Khoe Kay:
Biodiversity in Peril

by Karen Environmental
and Social Action Network

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Primary Author's Note

I am an indigenous Karen man from Karen State, Burma. My name is Saw Blaw Htoo. My grandfather was a hunter. When I was young I followed my grandfather whenever he went hunting. At about the age of 12, my grandfather died. Then I started following my father, who worked as a logger in the Taungoo area and used his elephant to pull the logs. I stayed in the forest with my father and my grandfather more than twenty years and only came to town during school season. Now my parents are farmers and use both traditional Karen rotational farming and wet rice farming systems.

From an early age I went to the forest and identified plants and others species; every time I would introduce myself to the species by saying their name to myself. My parents and other friends always helped me to identify the species in the forest based on Karen traditional knowledge. Before going to university, I already knew hundreds of species in the forest.

Since I was a child, I have also loved to learn about animals, especially birds. When the rainy season came, I went to the forest with my father and if I saw a bird's nest destroyed by wind, with the chicks forced to the ground, I took the chicks back home and raised them myself. Sometimes the rearing was successful and the bird became my pet. Animals such as bamboo rats, bears and monkeys often became pets in my community.

I have worked for KESAN in Biodiversity research for about two years. Even now, I always watch birds, fishes, animals and identify plant species in my free time. Every time I go back to Burma I spend many days in the forest just watching for birds and animals.

Gaining Indigenous Knowledge

Identifying species in the forest is always difficult, but I always try my best to study how to identify species using the old knowledge of Karen communities. It is important to know the species in the forest because many species are useful while others are dangerous. Because many plants are toxic to humans, the local people need to know the species well before using them. Local species identification methods are based on humans' five senses: touch, taste, smell, hearing and sound.

Since I was young my parents have taught me how to identify plants and animals so I can survive in the forest. They taught me to make a fire when there is no lighter by using bamboo chits or stones, and how to extract water from plants in case there is no water. This knowledge is important and useful for me when traveling in the deep forest. I can pick the right wild vegetables for food, weave my own basket where there is no bag, and cook in the forest without pots. Also, I am able to identify animals by looking at the activity period of each species. Some wild animals such as wild elephants and guars have their own time of aggression. If you know when it is dangerous to approach these animals, then you can also choose the correct safe time for doing so.

Gaining Knowledge from University

The academic methods used to identify animals and local knowledge are quite similar. Generally, the common indicators used by indigenous people are colors, sizes, sounds, ecological behavior and ecological niches, similar to those used by Western scientists. However, the university teaches much deeper classifications such as genotypes, phenotypes, skeleton formations, cell structure and chromosome number. In plants, monocotyledon and dicotyledon taxa are identified.

One university experience that I had was working as a university biology research assistant at Chiang Mai University. I collected bird droppings from their perches and brought them back to the Chiang Mai University herbarium to identify any plant seeds. Mostly, the plant seeds were identified by the shape of seed, eyes, stripes, sizes and colors. If the plant seed could not identified in the laboratory, then it was planted in the germination garden at Doi Suthep National park. This reminds me of local knowledge that my grandfather taught me: if the plant species' color or size is different from those in the current area, replant them in their native place.

Executive Summary

A team of Karen researchers from the Karen Environmental and Social Action Network has undertaken this study to begin documentation of the rich biodiversity of Khoe Kay, a bend in the Salween River that is part of their homeland. They also want to document and expose the severe threats faced by this stretch of the Salween, both from large dams and ongoing militarization.

Using methods of their own culture, as well as those used in university research, they have found that Khoe Kay is studded with both plant and animal diversity, with 194 plant species and 200 animals identified.

Forty-two of these species are considered endangered, being found in IUCN's Redlist, the CITES Appendices, or both. Thus, conservation of the area will protect many globally important resources.

Endemic and unknown species are also represented, with eight endemic fish species of particular interest. Also, many of the plants and animals unknown to Western science are used by the Karen for food and medicine, providing opportunities for further research. Furthermore, several entire taxa, such as mollusks, spiders and fungi, have been treated very lightly if at all in this report, so the reader is encouraged to undertake further study with assistance from KESAN.

Lying on the riverine border of Thailand and Burma, the area is relatively untrammeled. Teak trees dominate, and therefore Khoe Kay provides a window into the biodiversity of the entire region prior to industrial development.

Threats from proposed large dams and militarization may seriously degrade Khoe Kay. With dams, the main concerns are greenhouse gas emissions, loss of fisheries, cumulative effects of several cascading dams, and flow changes and sedimentation. Militarization of the area is also increasing, having already resulted in the loss of one severely endangered Sumatran Rhinoceros.

1
Introduction

To most people on earth – even biodiversity scientists – the Salween Basin is like the dark side of the moon. It is the second-longest river in Southeast Asia, yet few have even heard of it. Even in the populated valleys and cities of the countries that claim Salween waters – China, Burma, Thailand – people know little of this river. There are no big cities, no famous ruins, no superhighways, no dams – yet. But it is precisely this obscurity that makes the Salween Basin a place of great biodiversity. This report is an effort to document the biological richness of one remote southern corner of the basin, and to alert the reader about its imminent peril.

This story of biodiversity at risk is set in the deciduous hills and evergreen galleries where the Salween cleaves apart the countries of Burma and Thailand. The Khoe Kay village tract occupies a great oxbow in the Salween River, where Burma's Karen State and Thailand's Mae Hong Son Province meet. This "border" until quite recently was not recognized by the indigenous Karen forest farmers who call both banks of the river their home. It looks simple enough, this border, when reading a map in Bangkok or Rangoon. But on the ground, this deep, fast, cold, narrow river originating in Tibet has never been much of a border to the Karen. Language, customs, and land-use practices are common to both banks. For centuries the Karen have been living and farming the hills and narrow valleys of this stretch of the 2,800-km. river. The border that is so important to military planners was unknown to the Karen. The situation has changed dramatically now, with many implications for biodiversity.

Today the river separates a Burmese war zone and a (nominal) Thai wildlife sanctuary. For the Karen on the west bank, the river is vital. When the Burma Army comes from the west with rifles and torches and worse, Karen villagers slip across the river and hide. If the world knows anything of the Thai-Burma border, it knows about the refugee camps strung along its length. The world is not aware that, geographically, most of these camps are in the Salween Basin.

The other thing the world is ignorant about is the natural richness of this stretch of the river. This study illuminates a biologically lush area virtually unknown to science. More than 420 plant and animal species were documented, with no less than 21 species found in the World Conservation Union (IUCN) Red List documented in this study. Megafauna like tiger, banteng, and even Sumatran rhinoceros are known to exist in the Dawna Range of Karen State, to the west of the study site. The mixed deciduous forests are still rich, with meter-wide teak trees the most common tree found along the study's rope transects. For its part, the Salween River mainstream is remarkable for its aquatic species endemism, with more than a third of its 160 recorded fish species found only in its waters (Chavalit, personal communication).[1] The WWF calls the Salween the most diverse turtle habitat on earth. The lead author of this KESAN report received his biology training in part in the famous Khao Yai National Park of Thailand, designated in 2005 as a World Heritage Site for its biodiversity; the Khoe Kay area compares favorably Khao Yai in diversity and ecosystem health.

The indigenous wisdom of the Karen in this area is also strong, which is remarkable given the rapid decline of indigenous knowledge across the border in the consumption-preoccupied societies of Thailand. The pharmacopeia known to the grassroots researchers participating in this study is something precious but dwindling with each new generation and, today, threatened with drowning under the reservoirs of large hydro-electric dams.

The significance of this report is the documentation of biodiversity in a war zone. The insecurity of the area acts as an effective deterrent to outside attention: academic study, green NGO intervention or even serious environmental impact assessments for the proposed dams. But while this makes KESAN's work infinitely more difficult, it does not stop the organization from doing sound field work in the area. One of the objectives of this report is to alert biodiversity scientists, naturalists and other interested parties to both the rich biodiversity of the area, and to the imminent threats it faces. It is hoped that this snapshot of the natural world of the lower Salween will encourage others to become involved in research and conservation activities.

The threats to the biodiversity of the study area are many. The dangers facing the Salween were recognized in 2007 by WWF, which listed the river in its Ten Rivers at Risk.[2] The threats to the biodiversity and indigenous people of the research site are discussed briefly in this paper, but not comprehensively. This report focuses on the biodiversity at risk, not the threats themselves. The Reference section of the paper suggests further reading for those interested in the background of this drama.

[1] Dr. Chavalit Witdhayanon is an aquatic biologist with World Wildlife Fund – Thailand undertook a study of Salween River fish endemicity and helped identify the fish species in this study.

[2] World's top 10 rivers at risk, Gland, Switzerland, WWF International, March 2007. The other rivers listed, in addition to the Murray-Darling, Mekong and Salween, were the Danube, La Plata, Rio Grande-Rio Bravo, Ganges, Indus, Nile and Yangtze. http://assets.panda.org/downloads/worldstop10riversatriskfinalmarch13.pdf

In brief, four pertinent threats are discussed, in order of their imminence: 1) military action by the Burma Army in Karen State; 2) natural resource exploitation by various stakeholders; 3) the Salween dams; and 4) the militarization of "protection" in Burma. The first threat is also a major impediment to the very study of biodiversity, and the reason why this area is so little known, even to wildlife scientists and others interested in biodiversity. This threat, and the resulting "information shadow" over the land, is being challenged by KESAN and this report. KESAN's agenda in the Salween is discussed in greater detail below.

The third threat, the Salween dams, should be highlighted here because of the huge potential impact. The study area, known locally as Khoe Kay and sitting adjacent to Thailand's Salween Wildlife Sanctuary, is the site of one of the larger dams planned for the Salween.[3] The Weigyi dam would stand 220 meters high, cost US$3 billion, rated at 4500 megawatts and create a reservoir as large as 1000 square km.[4] The planning process for this dam and hydropower station, to be built by Thailand on Burmese territory with Chinese capital, is shrouded in secrecy, but initial steps have been taken. For instance, Thailand's Salween Wildlife Sanctuary has allowed the Electricity Generating Authority of Thailand (EGAT) build an initial access road through the heart of the sanctuary to the dam site on the river bank, hardly consistent with its biodiversity protection mandate,. Plans call for this road to be upgraded to a multi-lane highway for large trucks. To say that the rich biodiversity of this area will be "impacted" or "affected" is a euphemism for what will really happen. The forest will be cut down, and the land will be torn apart and submerged underwater.

> "The insecurity of the area acts as an effective deterrent to outside attention: academic study, green NGO intervention or even serious environmental impact assessments for the proposed dams."

