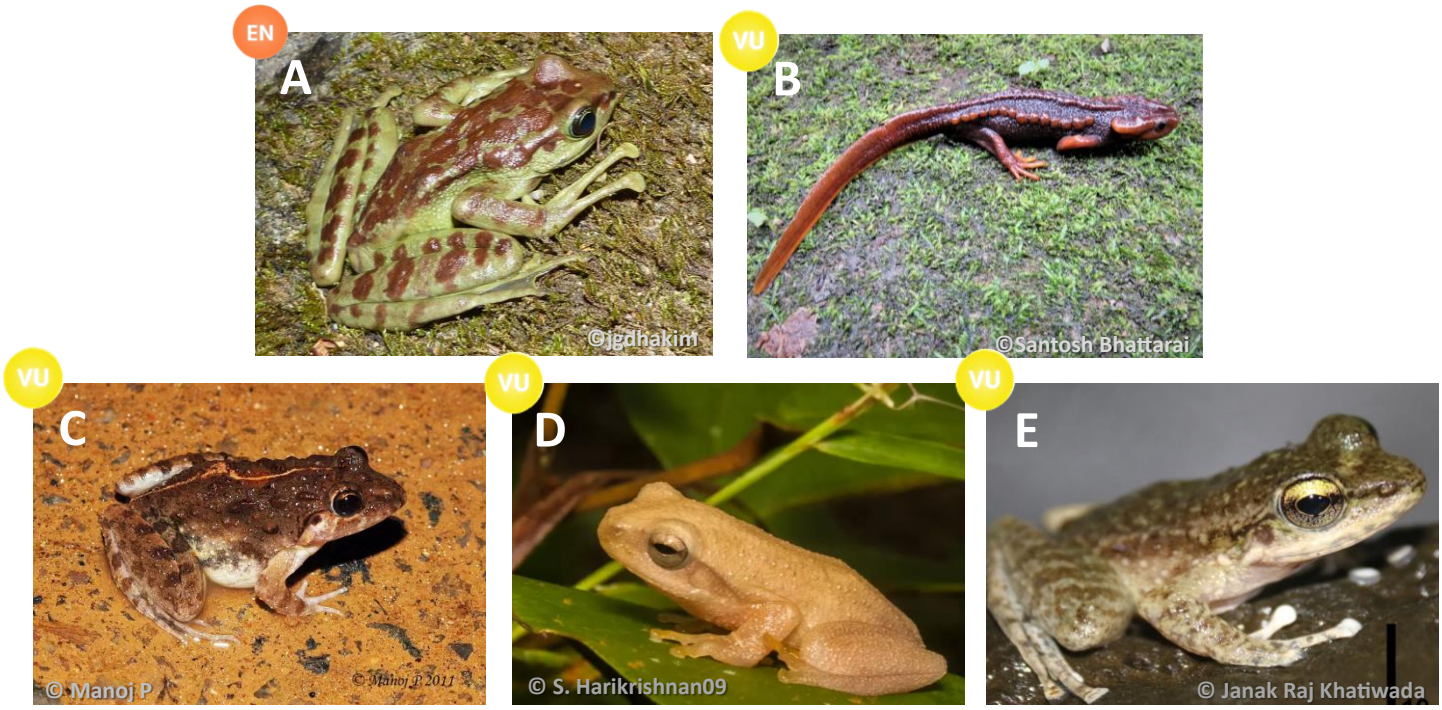


Figure 23 : Endangered Amphibians in Nepal

(A) Mountain Cascade Frog (Amolops monticola)
(B) Himalayan Salamander (Tylototriton himalayanus)
*(C) Kerala Warty Frog (*Minervarya keralensis*)*
(D) Dudhwa Tree Frog (Chirixalus dudhwaensis)
(E) Mahabharat Torrent Frog (Amolops mahabharatensis)

Amphibians at SU4E

Ten species of amphibians have been identified in Chitwan National Park. Among them, six species, all classified as of least concern, are present in the sanctuary: two species of toads and four species of frogs. These amphibians, like reptiles, appear only during the summer season, coinciding with the monsoon period. Among these amphibians, the Chunam Tree Frog (*Polypedates maculatus*) is mainly found in trees and banana plants around the camp (*Figure 24F*). The Asian Common Toad (*Duttaphrynus melanostictus*) and the Indian Marbled Toad (*Duttaphrynus stomaticus*) are often seen in the grasses of the sanctuary (*Figure 24A, 24B*). As for the frogs, they are mainly found in the pond located in the elephant enclosure (*Figure 24C, 24D, 24E*).

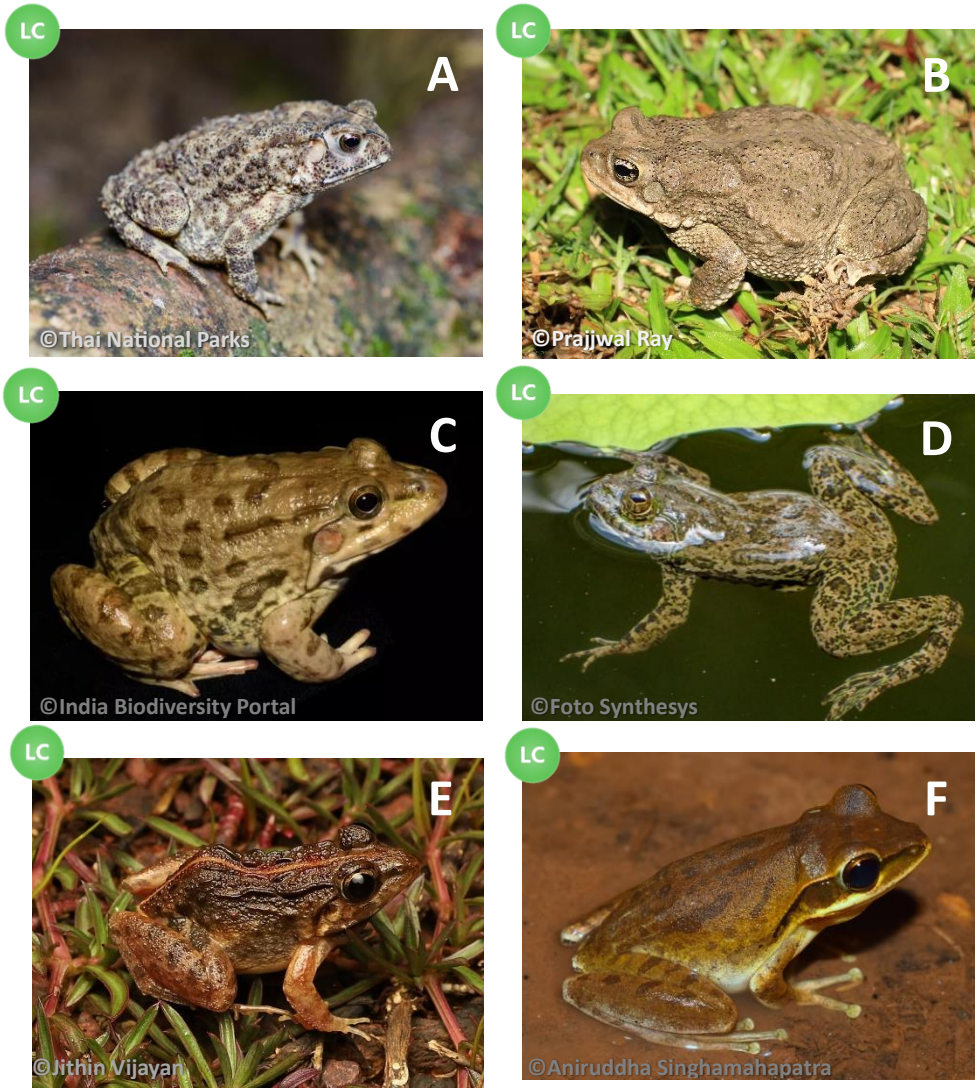


Figure 24 : Six Amphibian species observed at SU4E

(A) Asian Common Toad (Duttaphrynus melanosticus) *(B) Indian Marbled Toad (Duttaphrynus stomaticus)*
(C) Indian Bull Frog (Hoplobatrachus crassus) *(D) Skittering Frog (Euphlyctis cyanophlyctis)*
(E) Long-legged Cricket Frog (Minervarya syhadrensis) *(F) Chunam Tree Frog (Polypedates maculatus)*

5# Insects

Insects around the world

Insects are the most diverse class of arthropods, comprising over half of all known animal species. They are characterized by a body divided into three distinct parts (head, thorax, and abdomen), three pairs of articulated legs, often wings, and sensory antennae. Insects breathe through tracheae, a system of tubes that carries oxygen directly to their body tissues. They typically reproduce through eggs, although some species may give birth to live young. Insects play essential roles in ecosystems, acting as pollinators, decomposers, predators, and prey, and providing a food source for many other organisms.

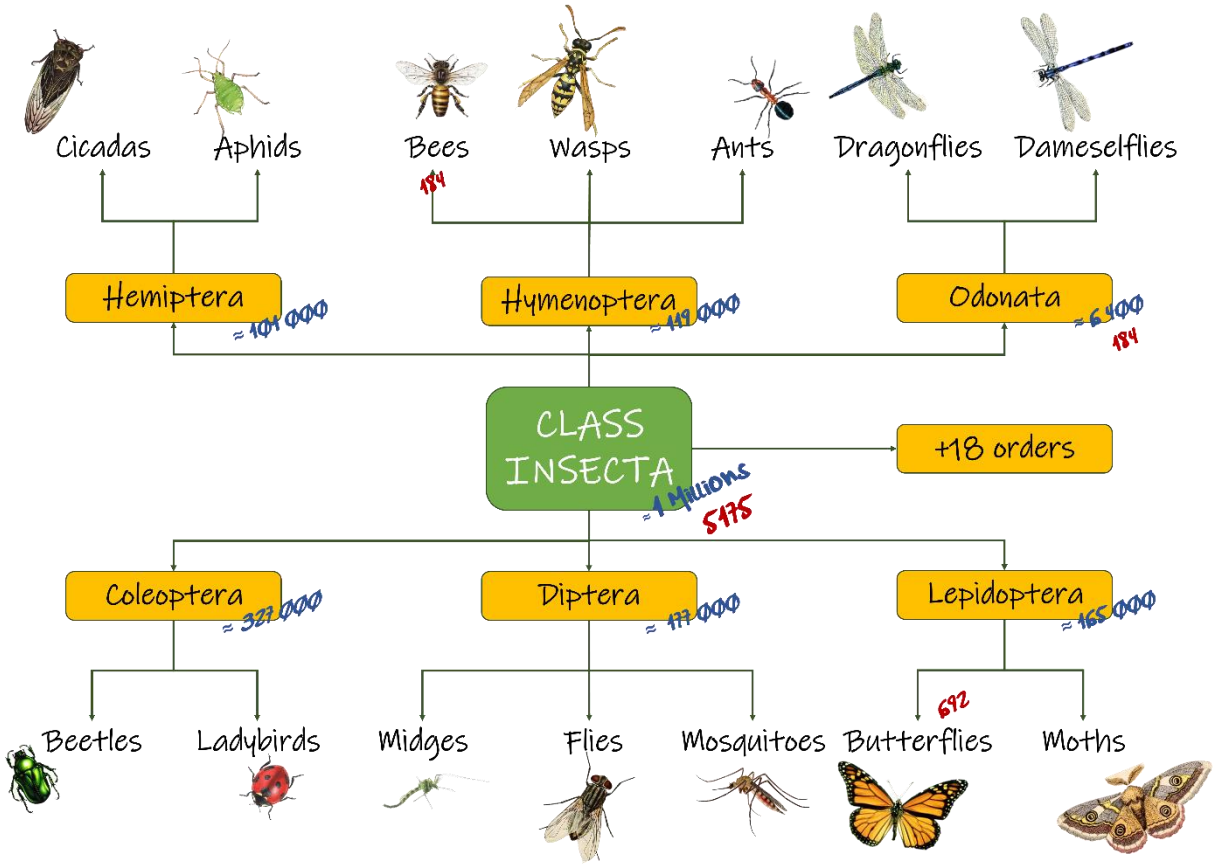


Figure 25 : Classification of the 6 largest insect orders (Blue : Number of species in the world ; Red : Number of species in Nepal) (Data for Nepal are not available for all categories due to lack of data and publications)

More than one million species of insects have been identified and cataloged, with estimates of their actual number ranging from 2 to 7 million, reflecting the complexity and richness of this taxonomic group. This diversity is distributed across 24 orders, but there is an uneven distribution, with nearly 90% of species concentrated in five major orders (17).

Among these orders, beetles (scarabs and ladybugs) account for 326,049 species, followed by dipterans (flies, mosquitoes, and midges) with 176,584 species, lepidopterans (butterflies) with 164,357 species, hymenopterans (bees, wasps, and ants) with 118,234 species, and hemipterans (cicadas, aphids) with 100,723 species (*Figure 25*) (18).

Data collected by the IUCN reveals an alarming gap in our understanding of insect biodiversity. Only 12,568 species of insects are currently listed, representing barely 1.25% of the total number of described species. Among these, 2,361 are listed as threatened, accounting for about 19% of evaluated species, or one in five insects being threatened (*Figure 26*) (4).

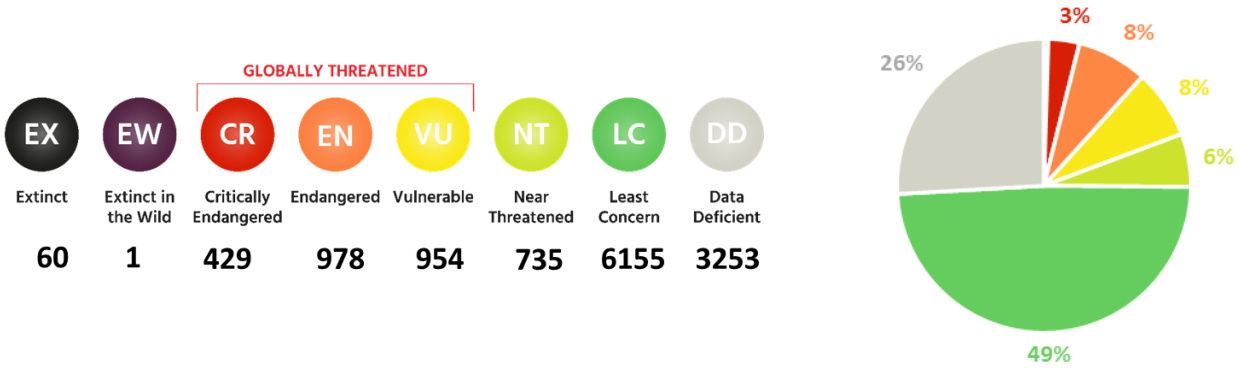
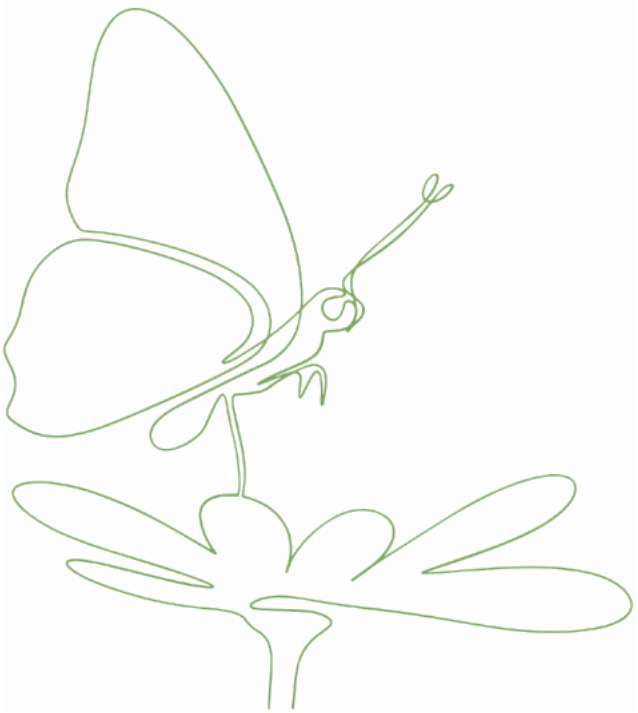


Figure 26 : Number and percentage of species of Insects in each IUCN Red List category



Insects in Nepal

The IUCN Red List only lists 205 species of insects in Nepal, including 170 odonates and 29 lepidopterans (4). However, the publication on biodiversity in Nepal from 2000, also conducted by the IUCN, lists 5175 insects, including 1506 coleopterans, 925 dipterans, 519 heteropterans, 165 hymenopterans, and 210 odonates (19).

These numbers seem to underestimate the actual diversity, considering the number of studies conducted to survey biodiversity over the past 24 years. It appears that the numbers vary significantly depending on the sources and methods of data collection. The discrepancy between the figures in the IUCN Red List and those reported in other publications underscores the importance of consulting multiple sources and considering individual research efforts focusing on specific groups of insects.

For example, in Nepal, 184 species of bees belonging to the order Hymenoptera have been recorded (20). The work of C. Smith and colleagues, experts on Nepal's butterflies belonging to the order Lepidoptera, records 692 species, including 6 endemic to Nepal (21). In Chitwan National Park, 206 species of butterflies have been recorded (12). As for odonates, expert K. Cornniff records 184 species in the country out of the 6385 known worldwide, including 3 endemic species and 40 species recorded in the Terai region (*Figure 25*) (22).

Insects at SU4E

Conducting an inventory of insects on this one-hectare plot requires following a precise protocol, specific methods, and having the appropriate equipment to comprehensively cover such a vast area, harboring a great diversity of ecosystems. The use of tools such as a sweep net is necessary to capture orthopterans (crickets, grasshoppers, and katydids), beetles, and heteropterans (bugs), as well as non-flying or weak-flying insects. The butterfly net is used for flying insects such as lepidopterans (butterflies), odonates (dragonflies and damselflies), dipterans (flies), and hymenopterans (wasps and bees). Beating branches and leaves of trees and shrubs using the Japanese umbrella aims to dislodge insects like caterpillars, bugs, beetles, and spiders. The oral aspirator is useful for quickly capturing moving insects such as ants. Ground traps are used for insects living on the ground or in litter, like ground beetles, rove beetles, or ants. Finally, light traps are employed to capture nocturnal flying and crawling insects (23). The individuals are subsequently preserved in alcohol for identification under a zoom microscope.