KESAN's Biodiversity Program

KESAN's Biodiversity Program started with reports of massive forest destruction in Karen State. When Thailand banned logging in 1989, many Northern Thai companies turned to Burma to log the rich forests there, which the cash-starved

[3] Thirteen dams are planned for the Nu Jiang (Salween) in Yunnan, China. The Burma and Thai border stretch of the river includes four large dams and several more on tributaries like the Pai, the Ngao and the Moei. (See Dore and Yu, 2004; Riverswatch East and SE Asia, http://www.rwesa.org/mekong.html#n-s; Karen Rivers Watch, 2004; Salween Watch and SEARIN, 2004; www.salweenwatch.org; www.searin.org

[4] http://www.salweenwatch.org/dam_site.html

Burmese military government was more than willing to sell. Many of these concessions, granted by the Myanmar Timber Enterprise (MTE), were in conflict zones along the Thai border, so the companies also had to negotiate with local authorities such as the Karen National Union (KNU), or after 1994, the rival Democratic Karen Buddhist Army DKBA. Logging also moved deeper into Karen State following the 1994 fall of Manerplaw. The multiple authorizations led loggers to ever harsher forest practices, and the resulting logging left many areas in a highly degraded state.

KESAN's first report on biodiversity, "Destruction and Degradation of the Burmese Frontier Forests," recorded the impacts of some of this logging, and found that the loss of forests was caused by the massive commercial logging and charcoal production, as well as the needs of local people to sustain their livelihoods. Much of the logging was done by outsiders, and the local people are well aware of the problems caused by forest loss, but there are no easy answers.

The fighting in Karen State (including Khoe Kay) makes the local people's situation highly insecure. But, as one villager noted, "if they [the leaders] wait until Burma gets democracy and the military government changes, the forests will be gone and there will be no forest for the coming generations... In our forest, we need to stop logging and take the wood that is just enough for our household needs. We need to protect our forest from fire, so more trees can grow up and more animals will come back to the forest." These sentiments led KESAN to adopt several small-scale projects aimed at using and preserving traditional agricultural practices to undertake forest conservation.

KESAN also issued a report called "Diversity Degraded" (the Karen language version included a focus on rotational agricultural practices). These studies found that Internally Displaced People (IDPs) cannot use their traditional farming practices, and examined the impacts of this on food production, seed collection and use, and livelihoods.

The lead author of the report returned to his home village to record what plants were used in traditional rotational agriculture areas, and compared that to the farming situation after the Karen villagers were forced to relocate by the military. The variety of crops was greatly reduced by conflict, with only main crops like rice, beans, sesame and cucumbers remaining for farmers' use. Further, the loss of crop diversity led to an increase in insect infestations, increasing the impacts to livelihoods. As a result of these findings, KESAN began to a series of projects to encourage local people to save their seeds and keep the widest possible number of crops in production to maintain the ecological balance.

The main lesson of these studies is that biodiversity in Karen State is closely related to both Karen culture and food security. This connection leads to KESAN's goal to maintian Karen culture and local biodiversity through traditional agricultural

practices like rotational farming and community forests. The use of these practices leads to better farm production, and also conserves biodiversity more effectively. In addition, Karen culture and livelihoods can not wait for democracy and regime change in Burma. Action must be taken now.

This last conclusion led directly to the current Khoe Kay study, in that biodiversity (like Karen culture) can not wait for international actors to bring about change. The local people must do all they can to conserve their forests and biodiversity or they will be lost to logging, dams and other industrial extraction.

Currently, international non-governmental organizaions (INGOs) are working with the Burmese military government in a top-down effort to create exclusionary Protected Areas. However, KESAN has found that the INGOs are not paying attention to biodiversity loss in conflict areas like Karen State, and conservation efforts in the Protected Areas are often overwhelmed by resource extraction by the military government and its associates. For example, one INGO was quite enthusiastic about the discovery of Gurney's pitta, an endangered bird in Tennasarim Division, and set about creating a Protected Area in the pitta's habitat. Unfortunately, they were not able to prevent the creation of a huge palm oil plantation in that habitat. It is KESAN's position that INGOs operating in Burma should focus on stopping bad extraction projects by advocating for the enforcement of environmental laws, rather than creating Protected Areas that will be subject to severe encroachment by greedy, corrupt officials.

These extraction projects put enourmous pressure on both people and forests, and the creation of protected areas makes this pressure worse by denying local people access to the resources they need. As a result, KESAN is focusing on a people-centered approach to biodiversity conservation, focusing on food and livelihood security through traditional agricultural practices that also conserve biodiversity. In addition, KESAN is pushing for adoption of a law in Burma requiring Environmental and Social Impact Assessments (EIA/SIA) prior to large extraction projects, as well as the creation of new Protected Areas with real conservation mandates.

Report Contents

This report was written to inform the world's concerned biodiversity scientists about a biodiversity hotspot under imminent threat. The report is structured in this way: First, some brief background about this hotspot, its political economy and the key threats to biodiversity in the area. The heart of the paper is the information about the study area's biodiversity: how the information was gathered (section 3), the key findings (section 4), and what this information might mean (section 5). Finally, recommendations are made for concerned scientists and environmental organizations, including suggestions for further research. The report tries to be dispassionate and apolitical, which is not easy for an area so full of hope and heartbreak, but the reader will note a sense of urgency. The message should be clear: if anyone out there wants to know about the great diversity of plants and animals in this place, they'd better hurry. The flood is coming.

2

The Setting

Speaking in terms of political geography, the research site falls within western mainland Southeast Asia, along the border between Burma and Thailand. It is more interesting, however, to locate the site using bioregional terms. We will locate the site using three lenses, in order of decreasing size: Conservation International's Indo-Burman Biodiversity Hotspot, the Salween River Basin and the WWF's Kayah-Karen Montane Forest ecoregion. Then we will focus on the study site itself.

2.1 Indo-Burma hotspot

The Indo-Burman hotspot stretches from northeastern India to the South China Sea, and from southern China to northern Malaysia.[5] It encompasses an area of about 2.4 million sq. km., nearly all of Mainland Southeast Asia. Like all of Conservation International's (CI) hotspots, Indo-Burma is notable both for its diversity and the rapid decline of this diversity from human impacts. In terms of endemism, there are about 7,000 endemic plants, 25 threatened endemic mammals and 18 threatened birds found nowhere else on earth. The hotspot is best known by scientists for the recent discovery of several large mammals along the Vietnamese-Laos frontier, including the Annamite muntjac (Muntiacus truongsonensis), and a species of leaf deer found in extreme northern Burma. If the same access and attention were given to the little-studied lower Salween, it is possible that other exciting

[5] The Indo-Burma hotspot encompasses 2,373,000 km of tropical Asia east of the Ganges-Brahmaputra lowlands. It begins in eastern Bangladesh and then extends across north-eastern India, south of the Bramaputra River, to encompass nearly all of Myanmar, part of southern and western Yunnan Province in China, all of the Lao People's Democratic Republic, Cambodia and Vietnam, the vast majority of Thailand and a small part of Peninsular Malaysia. In addition, the hotspot covers the coastal lowlands of southern China (in southern Guangxi and Guangdong), as well as several offshore islands, such as Hainan Island (of China) in the South China Sea and the Andaman Islands (of India) in the Andaman Sea. See http://www.biodiversityhotspots.org/xp/hotspots/indo_burma/Pages/default.aspx

discoveries would occur.

This hotspot also holds remarkable endemism in freshwater turtle species, most of which are threatened with extinction due to over-harvesting and extensive habitat loss, according to CI. The WWF cites the Salween as the most diverse turtle habitat on earth.

The climate of Indo-Burma is characterized by distinct seasons. During the northern winter months, dry, cool winds blow from the stable continental Asian high-pressure system, resulting in a dry period under clear skies across much of the south, center, and west of the hotspot (the dry, northeast monsoon). In this era of intense competition for water, government and media in Thailand decry this period as a "drought." In fact, the existence of deciduous forests – the habitat of the fabled teak tree – is the legacy of this "drought." As the continental system weakens in spring, the wind direction reverses and air masses forming the southwest monsoon pick up moisture from the Indian Ocean to the southwest and bring abundant rains as they rise over the hills and mountains.

CI reports that "a wide diversity of ecosystems is represented in this hotspot, including mixed wet evergreen, dry evergreen, deciduous, and montane forests. There are also patches of shrublands and woodlands on karst limestone outcrops and, in some coastal areas, scattered heath forests. In addition, a wide variety of distinctive, localized vegetation formations occur in Indo-Burma, including lowland floodplain swamps, mangroves, and seasonally inundated grasslands."

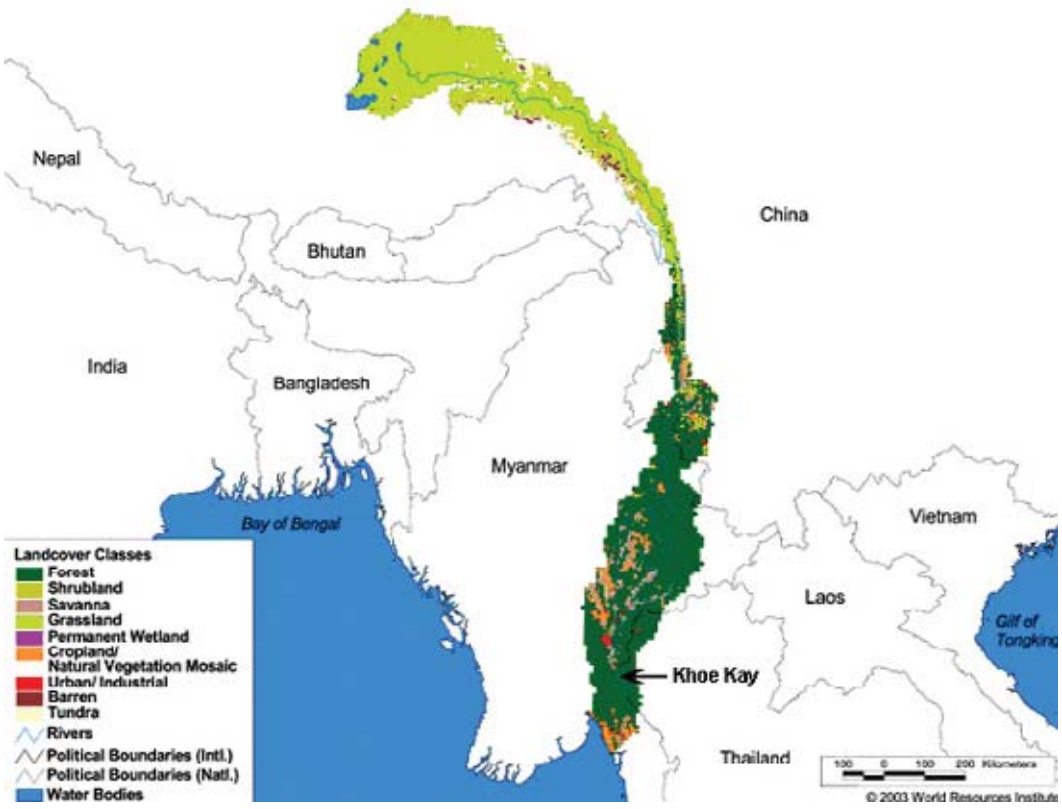
2.2 Salween Basin

By most measures, the Salween Basin is of little significance. At 2,800 kilometers, the Salween River is significantly longer than the Ohio in the USA, twice the length of Europe's Rhine and the equal of the Indus, the Danube, the Parana of South America and the Darling of Australia. At one point in its journey to the Indian Ocean, the Salween parallels its great Asian sisters, the Yangtze and Mekong, running side by side a mere 100 km from each other as the crow flies. In terms of drainage, the Salween is a shadow of these other venerable rivers. The Salween drains a mere 244,100 sq. km.[7] (Wolf et al, 1999). This is a one-sixth the drainage of the Yangtze and less than a third of the Mekong. While these two latter river basins encompass national capitals (Vientiane, Phnom Phen) and great world cities (Shanghai and Ho Chi Min City), the principal city of the Salween is the old port city Moulmein, in Burma.