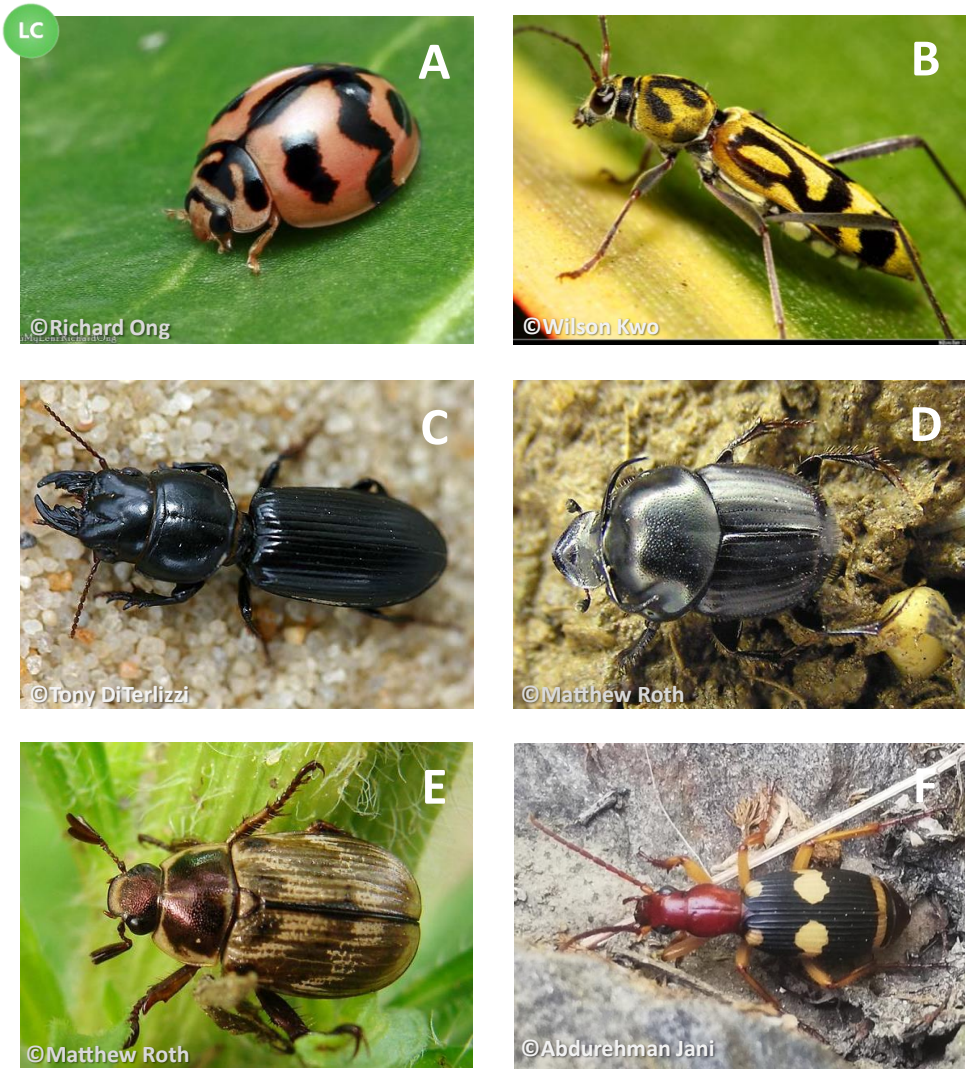


Figure 27 : Six Beetle species observed at SU4E

(A) Six-spotted zigzag Ladybird (Cheilomenes sexmaculata) *(B) Bamboo Tiger Longicorn (chlorophorus annularis)*
(C) Taurus Scarab (Onthophagus taurus) *(D) Big-headed Ground Beetle (Scarites subterraneus)*
(E) Oriental Beetle (Exomala orientalis) *(F) Bombardier Beetle (Pheropsophus catoirei)*

All these methods and equipment are necessary to conduct the most comprehensive inventory possible. However, our sanctuary does not have any of these equipment, and collecting insects poses risks to their integrity. Furthermore, it is important to note that this type of inventory requires a considerable investment of time. For these reasons, we have decided to present only six identified species belonging to the families of beetles (*Figure 27*), butterflies (*Figure 28*), and dragonflies (*Figure 29*) found in the camp. Insect identification was carried out by taking photos and cross-referencing the results obtained using applications such as iNaturalist, an online platform and mobile app for reporting and identifying wildlife observations, as well as Picture Insect, an app specialized in insect recognition from photos. Additionally, the help of the Facebook group "Entomology" was sought to refine the identifications.

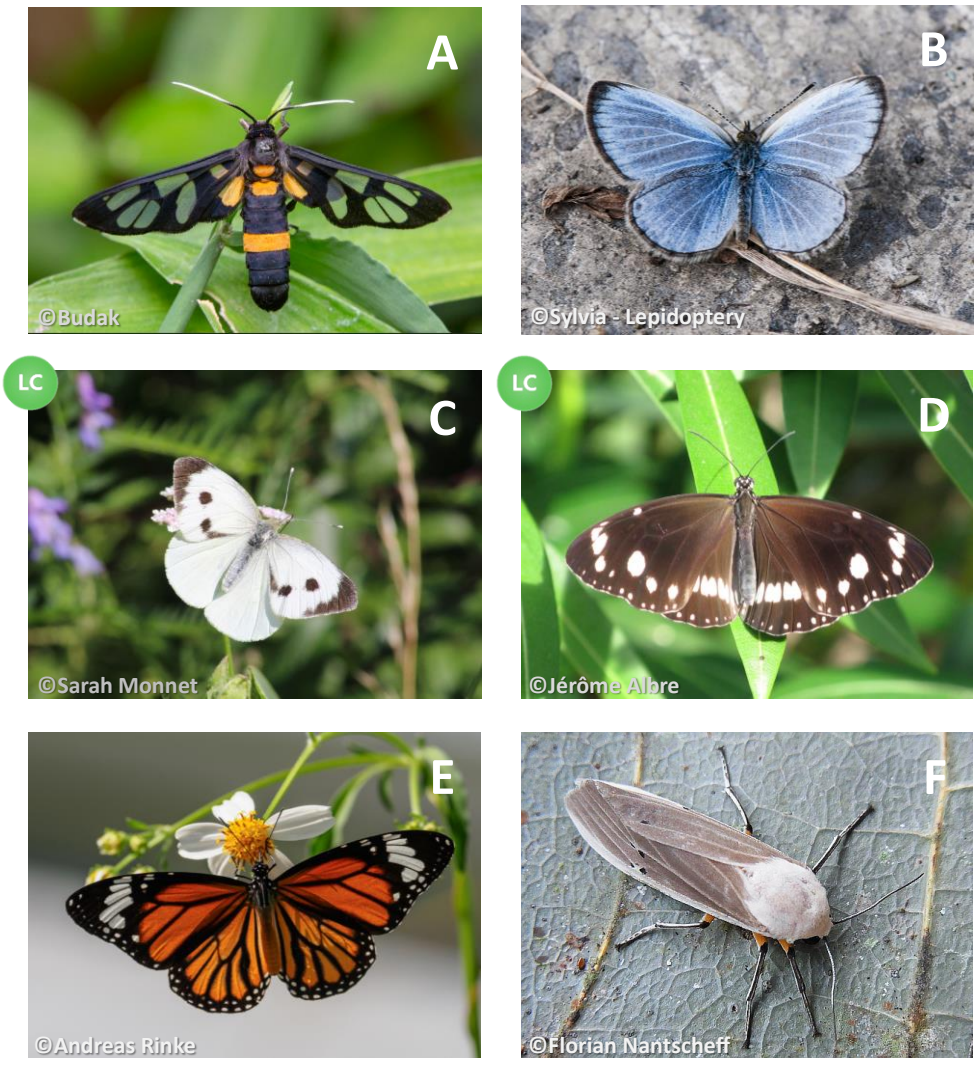


Figure 28 : Six Butterflie species observed at SU4E

(A) Amata Sperbius (Amata Sperbius)
(B) Pale Grass Blue (Pseudozizeeria maha)
(C) Large Cabbage White (Pieris brassicae)
D) Common Indian Crow (Euploea core)
(E) Common TIger (Danaus genutia)
(F) Clouded Tiger Moth(Creatonotos transiens)

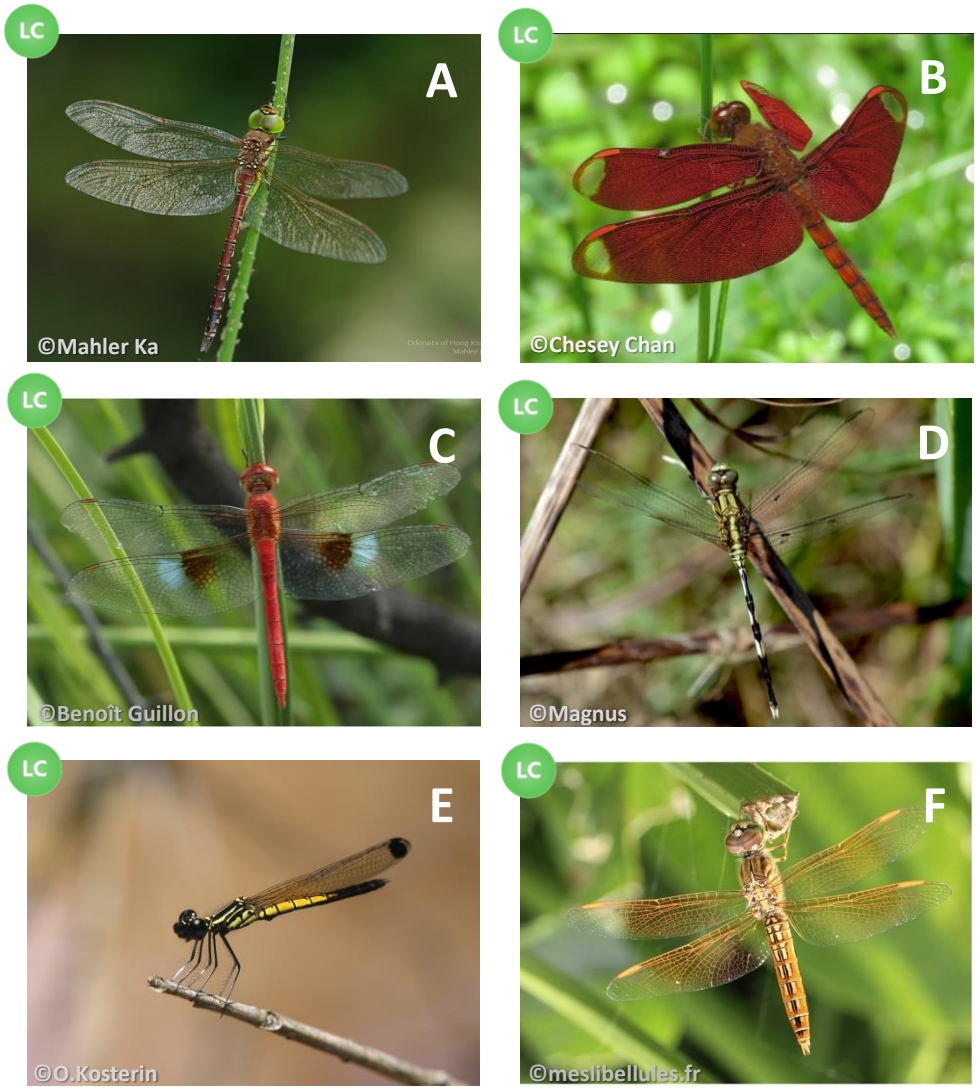


Figure 29 : Six Dragonflie species observed at SU4E

(A) Rusty darner (Anaciaeschna jaspidea)
(B) Russet Percher (Neurothemis fulvia)
(C) Coral-tailed Cloudwing (Tholymis tillarga)
(D) Slender Skimmer (Orthetrum sabina)
(E) River Heliodor (Libellago lineata)
(F) Ditch Jewel (Brachythemis contaminata)

6# Arachnids

Arachnids around the world

Arachnids are a class of arthropods characterized by the presence of four pairs of legs, a body divided into two parts (the cephalothorax and the abdomen), and the absence of antennae and mandibles. They include animals such as spiders, scorpions, mites, and harvestmen. Arachnids generally breathe through sac-like lungs called "book lungs" or through tracheae, depending on the species. They primarily reproduce by eggs, although some species can give birth to live young. Arachnids play an important role in ecosystems as predators of other arthropods and by contributing to the decomposition of organic matter.

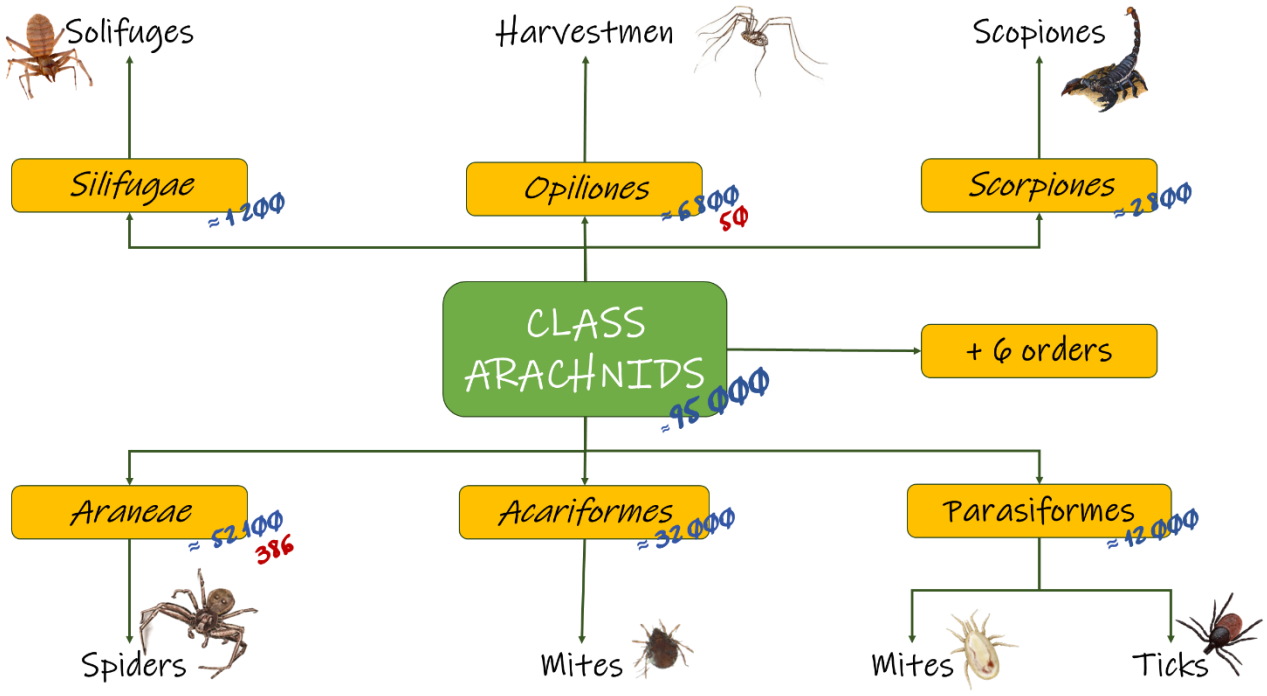


Figure 30 : Classification of the 6 largest arachnids orders (Blue : Number of species in the world ; Red : Number of species in Nepal) (Data for Nepal are not available for all categories due to lack of data and publications)

The Catalogue of Life database provides an overview of the taxonomy and diversity of all known living species and is managed by an international consortium (18). It has managed to record approximately 95,000 species of arachnids spread across 12 orders, among which the most well-known include 52,132 Araneae (spiders) (24), 2,815 Scorpiones (scorpions) (25), 6,749 Opiliones (harvestmen) (26), and Silifuges (windscorpions), as well as numerous mites distributed in orders such as Sarcoptiformes, Trombidiformes, Mesostigmata (*Figure 30*).

The IUCN only lists 591 species of arachnids in total, among which 268 are considered threatened, nearly 45%, meaning that about one in two arachnids is threatened (4). This significant disparity between the data from different databases and those of the IUCN underscores a crucial lack of information about this class.

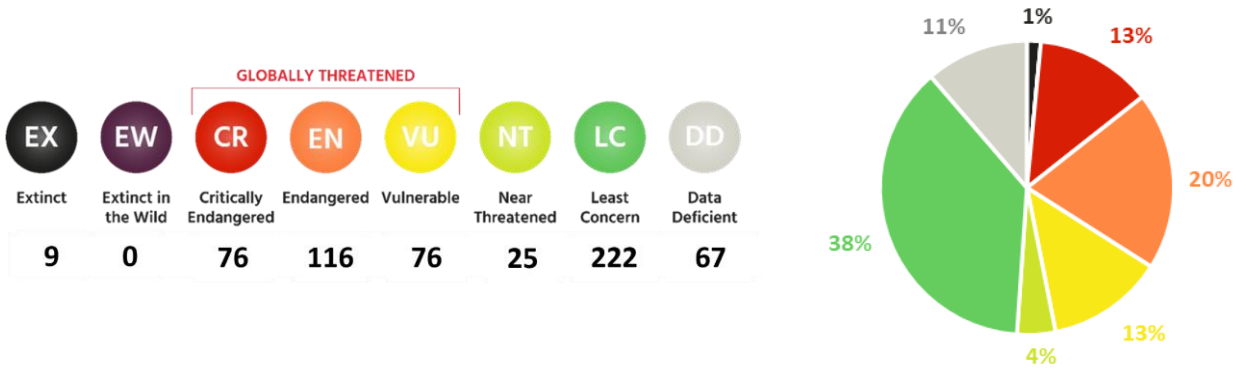


Figure 31 : Number and percentage of species of Arachnids in each IUCN Red List category

Arachnids in Nepal

The IUCN currently recognizes only three species of spiders in Nepal (4), whereas a recent study from 2022 identified 386 distinct species belonging to 135 genera and 34 different families in the country (27).

A single study in German from 1987 lists 50 opiliones in the Nepalese Himalayas, but no study has been conducted for the order of mites (28). No data regarding the current threats facing this arthropod family in Nepal is available, nor has any government protection measure been noted. Unfortunately, publications regarding scorpions are not accessible to the public.

For similar reasons to insects, we also chose not to undertake a comprehensive inventory of arachnids on our sanctuary, including the presence of two scorpions that we unfortunately could not identify. The same material, logistical, and ethical constraints apply. Therefore, we have decided to limit our presentation to six different species belonging to various spider families present in significant numbers at the sanctuary. Just like with insects, spider identification was done by taking photos and using apps such as iNaturalist and Picture Insect, with additional support from the Facebook group "Entomology" to validate identifications. Furthermore, we also consulted the Spider World Catalogue and GBIF databases to supplement our research and ensure the accuracy of identifications.