[7] Estimates of this vary, including a high of 320,000 sq. km. (See Wolf et al, 1999; WRI at http://multimedia.wri.org/watersheds_2003/as26.html; http://www.worldwildlife.org/wildworld/profiles/g200/g173.html

The Salween mainstream forms an international border for a mere five percent of its length. From its mouth, it is navigable for only about 100 kilometers. For almost the entirety of its length the Salween travels through some of the most remote areas of the nations that claim the river. It originates in the rugged Tibetan plateau, in an area known as Kham, where the Chinese have until recently held only the most tenuous sway. In Yunnan the river careens through 3,000 meter deep gorges and brushes against 6,000 meter high mountain peaks. For most of its run through Yunnan the river is pressed hard against the Burma frontier, one of the most remote mountainous areas left on earth.

Figure 1 - Map of the Salween Basin[8]



[8] Courtesy of the World Resources Institute. http://multimedia.wri.org/watersheds_2003/as26.html

In Burma, the river runs through a land forgotten by the world. This is Kokang country, home to some of the world's most prolific heroin producers. This is the land of the Wa, where tens of thousands of people were forcibly relocated in the late 1990s without world headlines or international condemnation. This is the country of "License to Rape" where the Burma Army was charged with the systematic use of rape as a war weapon against the people of the Shan State (SHRF and SWAN, 2002)[9]. Where the Salween cleaves through Karenni and Karen States, the world's longest running civil war continues to spark and sputter with daily violence. In Thailand's small remote corner of the Salween Basin, chain saws cleared millions of board feet of teak under the nose of the Thai state years after logging was formally banned in the country.

The Salween is a place where the majority peoples of the three basin countries have throughout history rarely tread and never settled. It is not the home of Han or Burman or Thai, but of Kham, Nu, Lisu, Shan, Karen, Karenni and Mon. Geographically, economically, ethnically and politically, the Salween Basin is on the extreme edge of every country that claims its waters. Google Salween or search the online catalogue of the library of Australian National University, for example, and the pickings are relatively slim. For the second-longest river of Southeast Asia, there are no coffee-table books with glossy photos of fishers or forests.[10] No institute or province or academic journal bears the river's name. The name Salween is probably unknown to the vast majority of educated people on Earth. Its one superlative is that the Salween is the most diverse turtle community on earth (WWF, 2001).

While the Salween is marginal in economic terms, this report argues for seeing the river basin through the unconventional lens of biodiversity. In these terms, the river is world class. The reptilian footnote above gives us a hint of the real significance of the Salween Basin: its biodiversity. The basin's biodiversity is much better documented along its length in China, where "The Grand Canyon of the Orient" is part of a UNESCO World Heritage Site: the Three Parallel Rivers. About fifty percent of all of China's plant and animal species live there.[11] At least 13 different ethnic groups coexist along the extreme slopes that rise above the Nu canyon, as the river is known in China, and on the small natural terraces that support human habitation.

This stretch of the river, too, is under threat. Despite the influence of UNESCO, some 13 dams have been proposed along the Nu. If all the dams are built, the chain-of-bathtubs transformation of the Nu would yield the most powerful hydropower complex in the world. Despite a moratorium on dam building ordered in 2004 by the Chinese premiere, preparations continue.[12]

[9] http://www.shanland.org/resources/bookspub/humanrights/LtoR

[10] As with many things involving the Salween, the Chinese section – known as the Nujiang – is at times an exception. A length of the Salween that passes through the Gaoligong Mountain National Nature Reserve has been the object of considerable international and national attention. (See Stotz et al.)

[11] See http://www.irrawaddy.org/print_page.php?art_id=6024

[12] http://assets.panda.org/downloads/worldstop10riversatriskfinalmarch13.pdf. at p. 10.

2.3 WWF Kayah-Karen Forest

The site of this research can also be considered through the lens of the WWF's ecoregions focus. This stretch of the river, and the Thai-Burmese border, resides in the Kayah-Karen Montane Forests ecoregion,[13] so named for the principal ethnic groups in the area. This ecoregion "harbors globally outstanding levels of species richness. Among the ecoregions of Indochina, it ranks second for bird species richness (568 species) and fourth for mammal species richness." The WWF writes that "because the ecoregion remains unexplored scientifically, especially the parts that lie in (Burma), it probably will yield more biological surprises."

This is a complex, minutely dissected land of sheer limestone mountains, caves, waterfalls and small scattered forest-farming communities. "Much of the region consists of hills of Paleozoic limestone that have been dissected by chemical weathering. The overhanging cliffs, sinkholes, and caverns characteristic of tropical karst landscapes are all present in this ecoregion. The flora and fauna here is distinct and includes several endemic species. Because complex habitats are little explored, it is likely that they contain undescribed endemic species."

The mountains of this ecoregion are not especially high – rarely exceeding 2,000 meters above sea level – but they are steep, separating many narrow and fertile valley bottoms. The mountains form a continental divide, with slopes to the west draining into the Gulf of Martaban in the Indian Ocean. The eastern slopes drain into the Chao Phraya River, which drains into the gulf of Thailand and the Pacific. The entire region has a monsoonal climate with warm, moist summers and mild winters that tend to be dry. Overall annual rainfall averages 1,500 to 2,000 mm. Although this ecoregion lies south of the Tropic of Cancer, winter temperatures can be cool, especially at the higher elevations, where frost has been recorded from the northern part of the ecoregion. West-facing slopes (on the Burma side) face the Bay of Bengal and receive more precipitation. East-facing slopes (on the Thailand side) lie within a partial rain shadow and tend to be drier. This climatic difference is clearly reflected in the vegetation.

Forest types vary according to a range of factors, with altitude and aspect being the most significant natural ones. Fire is the predominant human factor in the forest equation of the region. The lowland evergreen forest that once perhaps dominated the valleys and low hills of the region has now been largely replaced with rice fields or more modern human developments. Remnants of the Dipterocarp giants that once might have filled the skies of the region's lowlands – *Hopea odorata, Dipterocarpus turbinatus* and their fellow evergreens – can still be found in gallery forests. In the foothills up to 700 masl, the mixed deciduous forests, famous for teak (*Tectona grandis*) and other valuable hardwoods, are still present though degraded in most places of the region (see section 4 below for a description of the

[13] http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0119_full.html

teak forests of Khoe Kay, which are still rich). In concert with these moister forests can be found the drought-and-fire-resistant dry dipterocarp forests, so named for the dominance of a handful of hardy members of that tribe like *D. tuberculatus* and *Shorea obtusa*. The interplay between the two deciduous forest types can be seen clearly in the research site, where the Karen State bank of the river is richer in teak and other mixed deciduous trees, whereas the west-facing slopes of the Thai side are dominated by dry dipterocarp species. Above 1,000 meters, the montane evergreen forests are rich with temperate species of the families *Magnoliaceae* and *Lauraceae*. "Ridgetops include a plethora of Himalayan plant taxa including members of the oak family (*Castanopsis*, *Quercus*, and *Lithocarpus*), *Schima wallichii*, and members of the birch and alder families." Native pines (mainly the three-needled *P. kesiya*) occupy the steepest and most exposed ridgelines. In the research site, analysis of the rope transects shows clearly the dominance of teak from 1,000 meters from the river.

According to the WWF, in the ecoregion as a whole, mammals of conservation importance include several threatened species such as the tiger (*Panthera tigris*), Asian elephant (*Elephas maximus*), gaur (*Bos gaurus*), banteng (*Bos javanicus*), wild water buffalo (*Bubalus arnee*), Southern serow (*Naemorhedus sumatraensis*), Clouded leopard (*Pardofelis nebulosa*), Malayan tapir (*Tapirus indicus*), Dhole (*Cuon alpinus*), Asiatic black bear (*Ursus thibetanus*), Assamese macaque (*Macaca assamensis*), Rhesus macaque (*Macaca mulatta*), smooth-coated otter (*Lutrogale perspicillata*), Large Indian civet (*Viverra zibetha*), and particoloured flying squirrel (*Hylopetes alboniger*).

The WWF reports that the "Sumatran rhinoceros is believed to have inhabited remote regions of the Tenasserim Hills in recent years, but this critically endangered species is now thought to have been extirpated from this ecoregion." In the Dawna Range south of the Khoe Kay research site, however, sightings of the rhinoceros still occur.

For the WWF, the ecoregion has outstanding conservation potential.

> "The relatively intact, contiguous habitat has potential to conserve large landscapes that will provide adequate habitat to maintain a viable population of Asia's largest carnivore, the tiger, as well as other species of critical conservation significance. Therefore, the ecoregion lies within a high-priority (Level I) TCU (Olson and Dinerstein 1997). Several of Thailand's largest and most intact wildlife reserves lie within this ecoregion, including Huai Kha Khaeng Wildlife Sanctuary (2,575 km2) and several other protected areas with which it forms a contiguous network. Huai Kha Khaeng is prized for the high diversity of cat species it supports and its relatively intact vertebrate communities and intact lowland dipterocarp forests. Moister habitats on the (Burma) side of the Tenasserim Range also include significant amounts of intact habitat, probably still in better condition overall than the forest on the eastern (Thai) side of the range. However, it is difficult to assess ecological conditions in the forests of eastern (Burma) at this time."

The Dawna range links to the Tanintharyi Forest Complex in Burma, which in turn connects to the Western Forest Complex in Thailand. This area is also the subject of significant tiger conservation efforts.[14]

Assessing the ecological conditions of a part of eastern Burma is the business of KESAN, and of this report. Descriptions of the Khoe Kay forests and aquatic environments are found in Section 4 below.

> “According to the WWF, “Sumatran rhinoceros is believed to have inhabited remote regions of the Tenasserim Hills in recent years, but this critically endangered species is now thought to have been extirpated from this ecoregion.” In the Dawna Range to the immediate west of the Khoe Kay research site, however, sightings of the rhinoceros still occur.”

[14] http://www.wcs.org/globalconservation/Asia/thailand/thailandtigers

3

Scope and Methods

3.1 Research Objectives

The objectives of this research are to (1) Survey the Khoe Kay area as comprehensively as possible for biological diversity, and analyze and report those findings; (2) Use these findings to promote more in-depth study of Khoe Kay's biodiversity; and (3) Promote awareness of the largely negative impacts that proposed dams and other development will have on the ecology of Khoe Kay.

3.2 Research team

The research team is made up of KESAN staff members and other staff from the Salween Watch alliance (www.salweenwatch.org).

A total of four KESAN staff worked on this research in the field. KESAN workers include Saw Wee Eh Htoo, research coordination, Saw Ra Htoo, research assistance, and Saw Htee Po Shee (now deceased), staff. However, two other staff, Saw Lay Shee and Johnny Lay from the Salween Watch alliance assisted our efforts, using their invaluable experience in conducting research on local people's knowledge of forests and wildlife.

One of our team members, Saw Ra Htoo, did research for the book Biodiversity Degraded In Karen State, published by KESAN in October 2005. The team thus has experience in both Karen and Western methods of biological classification and study. Further, university and NGO experts provided significant help in identifying species. The team contacted Prof. Philip Round of Mahidol University, Prof. J. Maxwell of Chiang Mai University, Dr. Chavalit Witdhayanon of WWF, John Parr, author of Large Mammals of Thailand, and Miss Prapaporn Pangkeaw of the Southeast Asia Rivers Network, who all made invaluable contributions.

3.3 Scope of the Study

3.3.1 Temporal Scope

The KESAN research team spent 3 months, full time, in Khoe Kay, from September to December 2006, and parts of 2007 and early 2008. During that time, the team conducted transect studies, interviews and forest walks with local people, and surveys for the various taxa (mammals, birds, fish, etc.). The team returned to Khoe Kay from March 10-20, 2007 to collect plant samples for further identification at Chiang Mai University.

3.3.2 Spatial Scope

Khoe Kay is a roughly oval area encompassing a large bend in the Salween River, which in that area makes up the Thai-Burma border. It is extremely rugged terrain, with steep mountains and deep valleys. It covers approximately 90 sq. km., and consists primarily of mixed deciduous forests, with some evergreen forest, and also includes the aquatic ecosystems of the Salween River and its tributaries. The area is located around 18 19' N, 97 35' E.

Figure 2 – Khoe Kay is between Chiang Mai and Yangon.

Figure 3 - The Karen villagers' map of Khoe Kay. The Wei Gyi dam site is in red, and protected forests are green.

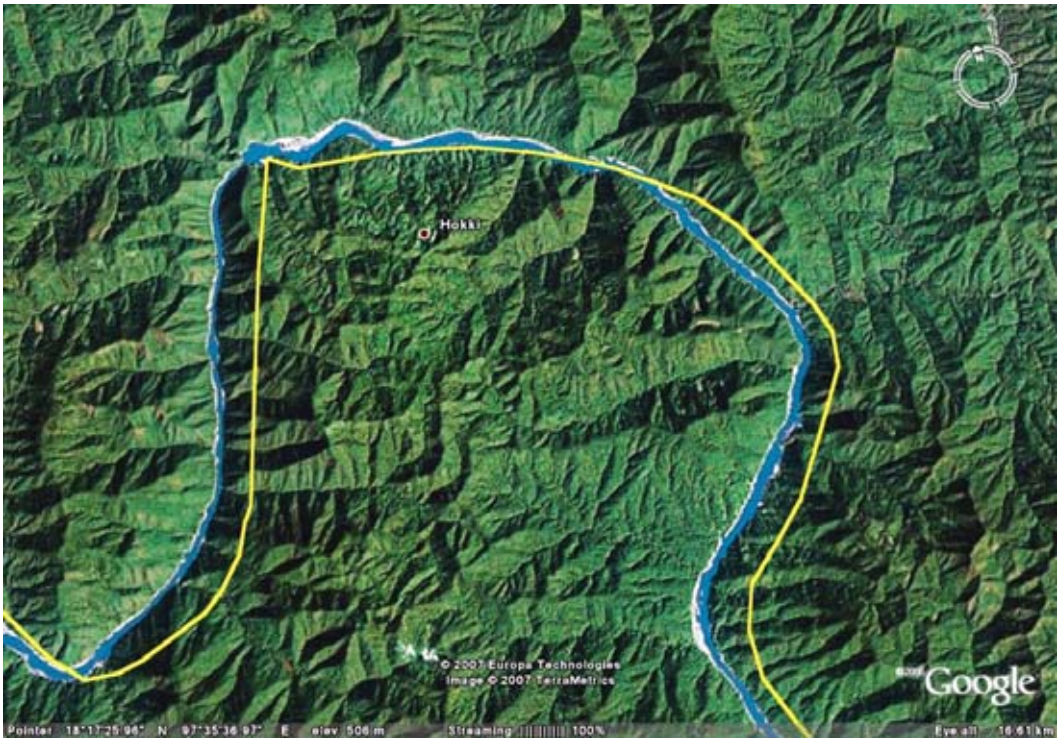


Figure 4– Google Earth image of Khoe Kay showing landscape features. Khoe Kay village is identified as Hokki.

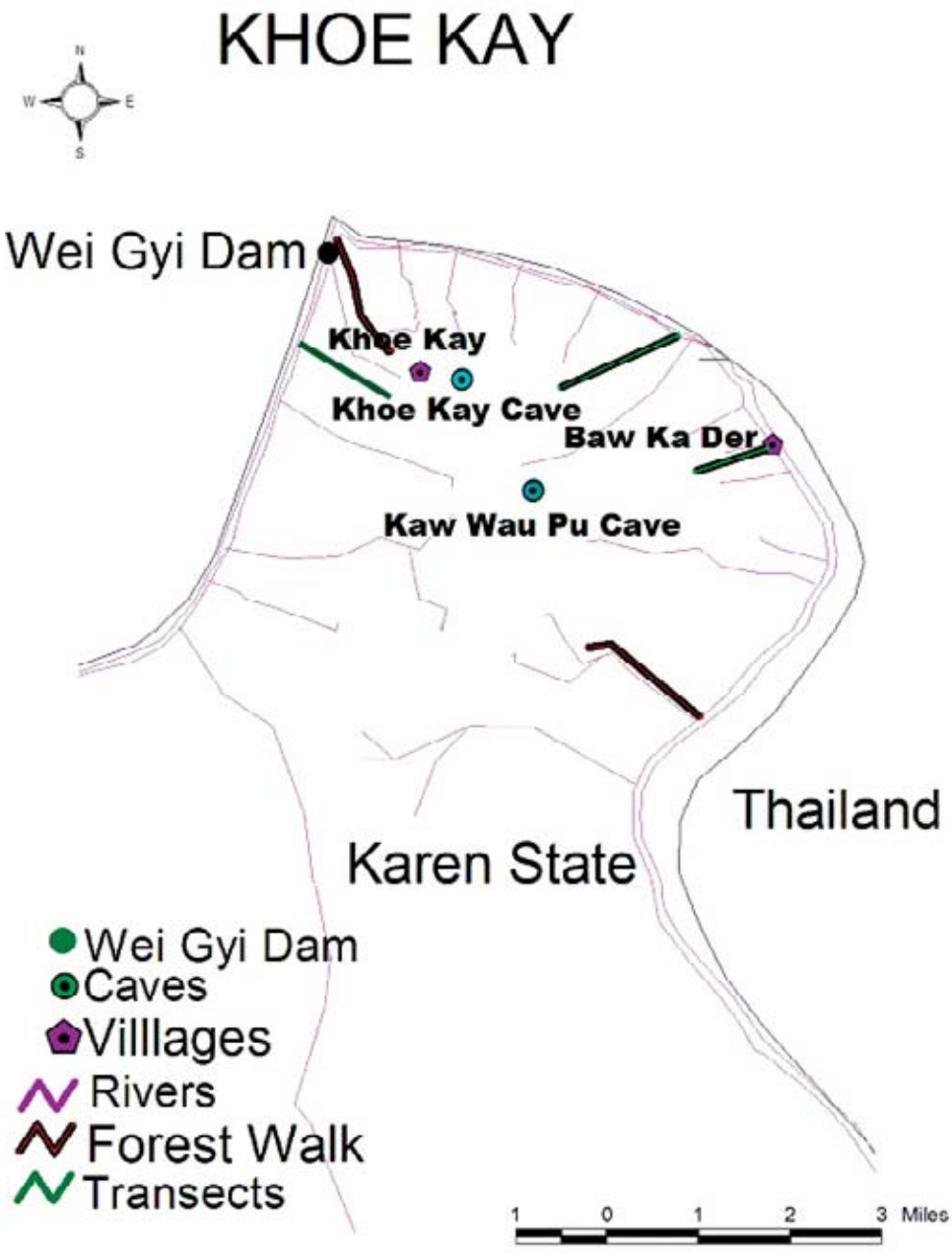


Figure 5 - Study Sites within Khoe Kay. Map by EDesk.

Indigenous and Western scientific knowledge

In the western tradition, the scientific study of plants encompasses the origin, structures and internal processes of plants as well as the relationships between living and non-living matter. While some study how global climate affects plants, others examine the molecules that make up plant cells. Some of the most common studies of plants are plant cell biology, plant biochemistry and plant genetics.

Studies of plant cell structure vary from the macroscopic to microscopic. Scientists study plant structure under microscopes in the laboratory. A plant biochemist studies organic compound in the plants, such as acidic and basic (alkaline) chemicals. Moreover, the plant geneticist studies the phenotypes (visible differences) and genotypes (genetic differences) of the plants. Therefore these western scientists are plant specialists in these science fields, because they know plants in great detail.

On the other hand, the indigenous people in the Salween research area practice a traditional science inherited from their forbearers. This knowledge is orally retold and has never been written down. The KESAN team is the first group in the area allowed by the local people to write down their own indigenous knowledge. The way they identify the species in the forest is similar to the science mentioned above. However, the laboratory evidence is not done in the same detail; instead it is more localized. Their evidence is based on their five senses which are: touching, hearing, smelling, tasting and sight.

The touching is based on hard, soft, rough, slivery, hairy, and itchy. The hearing is the sound of the tree leaves made when the wind blows (*e.g. the pine forests sound like a flowing river when the wind blows). The smell of plant leaves, flowers, bark and fruits are quite different for each species. Similarly, plant species also taste differently. Finally, the leaves' colors, sizes, shapes, veins, edge types, as well as branch types, make up the differences between them. These differences between the species enable the local people to identify local organisms.*

Evidence of the similarity between local knowledge and laboratory science is seen in the chemistry of tamarind leaf: it tastes sour to the local people, while laboratory evidence indicates the presence of carboxylic acid (-COOH), known to cause sour tastes. Both observations provide an opportunity to classify the species.