In this restricted selection, we observed various orb-weaver spiders in the camp, such as St Andrew's Oval Cross Spider (*Argiope aemula*) or *Argiope pulchella* (*Figure 32A*). These species are characterized by the formation of a zigzag-shaped stabilimentum and their numerous highly colorful patterns on their abdomen. We found these spiders in various environments within the sanctuary: near dwellings, in bushes, between the enclosure barriers. Spiders with dorsal spines, such as Hasselt's Spiny Spider (*Macracantha hasselti*) (*Figure 32B*) or the Black-and-White Spiny spider (*Gasteracantha kuhli*), are distinguished by their octagonal abdomen with spines. They primarily weave their webs in bushes. The Huntsman Spider (*Heteropoda venatoria*) is notable due to its size (*Figure 32C*). Nocturnal in nature, it does not weave a web and hunts at night. We encounter it in our dwellings, and its presence increases during the monsoon season. Despite being shy, its bite can be painful. Similar to the Huntsman Spider, the Grey Wall Jumper (*Menemerus bivittatus*) also does not weave a web (*Figure 32D*). It has the surprising ability to quickly jump on its prey, which it finds on walls of our dwellings and on tree trunks. The decorative Silver Orb Spider (*Leucage decorata*) are beautiful green and silver spiders, primarily weaving in grasses and low bushes, in shaded and humid environments (*Figure 32E*). The Lynx Spider, (*Oxyopes sertatus*), recognizable by its long spine-like hairs on its legs, are hunters that do not weave webs and are also found in grasses and grassy fields (*Figure 32F*).

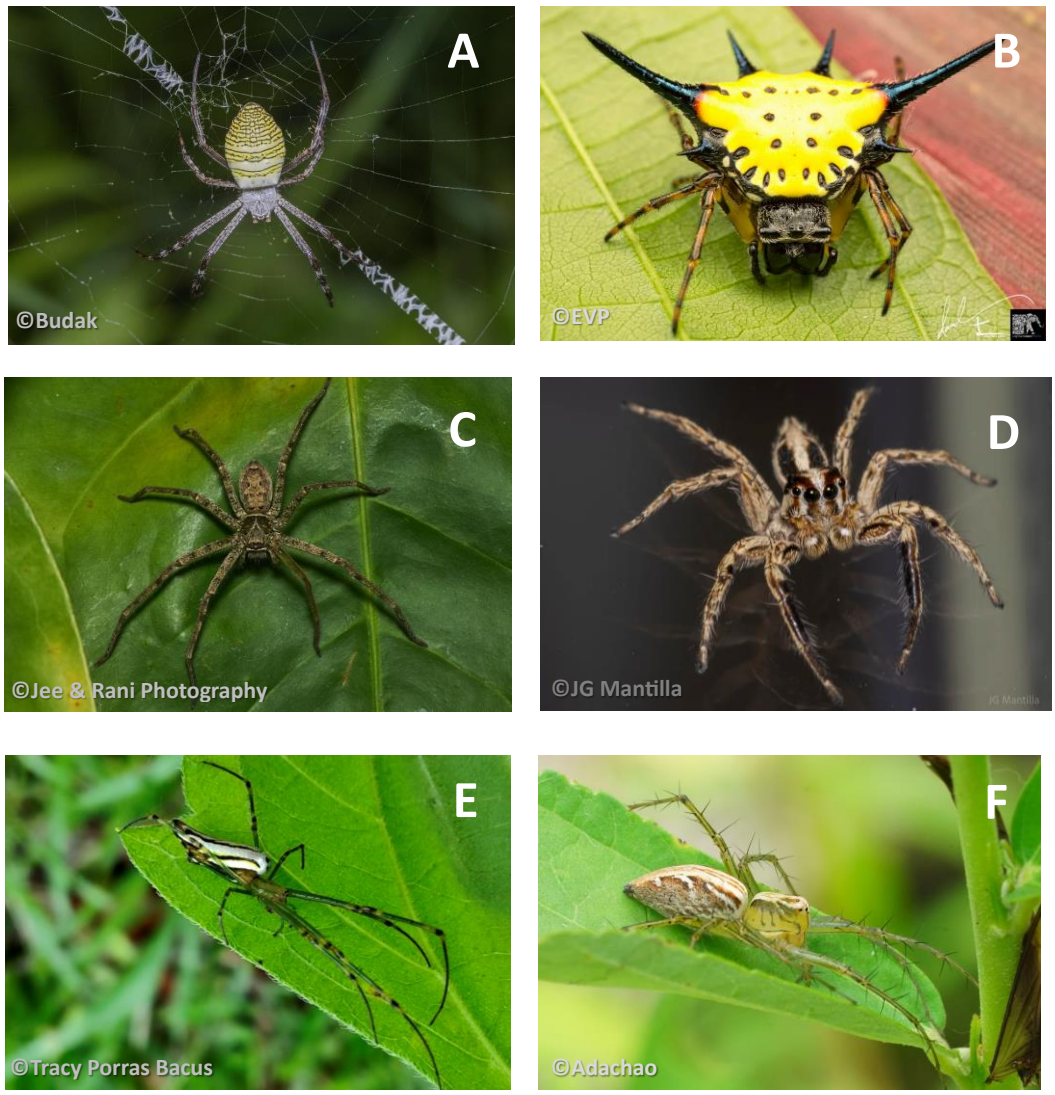


Figure 32 : Six Spider species observed at SU4E

(A) Oval St Andrew's cross spider (Argiope aemula)
(B) Hasselt's spiny spider (Macracantha hasselti)
(C) Huntsman spider (Heteropoda venatoria)
(D) Grey wall jumper (Menemerus bivittatus)
(E) Decorative Silver Orb Spider (Leucauge decorata)
(F) Lynx spider (Oxyopes sertatus)

7# Plants

Plants around the world

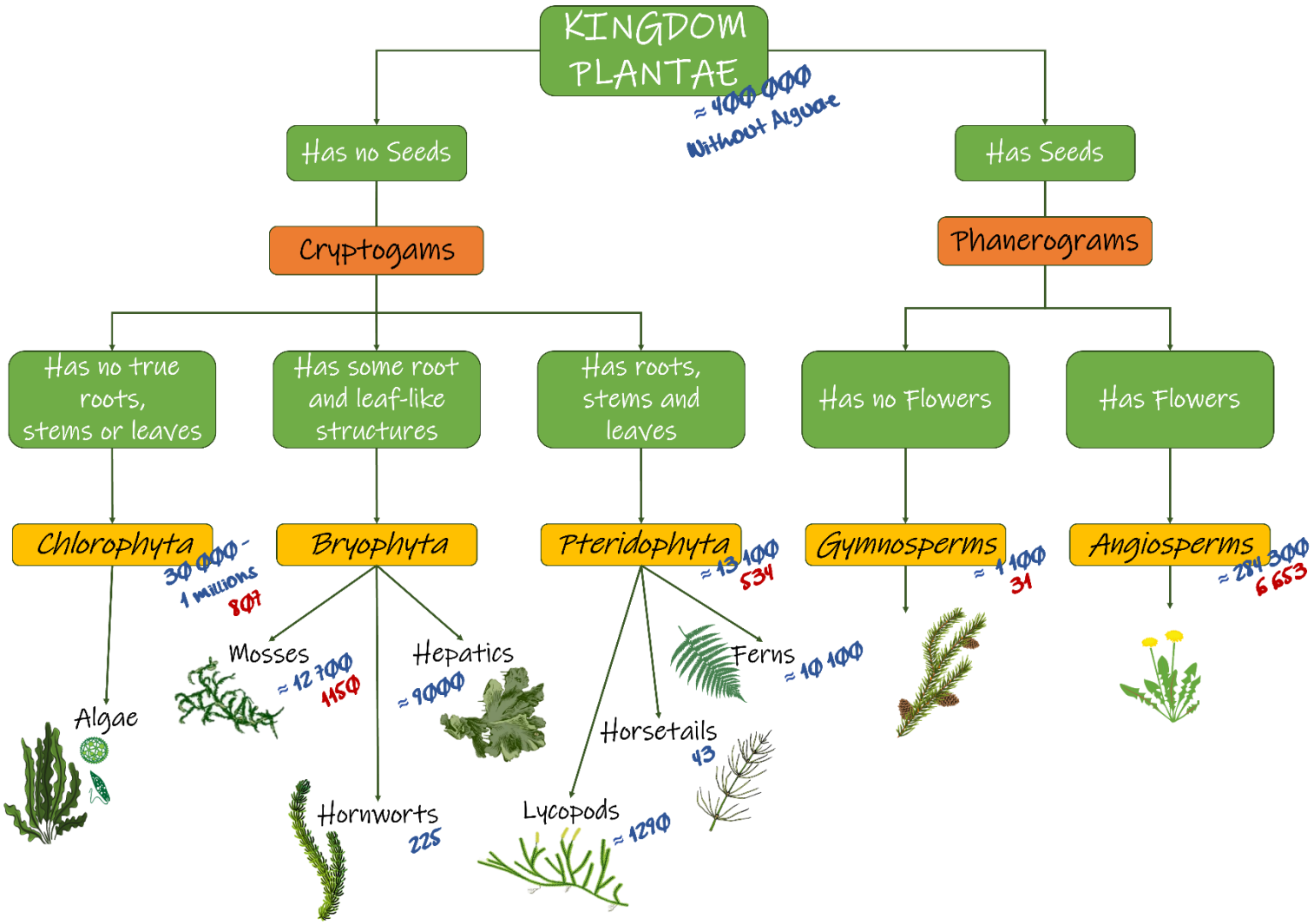


Figure 33 : Plant Classification (Red : number of species in Nepal; Blue : Number of species in the World)
(Data for Nepal are not available for all categories due to lack of data and publications)

Plants constitute an incredibly diverse and vital plant kingdom for ecosystems. They are characterized by their ability to produce their own food through photosynthesis, using sunlight, carbon dioxide, and water to synthesize carbohydrates and oxygen. Plants have varied structures but often share characteristics including roots for anchoring and nutrient absorption, stems that support leaves and transport water and nutrients, and leaves that capture light for photosynthesis. Plants reproduce in various ways, including seeds, cuttings, rhizomes, or spores. They play a crucial role in ecosystems by providing oxygen, stabilizing soils, providing habitats and food for a multitude of organisms, and regulating the water and carbon cycle.