3.3.3 Local Research Process

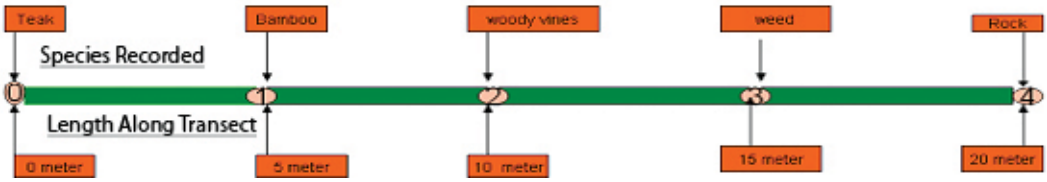
The KESAN research team planned and implemented a multifaceted research and data collection plan, involving both primary and secondary data. Our methods included the following.

1. Forest surveys using transect ropes.
2. Research and surveys of caves and forests, wherein we collected data on birds, plants, amphibians, mammals, reptiles, and insects during forest walks.
3. Interviews with local and indigenous forest guides and village leaders during forest walks.
4. Workshops and focus groups between researchers and local people to exchange knowledge about wildlife and biodiversity and participation in cooperative field surveys.
5. Bird surveys in the forest, along the Salween River and tributaries.
6. Fish surveys along the Salween River and tributaries.

The KESAN team was assisted by residents of the two villages, Khoe Kay and Baw Ka Der. They organized their own teams to undertake surveys and relate their knowledge. The local teams varied between three and 25 members, with ten field trips total. For each of the two villages, there was one big group forest walk, and the KESAN team also conducted one independent forest walk per village.

3.3.3.1 Rope Line transects

The research team arranged a 100 meter long transect rope starting from three points along the Salween River, running uphill, to examine the tree and plant distribution patterns in the area. They marked the rope with white tape at five meter intervals. The rope was set up from the Salween River bank as the zero-meter point. Then, the team recorded the species or other occurrence at each 5-meter mark. The 100 meter transect line ran from the riverside upslope for ten intervals, or a total of 1000 meters. The team was assisted by the villagers, who confirmed the local names of the species. The local people also helped the team by describing the species' attributes, including seasonal behavior such as bearing flowers or fruits and shedding leaves. The team randomly selected three places for conducting these forest survey techniques to make sure the estimation of plant distribution is as reliable as possible.



Figures 6a and 6b - The Transect Process In Theory And Practice

3.3.3.2 Forest Walks

For our study of local people's nature knowledge, the team conducted forest walks with the villagers. The routes are shown in Figure 5. During these field trips, plant and animal species details were recorded according to individual's local knowledge about those species. The local people helped determine the abundance of common plant species in the area. Two caves, Kaw Wau Pu and Khoe Kay, were also surveyed for bats.

With respect to species identifications, the knowledge differences between each village might create different methods of species identification However, the similarity between the processes are far greater than the differences.

The way the villagers valued the species in the forest is also dependent upon the sexes and ages of each person. Most women think some species are more important than the others. Similarly, the men believe some species have more impact on men than women. For example, women consider *Musa* (banana) species important for weaving, while men believe that rattan species are better. The result showed that the majority of the people learn the species in the forest depending on the genders. The boys always say that they are taught by their father, grand father, and uncles, while girls say that they are taught by their mothers and grandmothers.

For each animal species, the researcher implemented a different approach to collect data. For mammals, the researchers watched and observed foot prints, the smell of urine and stool, for their habitats, and evidence of food consumption. For reptiles

we were able to observe footprints, stool samples, and food consumption. Amphibians were surveyed by listening to the sound they made or by finding their eggs and offspring, especially tadpoles in frog species.

After specimens were photographed, the team sub-categorized specimen samples into endangered species and non-endangered species. The habitat, niche, and diet of each species and the role they play in their ecosystem were also observed. The KESAN group worked closely with local people in producing the animal analysis.

A Day in the Field with Local People

It was near the end of the rainy season. The sky cleared and the sun came up beyond the Salween River right above the mountaintop in Thailand. The five KESAN team members and 23 villagers from Baw Ka Der Village set out on their forest walk. During this trip with the local people, the team members used a walking and talking method with the villagers along the way.

The villagers were divided into two groups, male and female, and each main group was sub-divided into two groups based on their ages. The groups were from 18 and below and over 18 in each gender group. The activities during the day were based on the villagers' choices. The villagers used their ordinary way but were asked questions by the KESAN team members.

The villagers actively sought to catch fish, and looked for vegetables, mushrooms, and wild fruits. Midday, the villagers cooked enough lunch for everyone using their collected food, and using only native species such as banana leaves and bamboo tubes for cookware. The steamed fish, mushrooms, and wild banana flowers produced a very delicious meal for the KESAN staff.

The forest here is free from pesticides so the edible wild vegetables are safe even if they are consumed raw. Wild edible mushrooms are very abundant in the area, and could be available for commercial purposes because the villagers collect only a small fraction of what is available. The rest is left to decay in the forest.

About 5:00 pm the villagers and the KESAN staff began to prepare for their departure. Their one day in the forest, talking to each other and sharing food brought the entire group closer together. The forest walk with villagers created a better friendship and understanding among all. The first time the villagers looked very shy and seemed afraid to talk. Soon, they answered almost all of our questions, and they seemed to be gain confidence. It seems that most of the villagers were happy because this was the first time they could record their knowledge.

Figure 7 - Students seek assistance from an elder to identify species.

3.3.3.3 Interviews

We first conducted interviews of the local villages' elders, regarded as those who have the most knowledge in each village. We selected 6 village elders between the ages of 60 and 104. The interview questions were mostly based on environmental and biodiversity issues of the past, present and future. Questions for the interview can be found in Appendix C.

Prior to the forest walks, the researchers prepared separate question forms for the local participants. The questions in the form were based on the previous interviews with older villagers in the area.

On each village's forest walk the team divided the groups by age, between teenagers and adults. During this research, the local people identified only the species that they knew by name in their local tongues. The unknown species were excluded in their species list. The locally-known species were then brought to the herbarium at Chiang Mail University for Western-based identification by Prof. J.F. Maxwell.

3.3.3.4 Knowledge Exchange – Cooperative Field Surveys

Cooperative field surveys were conducted with each village. About 50 people participated in these activities from the two villages. The team prepared questionnaires for participants from the information collected by interviews of villager elders as mentioned above. The questions were based on the participant's five senses and their relevance to species identification. For example: "List five tree species that you see and you think is important during this trip. Why is each species important?" (See Appendix C for complete questionnaire). Moreover, the team asked a lot of extra questions related to the species interactions, such as food chain, food web, niches and breeding. The extra questions included, for example: "What kind of food does each species consume? Does the species migrate? What about breeding season, ecological behavior, and an estimated number of individuals in the area?"

3.3.3.5 Bird Survey.

The team used binoculars to look for birds in the forest, in the fields and along the streams. Two boat trips and several trips to the forest and fields were conducted. Researchers watched and identified the birds using guidebooks. Most of the birds are known both to the local people and the KESAN team workers, so instant identification was possible.

The way local people identified birds and the scientific identification process is similar. They both seek specific forms, colors, shapes, sounds, and behavior for identification of each species. The most common way that the scientific and local people both use to identify bird species are plumage marks, wing-feather tracts and bare body parts. A picture of one bird species that the KESAN staff could not identify was sent to Dr. Phillip Round of Mahidol University for further identification.

The team utilized different approaches in the data collection for birds. Teams chose the best low, middle, and high elevation bird observation sites. Teams recorded every activity that the species made during the observation period, which was about 2 hours per site, throughout the day. When surveying on the Salween River, researchers used boats to watch the birds for four hours in the morning and four hours in the afternoon.

Figure 8 - Bird Survey in Progress

3.3.3.6 Fish survey

On the fish survey days the team accompanied local fishermen while fishing, or while they checked their overnight nets. This happened for about 3 full days and 10 partial days throughout the 3 months spent in Khoe Kay. The team observed the fish species and asked the fish men how they fish and how do they know edible from inedible fish. Moreover, the questions were based on previous interviews and story telling. The fishermen were asked whether they knew the relationships between species, or the ecological niches occupied by each species. Again, the identification process for locals is similar to that employed by Western scientists because the local people identified the fish by checking out fish form, color, shapes, sizes, scales, fins, stripes, and mouth parts. Moreover, the breeding season is one of the main identification methods as well. The identification process should be similar from one village to another

3.3.4 Species Identification process

The identification techniques used by KESAN are different from the local villagers. Local villagers used their traditional identification methods and could identify species based on their own unique knowledge and their five senses.

3.3.4.1 Status determination Methods

The local status of vertebrates (common or rare) is determined by considering how many times the species is observed divided by the number of surveys (number of observations/number of surveys x 100%). If the result is less than 20% then the species is considered rare and more than 20% then it is common. Determining visitor or resident status is done by direct observation of changes over three months of observations, as well as interviews with the local villagers about when the species is seen during the year and information in field guides. Food source for each species is determined by the researches, and again interviews with local people and citations in field guides.

3.3.4.2 KESAN Species Identification Methods

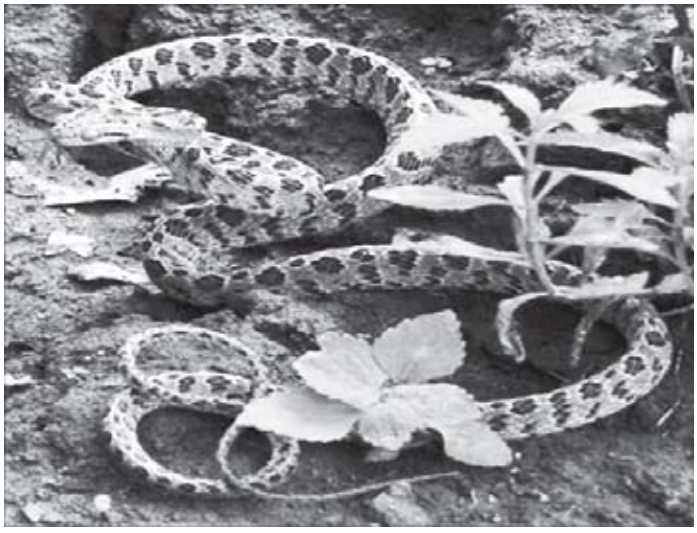


Figure 9 Cat Snake

KESAN used several methods to identify species, including guidebooks, referring to experts, local expertise, and the internet. Each technique is based on education, background and ethnicity. However, most people with university education and experience usually share common identification techniques. The primary method of identification is the use of pictures and descriptions in guidebooks.

[15] Full references to all species guides can be found in Appendix B

a. Birds

During this research we primarily used A Guide to the Birds of Thailand[15] ("Birds of Thailand"). We used the description of each species, such as appearance, taxonomic information, range, migration habits, voice and ecological habitat. Appearance was the primary indicator, with reference to color plates. We identified visitors and residents by using distribution maps. For the voices, sizes and habitats we referred to the description of the species. For species that were more obscure or harder to identify, we used internet searches, including the IUCN website, as well as other bird guides books such as Birds of Burma, Birds of Myanmar, and Birds of Southeast Asia. For one species we contacted Prof. Philip Round directly. We confirmed the conservation status for each species on the IUCN Redlist web pages.

b. Mammals:

Identification of mammals was primarily through A Guide To The Large Mammals Of Thailand. Indicators included colors, body part sizes, footprints, horns, tails, eyes and the area of each color part. Further, identification was assisted by the description of the animals' sound including tune and loudness. Similarly, the habitat and behavior of each species was compared with the book. Species were double checked using internet searches, especially Google and the IUCN Redlist.

c. Fish:

Fish were identified using Fishes of The Cambodian Mekong. Identification was based on the following: taxonomy, body parts such as fin number and size, head size, eye location, and tail shape and size. Fish pictures were sent to Dr. Chavilit of WWF, who along with his students assisted the fish identification process.

d. Reptiles:

The primary source for reptile identification was A Photographic Guide to Snakes and Other Reptiles of Peninsular Malaysia, Singapore and Thailand. Each species was identified by cross-checking the species description, appearance and ecological behavior. In addition, each species was double checked on the web site Herpetofauna of Myanmar.

e. Amphibians:

Amphibian identification was limited to frog species, also based on the Herpetofauna of Myanmar website. Further research into amphibians is certainly warranted.

f. Insects and Spiders:

Insect and spiders were identified by internet searches and the guide A Handbook of Interesting Beetles Of Thailand. We determined the species by order, such as *Homoptera* for cicada, *Hymenoptera* for bees, wasps and ants, *Phasmatoidea* for stick insects, and *Coleoptera* for beetles. The primary indicator for species identification was to look at the antenna forms.

g. Plants:
Trees were identified using A Field Guide to Forest Trees of Northern Thailand ("Forest Trees of Northern Thailand"). Indicators included fruits, flowers, barks, leaves types and leaves sizes. Other plants were identified with the help of Prof. J.F.. Maxwell of Chiang Mai University's herbarium. Prof. Maxwell was able to identify the vast majority of the species known by the locals, but a few species remain a mystery. See Table 5, Unknown Species.

Plant Collection Process

- Prepare some newspapers to hold the specimens.
- Take the plant's flowers, fruits, young leaves, and barks, or at least one of these samples.
- Put the sample into the newspaper and make it well packaged.
- Pour on some methyl alcohol (about 30 ml or more) to make sure that all the specimens are well soaked for preservation.
- Record and arrange the specimens by species names, than stack the species packages up in order.
- Put all the packages in a big plastic bag and make sure that the plastic bag has no holes to prevent dripping methyl alcohol.
- Check the plant packages two times per day to make sure that the specimens remain cool - if they get hot the plant specimens might decompose.
- Bring the specimens to laboratory as quickly as possible.

4 Results

4.1 Overview

The surveys performed by the research team and the local villagers represent the first comprehensive biodiversity study conducted on the lower Salween River. Most of the data is specific to the Khoe Kay area, obtained through line transects, local interviews and joint forest walks with local villagers and KESAN researchers. If the data is general to this bioregion orspecific to the rugged and remote Dawna Range, this is clearly stated in the text. The results of this report in brief include:

- Biodiversity: 194 species of plants and 200 species of animals identified by the KESAN research team and local villagers. Many of the locally-identified species have specific usefulness to the villagers.
- Endangered species: At least 42 species listed on the IUCN Red List[16] or the CITES Appendices[17] were identified in the study area. Many of these species are locally common, but if they are IUCN or CITES listed then they are referred to in this report as "endangered."
- The number of endemic plants in the area is approximately what is predicted by species-area relationships, such as those found in Ovadia (2003). However, the number and rarity of endemic vertebrates is still not well understood. In this report only endemic fish have been identified, and these fish are highly migratory within the Salween basin, which is much larger than Khoe Kay.
- Of the total of 394 species observed and categorized in this study, only 24 species could not be assigned Latin names. (Most of these were, however, locally familiar.) This can perhaps be explained by shortcomings in the methodology (e.g.

[16] Species are classified as Extinct, Extinct in the Wild, Critically Endangered, Enangered, Vulnerable, or Near Threatened. See www.iucnredlist.org for complete information and species lists.

[17] There are 3 CITES Appendices, I, II, and III, representing decreasing threat of extinction. Appendix I species are generally forbidden from commerce. See www.cites.org.

insufficient contacts with the appropriate experts), but is also intriguing and begs further research into possible endemism.

- Ecosystem health: The study found that disturbances to the forest appeared less than in either adjacent areas of Thailand or in downstream areas of Karen State, where logging, rotational cultivation and hunting have taken a greater toll on the ecosystems. Along the Khoe Kay area rope transects, teak was by far the most common tree, with trees a meter in diameter the norm.
- Terrestrial and aquatic ecosystem linkages. The Dawna Range and the Salween River are both oriented north south and parallel each other. Khoe Kay is positioned between the two, offering intriguing observations and stories about fauna from ecosystems of both types of physical terrain, including physical and anecdotal evidence of megafauna like tiger, gaur, and even rhinoceros. Further research is acutely required for both these remote and biodiverse terrestrial and aquatic environments.

Overall, 394 species were observed and categorized. This represents a tremendous genetic patrimony for the people of Khoe Kay. One of KESAN's major objectives is to prevent the loss of this diversity and patrimony.

Although this report does not seek to describe each observed species in detail, the complete tables of species by taxon can be found in Appendix A, with additional information on behaviour, habitats and locations. This results section focuses on the most significant findings of the surveys, with particular attention paid to diversity, the underlying stabilizer of any ecosystem.[18]

4.2 Forest types

The research site is a lightly populated area of ethnic Karen villages located near tributary streams on the west bank of the Salween River. The land is rugged and forested, with little flat land for farming or habitation. To the west of Khoe Kay is the remote and sparsely populated Dawna Range. To the east is the Salween River, and beyond that, Thailand.

The landscape is diverse, with forest types determined mainly by available moisture. The climate is monsoonal, with warm moist winds arriving with rain from the west between May and October, the rainy season. The rest of the year is divided into the Cool Dry and Hot Dry seasons, when there is little rain. Moisture retention is determined by several factors, including altitude, slope and aspect. Generally speaking, sites are moister along the river and tributaries, and in the highlands approaching 1000 meters above sea level (MASL). Furthermore, east and north

[18] "The evidence that has emerged from microcosm experiments, regardless of scale and system type (that is, terrestrial or aquatic), has tended to agree that diversity is positively related to ecosystem stability." McCann, K. The diversity–stability debate. Nature 405, 228-233 (11 May 2000).

facing slopes tend to retain moisture better than slopes facing other directions, as do concave and gently sloping hillsides. Extremely steep hillsides of medium altitude (300-700 MASL) are home to the driest and least productive forests of the area.

Such characteristics of the climate and terrain divide the region into four general but intermingling types of forest. From the lowest to highest elevation, these are: lowland evergreen, mixed deciduous, dry dipterocarp deciduous and montane evergreen. These are explained in more detail immediately below. The two types of deciduous forests are also associated with annual ground fires, the dry dipterocarp deciduous forest being the most resistant to fire and drought and thus dominates the most inhospitable terrain of the region.

In general, it can be said here that forest disturbance is less significant than other areas in the region, but it is still substantial. This will be dealt with in greater detail below, but the two most important causes of disturbance in recent decades are logging and rotational cultivation. The logging is largely restricted to mixed deciduous forests – teak habitat – and cultivation to the montane evergreen forests (the latter were largely located outside the study site). Areas where logging has been significant include a high proportion of bamboo species, many of which are robust pioneer species.

The structure and composition of the forests differs by type. For instance, the remnant lowland evergreen forests found along streams and the Salween mainstream are similar to rainforests, with complex strata and high species diversity. On the opposite end of the spectrum, the dry dipterocarp deciduous forests are poor in both structure and species, though they are said to be important habitat for grazers, due to the production of grass and other species of the herb layer. In the more productive types of forests, the sub-canopy is comprised of many species of woody climbing plants, rattans and epiphytes.

In terms of distance from the Salween mainstream, the forest type distribution was thus: The mixed-deciduous forest started from 0 meters beside the river bank to a 400 meter distance. Bamboos were common among the mixed-deciduous forest. From 400 meters to 700 meters, the transect entered the dipterocarp forest. Again from 700 meters to 900 meters were mixed-deciduous forests. From 900 meters to 1000 meters or more, montane evergreen forests dominated.

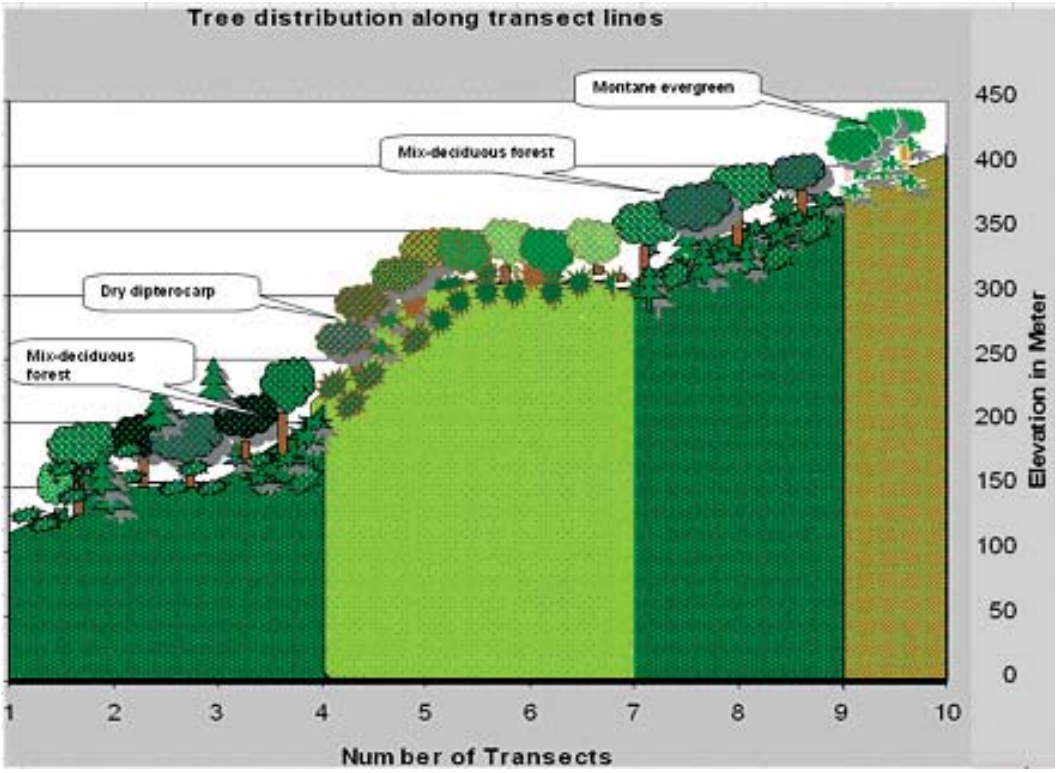


Figure 10 Forest Type Distribution. Note: Since each transect is 100 meters, the Number of Transects can be easily converted to distance from the Salween River, where each transect started.