The plant kingdom is divided into several groups (*Figure 33*). Firstly, flowering plants, called angiosperms, account for 284,281 species. Next, gymnosperms correspond to plants with naked seeds with 1,079 species. Then, pteridophytes, plants reproducing through spores, including ferns with 10,560 species, horsetails and clubmosses with 1,290 species. Following are bryophytes, which are non-vascular plants, such as mosses with about 12,700 species, liverworts with about 9,000 species, and hornworts with 225 species (29). In total, 350,386 have been identified by the Royal Botanic Gardens, Kew, which conducts research on plant biodiversity, plant conservation, taxonomy, and other related areas (30). Additionally, Kew plays a crucial role in the conservation of threatened species, both locally and internationally, producing several reports on the state of plants worldwide. The World Flora Online (WFO) database, endorsed by a global consortium of over 40 botanical institutions, lists 377,216 species of vascular plants and mosses (31).

In the IUCN Red List, we find only 66,535 plants, which represents only about 18% of the listed species. Among these plants, 26,276 are already threatened, which is 40%, equivalent to 2 out of 5 species (*Figure 34*).

Figure 34 : Number and percentage of species of Plants in each IUCN Red List category

The Ministry of Forests and Soil Conservation, through its Department of Plant Resources, published a comprehensive report on Nepal's flora in 2012. This document reveals an impressive botanical diversity, with 6653 species of angiosperms, 1150 bryophytes, 534 pteridophytes, and 31 gymnosperms, as well as 807 species of algae (*Figure 33*). Among these, 293 endemic flowering plants attest to Nepal's floral specificity (32). Furthermore, Nepal has identified 701 medicinal plants among the 28,187 recorded worldwide for their therapeutic properties (32) (33).

Nepal's flora benefits from conservation measures, with fifteen protected species (*Figure 36*). The Salampanja Orchid (*Dactylorhiza hatagirea*) and bark from the Common Walnut (Juglans regia) are strictly prohibited from collection, transportation, and trade. The medicinal properties of *D. hatagirea*, such as its anti-rheumatic, anti-inflammatory, antiviral, diuretic, neuroprotective, antioxidant, healing, hypoglycemic, antitumor, antimicrobial, antiviral, and anticancer activities, as well as its potential as a male aphrodisiac, have exerted such pressure on the plant that it is now classified as endangered (*Figure 35B*) (34). As for the walnut bark, it is used in traditional medicine to treat skin problems (*Figure 35A*) (35).

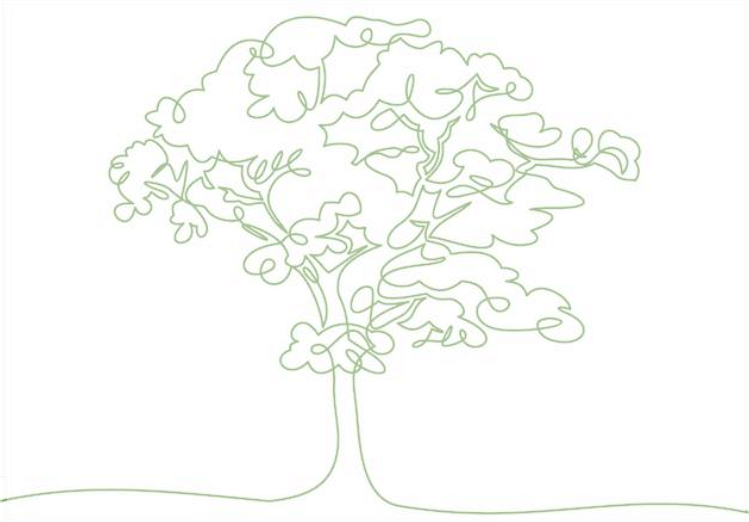
Figure 35 : Nepal's protected plants and their national status

*(A) Walnut tree bark (*Juglans regia*)*
(B) Salampanja (Dactylorhiza hatagirea)
(C) Yellow Gentian (Neopicrorhiza scrophulariiflora)

The Kukti (*Neopicrorhizia scrophulariiflora*), a Himalayan plant that only grows between 3500 and 5000 m altitude, is used in Ayurvedic medicine. It is subject to an export ban without identification or certification (32). This plant has traditionally been used to treat 82 diseases and has 124 major phytochemicals. A study revealed that the plant is anti-atherosclerotic, antidiabetic, and anti-inflammatory (in vivo studies), as well as antimicrobial, antimalarial, antioxidant, hepatoprotective, immunomodulatory, and potentiation of nerve growth factor (in vitro studies) (*Figure 35C*) (36). It's worth noting that no classification has been made by the authorities for this plant.

Eight other species are subject to a ban on raw export out of the country, unless they are processed beforehand, to preserve their balance. Their intensive use in traditional Ayurvedic medicine threatens these species, some of which are already endangered. Among them are the Eastern Himalayan Fir (*Abies spectabilis*), whose needles, bark, and resin are exploited, classifying it as near-threatened; the Nepal Camphor tree (*Cinnamomum glaucescens*), whose bark and leaves are used to produce its essential oil Sugandha kokila, classified as of least concern; the Spikenard (*Nardostachys grandiflora*), whose nard oil is extracted from the rhizome, classified as critically endangered. The Indian Snakeroot (*Rauvolfia serpentina*), for its roots and bark. The Himalayan Yew (*Taxus wallichiana*), used for bark, leaves, and seeds, is classified as endangered. The Indian Valerian (*Valeriana jatamansi*), used for its rhizomes and roots in essential oil production, and the Shilajit, a thick resin found in the Himalayas, as well as lichens (*Figure 36*).

Finally, four species, such as the Indian Rosewood (*Dalbergia latifolia*) classified as vulnerable, the Indian Kino tree (*Pterocarpus marsupium*) as near-threatened, and the Common Walnut (*Juglans regia*), the Sal tree (*Shorea robusta Gaertn*) as of least concern, benefit from total protection against any exploitation, whether it be logging, transportation, or exportation. Some are exploited for their wood, such as Rosewood, Walnut, and Sal, while others are valued for their fruits and the production of vegetable oils (Walnut and Sal). Others are used in Ayurvedic medicine, such as the Indian Kino tree, used for diabetes treatment and for its astringent properties, mainly from the tree's gum. Furthermore, Sal resin is used for making incense during Hindu ceremonies, and its leaves are used to make dishes, highlighting its importance in Nepalese cultural and spiritual practices (37) (*Figure 36*).



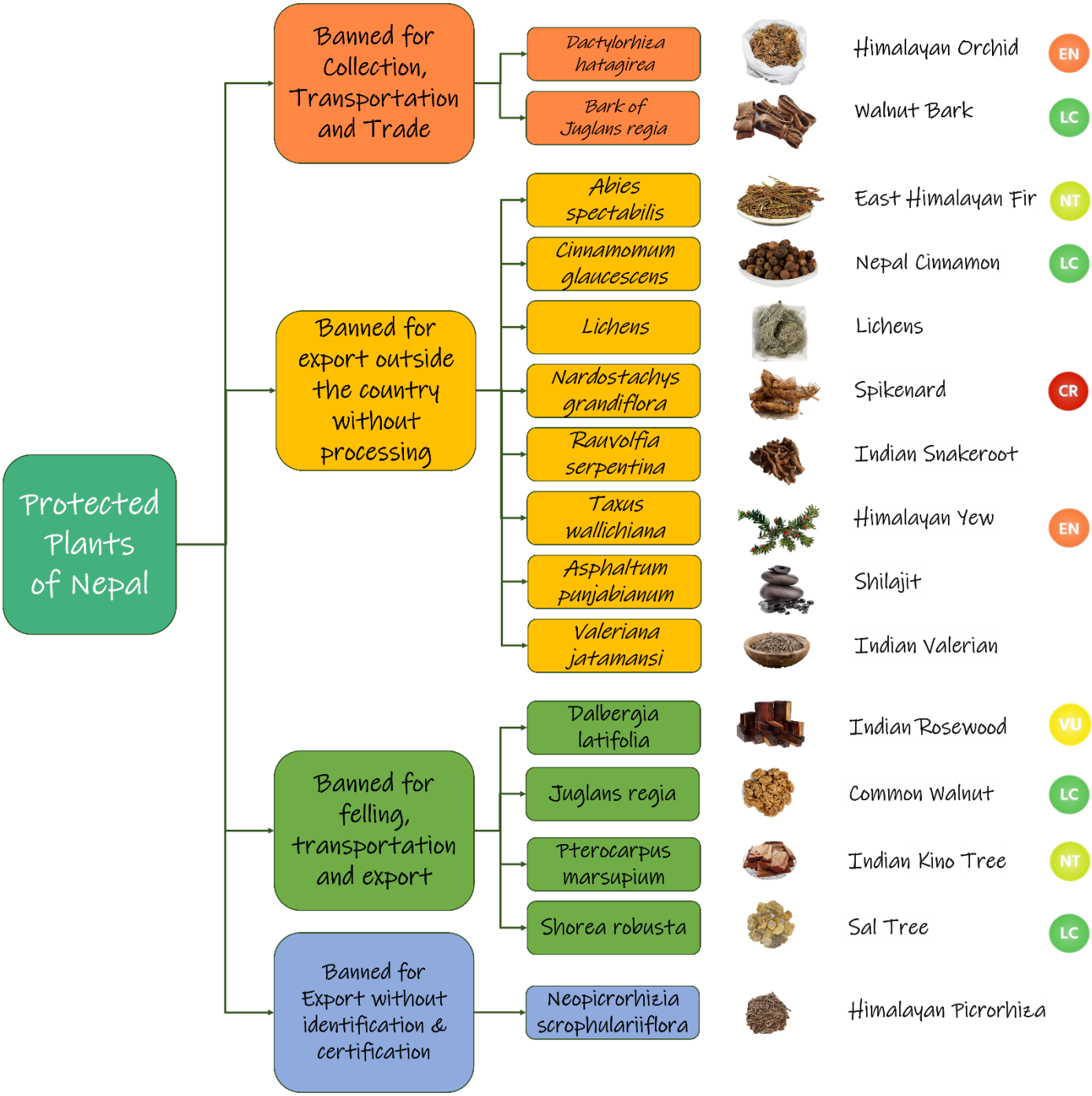


Figure 36: Protected Plants in Nepal

In the IUCN Red List, 881 plant species are listed, of which 33 are threatened species, representing less than 3%. This enumeration only covers 13% of the total plants recorded in Nepal, highlighting the gaps in knowledge within the plant kingdom.

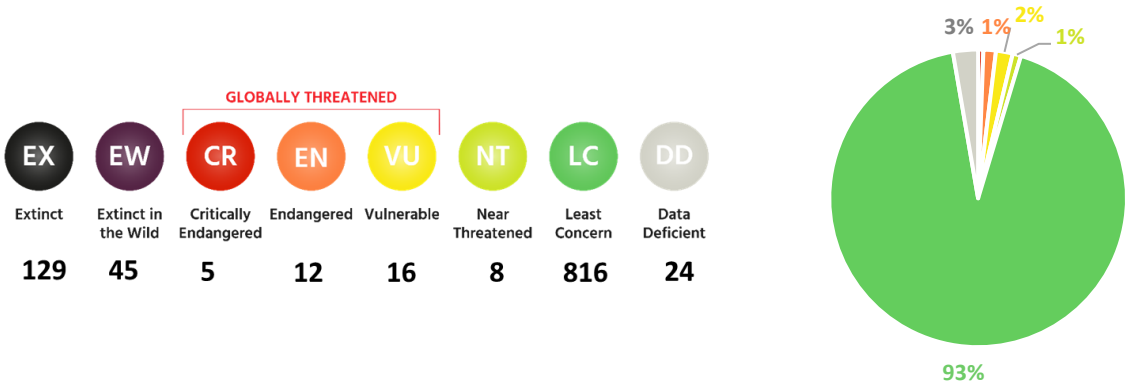


Figure 37 : Number and percentage of species of Plants in Nepal in each IUCN Red List category

Since 2017, 154 species have been registered in CITES. The Lady's Slipper Orchid (*Paphiopedilum venustum)* is listed in Appendix I of CITES, which means it is critically endangered or facing imminent extinction due to international trade (*Figure 38*).

Appendix II includes 149 species that are not necessarily currently threatened but could become so if their trade is not regulated. This list includes 4 tree ferns (Cyathea), 3 euphorbias (Euphorbia), 6 rosewoods (Dalbergia), 131 orchids, and 2 yews (Taxus).

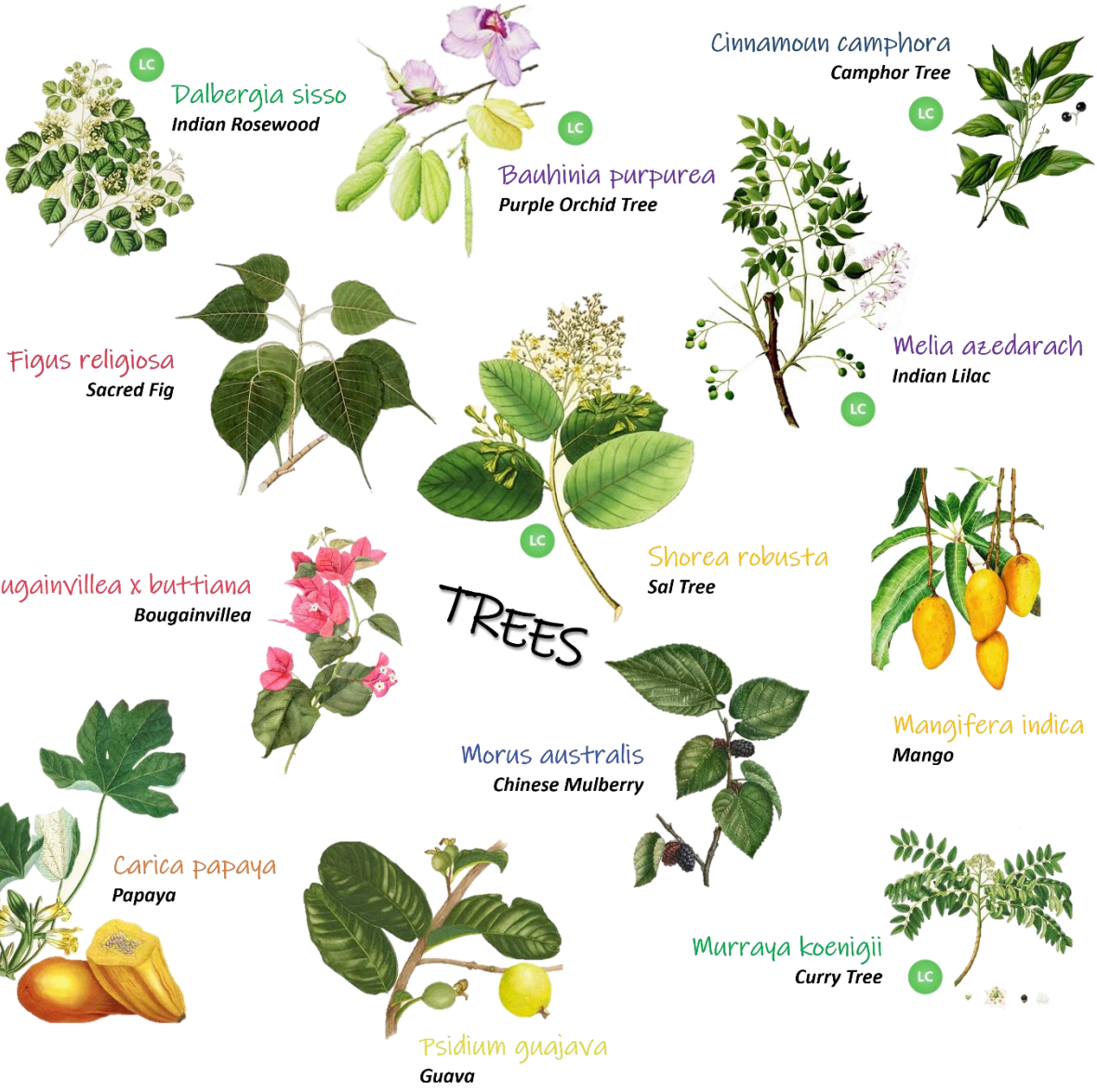
As for Appendix III of CITES, it contains species for which a member state requests international cooperation to control trade. Four species are listed: Chinese Tetracentron (*Tetracentron sinense*), Oleander-leaved Podocarp (Podocarpus neriifolius), Himalayan Blue Poppy (*Meconopsis regia*), and Mountain Gnetum (*Gnetum montanum*) (36)."

Figure 38 : Lady's Slipper Orchid (Paphiopedilum venustum)

Plants at SU4E

The completion of a comprehensive inventory of all the plants on our land would require year-round monitoring to also record annual plants. We have decided to only survey plants exceeding one meter fifty in height. This choice allows us to select trees, shrubs, vines, and tall herbaceous plants that are easily visible and have a strong impact on the presence of birds and insects. For tree identification, we used our knowledge along with the PlantNet application, which enables plant identification through photos. PlantNet was developed by a consortium of French institutes including CIRAD (International Cooperation Centre for Agricultural Research and Development), INRIA (National Institute for Research in Computer Science and Automation), INRAE (National Institute for Agricultural, Food, and Environmental Research), and IRD (Research Institute for Development).

In total, 422 plants were recorded in Chitwan Park. We identified 29 species based on our criteria, half of which are also found in the park. Most of these species were planted by the association, whose land was formerly used for rice cultivation. We identified 12 trees, 8 herbaceous plants, 6 vines, and 3 shrubs (*Figure 39*). Some of these plants bear edible fruits for elephants, such as mango (*Mangifera indica*), papaya (*Carica papaya*), guava (*Psidium guajava*), chinese mulberry (*Morus australis*), sugarcane (*Saccharum spontaneum*), as well as bananas (*Musa acuminata* & *Musa sapientum*). The entire plant of banana and papaya is edible for elephants. The leaves of Chinese Mulberry, Sacred Fig (*Ficus religiosa*), Purple Orchid Tree (*Bauhinia purpurea*), Giant Bamboo (*Bambusa balcooa*), and Elephant Grass (*Pennisetum purpureum*) are also consumed by the elephants.