4.2.1 Lowland Evergreen[19]

This is the most productive but least common forest type in the area. In lowland areas of Thailand and Burma, these forests have largely been converted to wet rice paddies. In the Khoe Kay area, lowland evergreen forests are mainly found in so-called gallery forests, along streambeds and the river. This forest type is home to the tree giants, emergent trees like *Tetrameles nudiflora* and *Dipterocarpus costatus,* which can reach heights of 35 meters and provide habitat for honey bees. The species composition, including many palms and rattans, is extremely rich, but the rope transects did not follow the streambeds and thus did not record many tree species from this forest type.

[19] "Moist" or "gallery" evergreen forests, Forest Trees of Northern Thailand, p. 11.

4.2.2 Mixed Deciduous[20]

The tropical mix-deciduous forest type changes color based on three seasons: cool dry, hot dry, and rainy. Trees begin to shed their leaves in the late cool season,from December to February. The forest looks dry during the hot dry season from March and April. Then, tree leaves again turn green starting in late April, and continuing through the rainy season from May to November.

In this forest type, plants have thinner barks, and the forest layers are more distinct. At least four layers are recognized in this type of forest. The soil is fertile, drying up in dry season but quite moist in rainy season. Disturbed mixed-deciduous forest has many bamboo species in the sub-canopy. Teak trees dominate the forest canopy while other trees are co-dominant. Other high-value timber trees like *Pterocarpus macrocarpus (Burmese: padauk)* and *Xylia xylocarpa (Burmese: pyingado)* are found in the canopy layer but they are not as abundant as teak. Most plants shed their leaves in winter, but several tree species are evergreen.

Secondary mixed-deciduous forests can be identified by the many bamboos in the area.[21] In some places, such as the community-prohibited area, bamboo is rarely seen. Therefore, it may be concluded that the primary mixed-deciduous forest has less bamboo while the secondary forest has many bamboos species.

4.2.3 Dry Dipterocarp Deciduous[22]

Most plant species in this kind of forest have thick bark and shed leaves during winter. The English, Burmese and Thai names for this forest are all derived from the fact that a few species of the family Dipterocarpacea dominate the landscape. The most common species are *Dipterocarpus tuberculatus* (large leaves used for roof thatch); *Dipterocarpus obtusifolius*; *Shorea siamensis* (whose leaves turn red before they are shed and give the hills the color of a Northern autumn landscape); and *Shorea obtusa*. The forest contains poor soil with stony ground. The plants have less variety; only species with similar attributes tend to be found in the area. Canopy and ground layers can meld with the other forest layers, makiing them less obvious. For example, the ground layer is grassy,[23] appearing green only in rainy season but drying up in winter. The canopy lacks emergent tree species. Bamboo is present in the area only in rare cases. Barking deer seem to be the dominant grazing species in this type of forest, based on foot prints observed by team workers. One edible mushroom species, Earthstar or *Astraeus hygrometricus,* is found

[20] Birds of Burma, p. xxx; Birds of Thailand, p. 9; "deciduous/bamboo forests" in Forest Trees of Northern Thailand, p. 12.

[21] Trees of Northern Thailand at p.12; Birds of Burma at p.xxxi.

[22] Referred to as such in Forest Trees of Northern Thailand, p.12, as well as in Birds of Thailand, p. 9, in which it is also called "savanna forest." Birds of Burma uses the name "Indaing Forest" p. xxxi.

[23] Birds of Thailand at p.9; Birds of Burma at p.xxxi.

exclusively in this kind of forest. It is found mostly in May and June, and it is sold at a high price in Thailand's fresh markets.

Only primary dipterocarp forests are found in the Khoe Kay area due to the infertile soil; there are no secondary forests of this type in the area. Once this forest is cut reestablishing trees is difficult, and farming is therefore incompatible with rotational agriculture. Thus the Karen have learned to leave this forest type alone.

4.2.4 Montane Evergreen[24]

This forest occurs above 900 meteres in Khoe Kay, and does not shed leaves all at once in the dry season, but rather, maintains a green color year-round. Species of the *Fagacae* family are common, including oaks and chestnuts. The forest structure is relatively complex, with at least four layers of forest. The soil is fertile and holds moisture better than dry dipterocarp and mix-deciduous soils. The canopy is dominated by oak species, and the subcanopy includes woody vines and smaller trees such as *Meaesa ramentacea* and *Wendlandia tinctoria*. Ground cover is made up of ginger and *Brainea insignis* species. *Schima wallichii* and *ficus* are most often seen as emergent tree species. The forest attracts bear and wild pigs, especially in September and October when acorns are ripe.

Primary montane evergreen forest – undisturbed by rotational cultivation – can be identified by the presence of certain species. The primary forest has many fern species at ground level. Also, there area many mosses on the oak trees on the upper parts of branches. However, the secondary forest lacks ferns on the ground. Instead, evergreen secondary forests are noted for certain kinds of ginger species and the lack of mosses on the trees.

[24] Birds of Burma, p. xxx; "Hill Evergreen" in Birds of Thailand, p. 10;

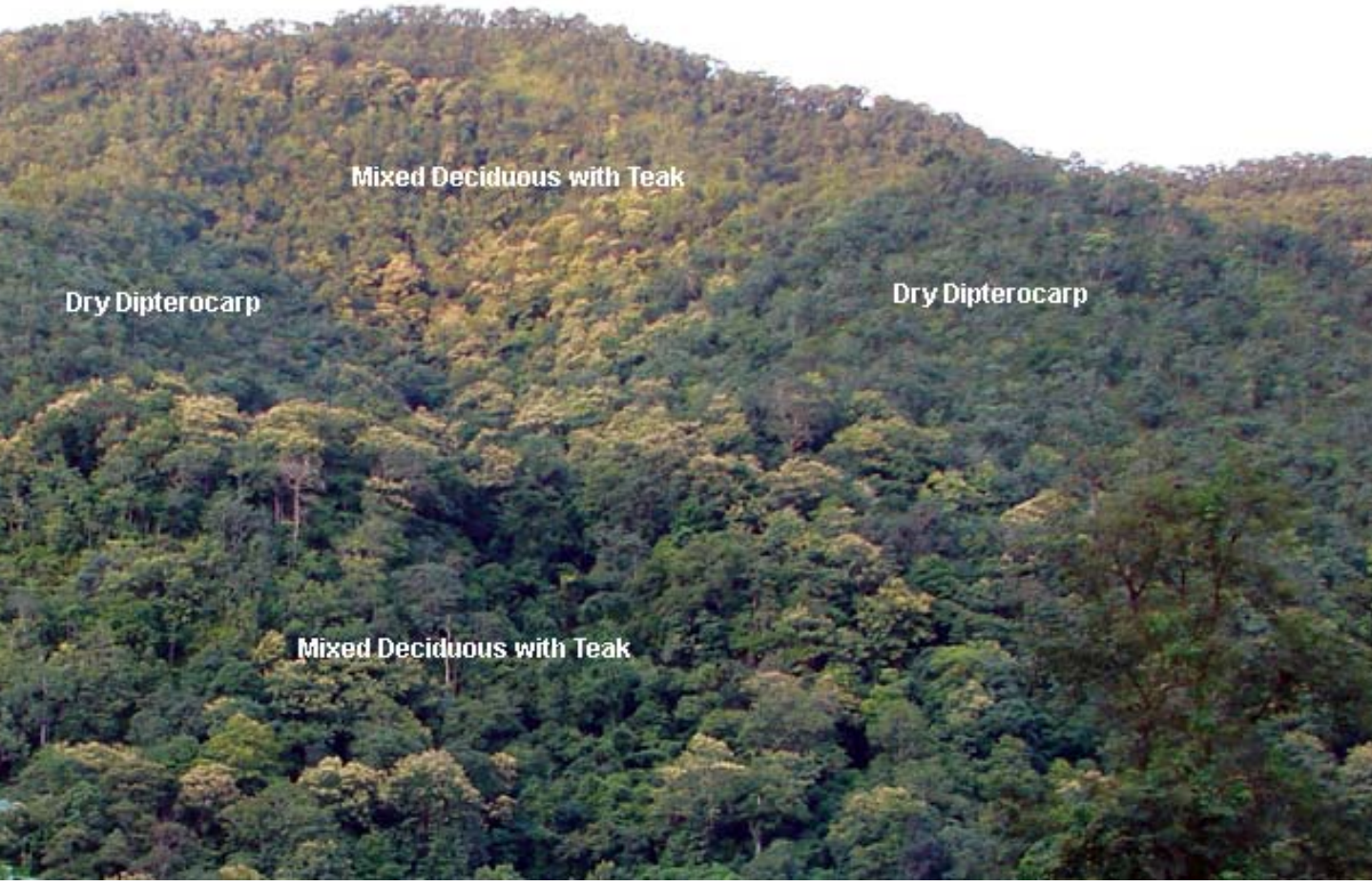


Figure 11 – Forest Type Distribution on the Mountainside
Figure 11 shows the distribution of the forest types in a lower-elevation section of hills. The forest types in this area can be identified from a distance by the flowering teak trees of the mixed deciduous forest. These are generally located at lower elevation and in less steep and concave terrain. The top and bottom show the white tinge of the mixed deciduous forest, while the middle and sides show the darker leaves of the dry deciduous dipterocarp forest, which tend to dominate on steeper and more exposed convex slopes. This does not mean that the Dipterocarp do not flower, but rather the different trees flower at different times throughout the year.

4.2.5 Forest Disturbance[25]

Forest disturbance to date has primarily been caused by logging and rotational cultivation, though fire has probably had a more fundamental impact historically in the distribution and condition of forest types. Logging is more important in terms of disturbance in the mixed deciduous forest, and rotational farming in the montane evergreen forests. In some areas, the influx of thousands of refugees has also had a profound local impact as forests were cleared for occupancy and agriculture.

[25] Called "Ponzo" in Birds of Burma at p.xxxii; "Farmland" in Birds of Thailand at p. 11.

Logging of the valuable teak forests has occurred at various times in history, with the most recent episode in the early 1990s, after cooperation between the Burmese and Thai governments put pressure on the KNU to grant timber contracts to Thai companies. These were select logging operations in the Khoe Kay area, restricted to teak trees one meter in diameter or larger. Although there was no clear cutting, the logging was not harmless: significant logging debris increased fire danger, and torrents of logging waste in local streams had a deleterious effect on aquatic ecosystems. Today, large trees are still common, and trees up to two meters wide are still found in the mixed deciduous forests, but the forest is still recovering from the effects of logging.