LC
Dalbergia sisso
Indian Rosewood
LC
Bauhinia purpurea
Purple Orchid Tree
Cinnamoun camphora
Camphor Tree
LC
Figus religiosa
Sacred Fig
Melia azedarach
Indian Lilac
LC
LC
Shorea robusta
Sal Tree
Bougainvillea x buttiana
Bougainvillea
TREES
Mangifera indica
Mango
Morus australis
Chinese Mulberry
Carica papaya
Papaya
Murraya koenigii
Curry Tree
LC
Psidium guajava
Guava


Allamanda cathartica
Golden Trumpet
SHRUBS
Clerodendrum japonicum
Japanese Glorybower

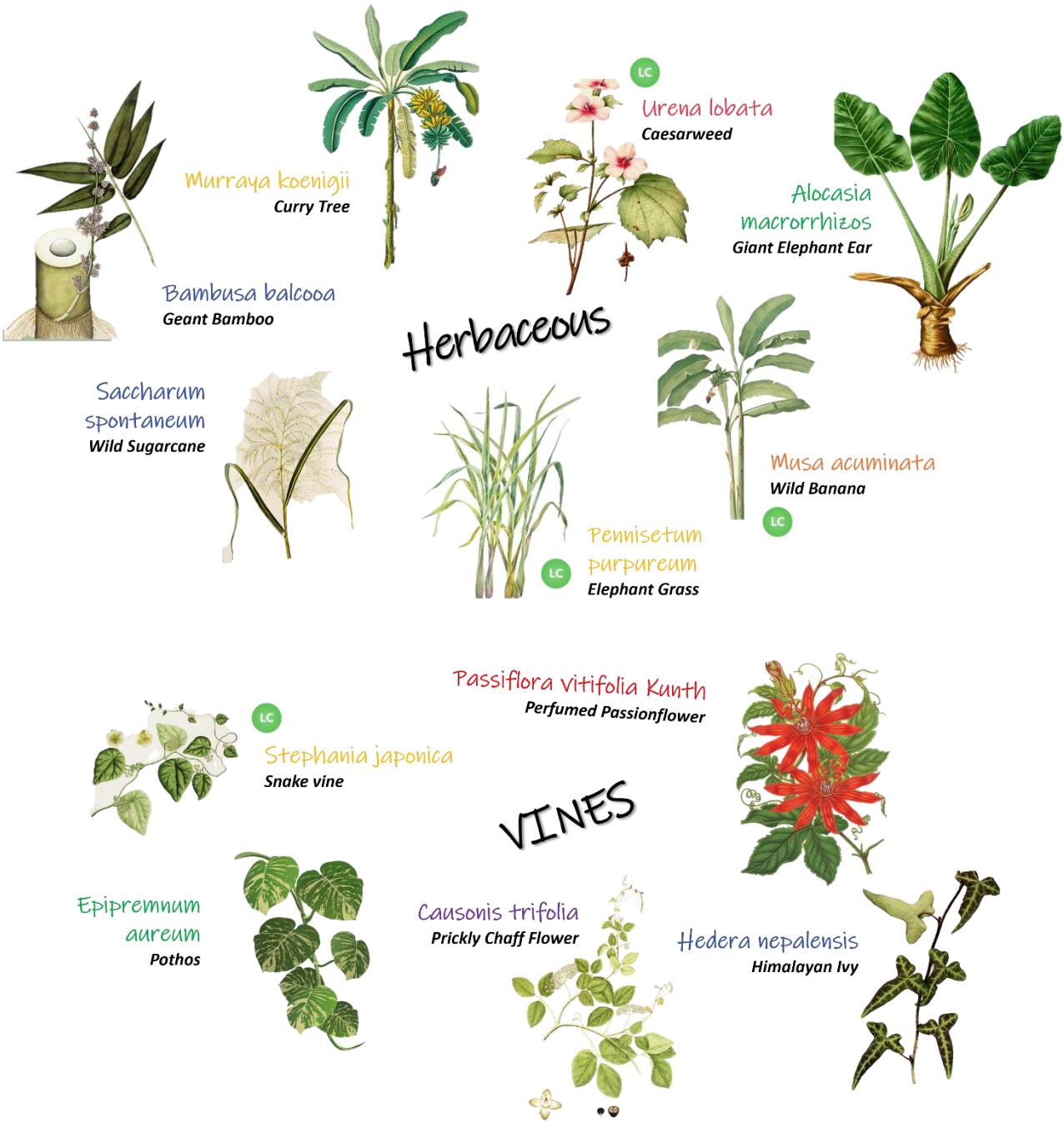


Figure 39 : Plant species observed at SU4E

Within the sanctuary, the presence of three invasive plants originating from South and Central America significantly influences our environment, requiring us to regularly manually eliminate them to preserve our ecosystems.

Firstly, there is the Siam Weed (Chromolaena odorata) introduced by the French in Laos. It competes with native vegetation, produces allelopathic effects, has a significant impact on the reproduction of certain reptiles, invades some plantations, constitutes a significant source of fuel in bushfires, and can cause allergies and asthma (Figure 40A).

Figure 40 : Invasive Plants at Su4E

(A) Siam weed (Chromolaena odorata)
*(B) Lantana (*Lantana camara*)*
(C) Bitter Vine (Mikania micrantha)

In addition, we have the Lantana (Lantana camara) introduced as an ornamental shrub. This species forms dense coverings that reduce plant diversity, alter natural fire regimes, and emit allelopathic substances disrupting the growth of neighboring plants, thus delaying forest regeneration for several decades. Additionally, it alters hydrology, affects agriculture, leads to grazing losses, and can poison livestock due to the presence of triterpenoids. Moreover, it serves as a refuge for parasites such as malaria-carrying mosquitoes. (Figure 40B).

Finally, the most invasive of all, the Bitter Vine (*Mikania micrantha*), capable of growing up to 9 cm per day. It competes for light, nutrients, and water, emits allelopathic substances, smothers plants on which it grows, and disrupts plantations, making crops more difficult to harvest (*Figure 40C*) (38).

Discussion

Situated in the village of Bairiya, near Chitwan National Park, the Stand Up 4 Elephants (SU4E) association is dedicated to the protection of captive elephants in Nepal. Since its establishment, SU4E has demonstrated remarkable progress in promoting a sustainable and ethically responsible approach to caring for elephants. In December 2018, the association created its sanctuary, which welcomed Eva in October 2019, followed by Lhammo in December 2020.

Since its foundation, SU4E has not only focused on the well-being of elephants but has also significantly contributed to improving local biodiversity. By creating a sanctuary that prioritizes the well-being of elephants, SU4E has developed a flourishing ecosystem supporting a wide variety of flora and fauna.

The sanctuary environment has become a safe haven for various animal species (Figure 41). So far, we have identified 11 mammal species, 32 bird species, 8 reptile species, and 8 amphibian species through direct or indirect observations. The sanctuary is also rich in insects and arachnids, which play a crucial role in the ecosystem. Regarding flora, the sanctuary is adorned with a diversity of plants, including 29 different species of trees, shrubs, and vines, as well as herbaceous plants and ferns, including edible species contributing to habitat balance.

The differences between species are also notable in terms of population. We have observed that a species like the jaguar or certain snakes have only one individual, while others, like amphibians, parrots, and banana trees, can have dozens of individuals.

However, the fauna and flora of the sanctuary are facing several threats. The village of Barhia is rapidly urbanizing, creating new pressures on the local ecosystem. Among the identified threats are habitat loss, degradation, and fragmentation, chemical poisoning, reduction of prey base, human-wildlife conflicts and persecutions, disturbances, diseases, reduced and/or fragmented populations, climate change, linear structures and hydropower, intensified agriculture, limited conservation measures, as well as inadequate knowledge and research. Forest fires also exacerbate these vulnerabilities. Furthermore, the issue of invasive plants affects not only the sanctuary but also the entire village.

The presence of this species diversity highlights the sanctuary's role in promoting ecological balance and biodiversity. Careful habitat management and protection within the sanctuary have allowed these species to thrive, demonstrating the interconnectedness between wildlife conservation and ecosystem health.

Through the sanctuary, SU4E has shown how targeted conservation efforts can lead to broader environmental benefits. The protection and care provided to elephants have ripple effects that extend to the entire ecosystem, making the sanctuary a microcosm of biodiversity and ecological richness.

Figure 41 : Aerial photo of the sanctuary SU4E with the location of some animals.

Conclusion

In conclusion, the efforts of the Stand Up 4 Elephants association to establish and maintain the sanctuary highlight the crucial importance of preserving not only individual species but also entire ecosystems. By improving the conditions for captive elephants, SU4E has simultaneously created an environment where biodiversity can thrive, illustrating the profound impact of well-planned and ethically guided conservation initiatives. This sanctuary is a testament to the potential of wildlife and flora conservation efforts to foster a vibrant and diverse natural world.

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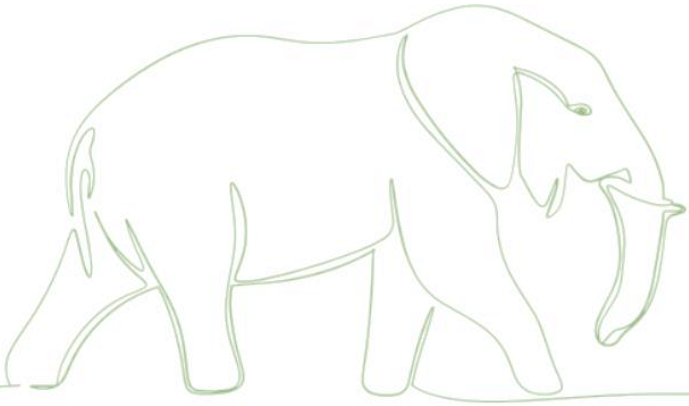

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