Contrary to popular and some officials' belief, the Karen do not traditionally practice rotational cultivation, or taungya, in teak forests. The Karen believe that the smell of burning teak is bad for human health, while the soils of such forests are far inferior to the humus-rich evergreen forest soils. To an even greater extent, the dry dipterocarp deciduous forests are considered unsuitable for farming. Shifting cultivation, and the resulting patches of secondary forests with trees under ten years of age, is sited in the montane evergreen forests, an area largely beyond the scope of the 1,000 meter rope transects.

Fire is common every year to both types of deciduous forest, but catastrophic crown fires are rare. The annual fires are generally ground fires and do not destroy the standing timber. The Karen villagers said that several decades ago, when the local leadership was stronger and more autonomous, such fires were prohibited. KESAN community forestry initiatives discourage the use of fire in forest management.

4.3 Plant Diversity

Table 1 indicates the diversity of plant species, while Figure 9 shows the abundance distribution of plants in the area as determined by the transect study, from most common to rarest. Unfortunately, some of the species could not be identified, so they were categorized as Unknown.

Table 1 – Plant Diversity

PLANTS – 200 Total Species Identified
83 Trees
16 Woody Vines
17 Shrubs
27 Herbs/Edible weeds, including Bananas
13 Bamboo, Palm and Rattan species
28 Ferns and Orchids
10 Mushrooms

The Khoe Kay forests show immense diversity, similar to Thailand's Khao Yai National Park.[26] At least 89 tree species are present, from the understory to the canopy, providing the structural backbone for the other plant and animals species. The shrub layer includes 15 shrubs, as well as 13 bamboo, rattan and palm species, so that the middle layer of the forest provides substantial resources to the ecosystem. Some 29 herbs and edible weeds occupy the ground layer, as well as 15 mushroom species. Epiphytes occupy nooks and branches in the shrub and canopy layers, while climbing from the ground to the canopy are 16 woody vines. Overall, in the less-disturbed sites, the plant species inhabit the forest from the ground to more than 25 meters, and provide food, water, shelter and other necessities to the animals that occupy the forest.

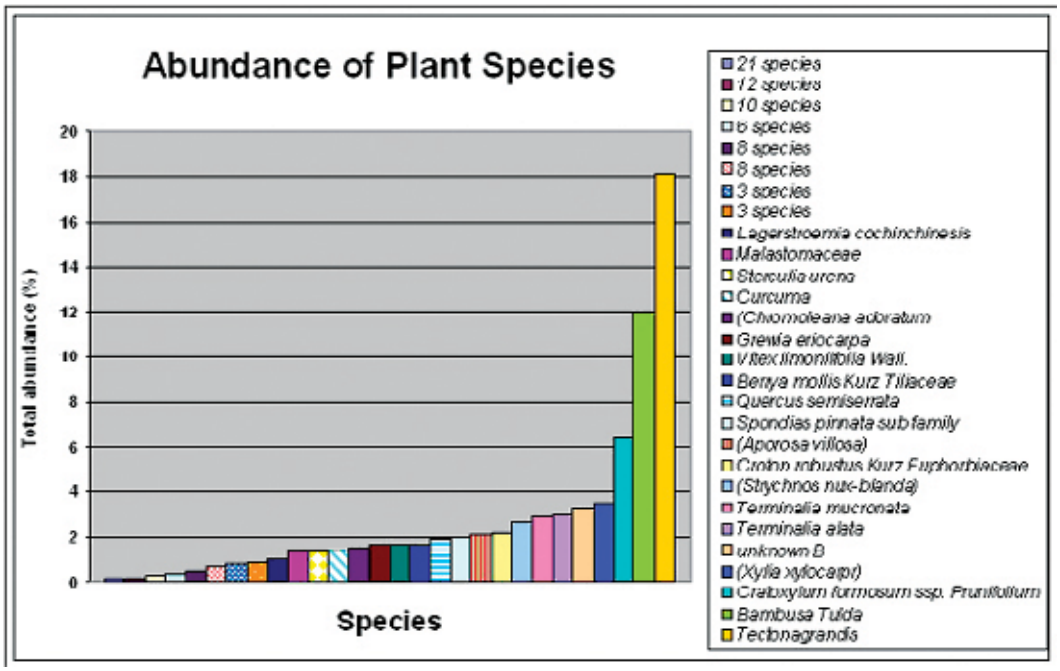


Figure 12 – Plant Abundance Distribution Least to most abundant. Teak and bamboo are most abundant.

4.4 Useful species

Local Karen villagers say they have been living in the forests of Khoe Kay for hundreds of years. Therefore, it is not surprising that many of the species identified in this research are used on a daily basis to improve their livelihoods. Plants and animals in the forest provide a wide variety of medicines, foods and building and weaving materials to the local people. Moreover, many of these useful species have

[26] A World Heritage site where the lead author did research during his undergraduate studies. http://whc.unesco.org/en/list/590

been introduced to the entire world, including modern medicine, which has studied several of the species in a laboratory setting to prove their usefulness. The Table of Plant Species in Appendix A includes specific information and citations about known uses of some species.

Of the 200 plants species identified, at least 35 have medicinal uses, including 16 trees, 6 vines, and 9 herbs. Twelve of these species have been the subject of published peer-reviewed scientific articles. Medical uses studied include antimicrobial, antifungal actions, treatment of malaria, wound healing, T-cell stimulating, tumor and skin treatment, diabetes treatment, extract for eyedrops, and liver protection from alcohol poisoning. Thus, the Khoe Kay forests provide an abundance of plants that promote human well-being, and there are certainly more of these medicinal species waiting to be discovered by modern medical science.

The list of food species is just as diverse. There are a multitude of ginger species that are used in curries, many of which also have medicinal properties. There are also several woody vines that produce nutritious foods, such as the fruit of the *Gac* vine, (a favorite in Vietnam) which is high in fatty acids, carotene and lycopene; there is also an edible wild yam that grows as a vine. In addition, several rattan, palm and bamboo species have edible young shoots, and these species are highly abundant. Two ferns are edible when prepared properly, and several mushroom species are much sought after for their culinary properties.

There is also an abundance of plant species that provide building and weaving materials. In their practice of rotational agriculture, the Karen traditionally build their houses out of bamboo, which decays after 3 years. Then, the Karen in Khoe Kay would move to their next site and build a new bamboo house there. According to their Animist religious beliefs, the Karen in Khoe Kay are not allowed to build wood houses. As a result, they make great use of the abundant bamboo, rattan and palm species, which provide many different sizes and strengths to provide for house construction, baskets and nets of any size, clothing, roofing material, etc. Some Karen use teak and other hardwoods for carving, crossbows, and other uses.

The wildlife of the area also provides humans with many opportunities for resource use. Wild bees provide significant amounts of honey, and the abundant wildlife keeps hunters (and poachers) busy, providing an essential part of the Karen diet. Further, bird feathers are used to fletch arrows for hunting, and banteng and guar horns provide trumpets for traditional ceremonial uses (it is strictly prohibited by the KNU to kill bateng and guar – their horns are only obtained when the dead animal's horn is discovered in the forest). Finally, the ecosystem itself serves humans by providing fresh water and fertile soil. Of course, there are other benefits, such as provided by bats and fish, who eat mosquitoes and their larvae.

Finally, given the diversity and health of the ecosystem, as well as the relatively low endangered species ratios (see below, Section 4.7.1). Animals living in the

Khoe Kay forest also seem to find all they need in their surroundings. Whether it is a bamboo rat or bird making a nest, or a linsang hunting for its meal, there is no shortage of niches available to the plethora of species, and as currently constituted, the ecosystem is abundant and resilient.

4.5 Aquatic Habitats

Ecological niches are dependent on the forest, streams and river of local areas. Fresh water ecosystems are located mainly in the Salween River and in small streams along the Salween valley. There are many streams in the Khoe Kay area and all the streams flow into the Salween Rivers. There are more than ten streams and many small ravines along the Salween River bank where the research was conducted. Some streams are itinerant, drying up during the dry season, while others run year round. The streams host many species, especially frogs, and normally each has many waterfalls and cliffs. Fish are common in all streams in the sites but most fish are small. Normally every stream has a marshy area at its mouth.

The streams are tropical and are rich in fish diversity and aquatic life, but a comprehensive study of aquatic biodiversity is beyond the scope of this study. Most species in the Salween valley streams are smaller and less varied than in the mainstream Salween River. Some streams have swamps or wetlands beside them. Most of the species in the swamp area are frogs, eels, crabs, tadpoles and some dragon fly larvae. These kinds of swamps maintain a high water value so there may be a variety of different niches in them. At the sources of the streams logging is forbidden, and these areas remain in pristine condition. Therefore, most of the headwaters areas are preserved until the present day. The majority of the fish species in the streams are insectivores but some consume small fish too. Other fish prey on mosquito larvae, small insects and plants.

The health of the Salween River corridor can be measured by the number and diversity of species found observed by KESAN (394) and others. Besides this survey, Dr. Chavalit of WWF identified 170 fish species, of which 60 are considered endemic.[27] Thus the Salween is not only diverse; it also exhibits a well-evolved and unique fish population.

Catfish and carp species seem to dominate KESAN's results, but there are also loach and eel. One shortcoming in this report is the lack of surveys for non-fish aquatic species, such as mussels, crayfish, and aquatic insect larvae. In any event, the high level of endemicity is an excellent indicator of ecosystem vitality, but with the impending dam-building frenzy, the river is at great risk of losing these unique species.

[27] Salween dams "will push up electricity costs", Bangkok Post, March 7, 2006 http://www.terraper.org/media_view.php?id=54, Accessed April 20, 2008.

The Salween River near Khoe Kay is special because the level of fishing is low, due to the low surrounding human population. Another factor is that fishing is only a part-time endeavor for the Karen people, who spend most of their time farming. Therefore, the aquatic diversity remains intact, and provides a window into what the other Southeast Asian rivers were like before industrial development, such as the Mekong and Chao Phraya.

4.6 Animal Diversity

4.6.1 Overview

The Khoe Kay area's forests and streams provide ample habitat for a wide variety of animal species, and over millions of years, several endemic species have evolved. Table 2 indicates the breadth of Animal Diversity, focusing on Mammals. From this table, it can be seen that several types of species, such as deer, porcumpines and bats, have a multiplicity of niches available. Unfortunately, encroachment by humans has forced several animal species toward endangerment and extinction.

Table 2: Animal diversity. For details, see Appendix A, Animal Species Table.

MAMMALS – 39 Total
Ground Dwellers
2 deer: Red and Fea's muntjac
Goral: Long tailed
2 porcupines: East asian and Asiatic brush-tailed
Eurasian wild pig, Dhole
2 rats: Cave and Farm dwellers
3 Bamboo rats: Large, Hoary and Bay
Hog Badger
2 Bears: Asiatic Black and Sun
2 Pangolin: Sunda and Chinese
Tree Dwellers
Eastern Hoolock Gibbon
3 Monkeys: Phayre's langur, Rhesus macaque, Assamese macaque.
Banded linsang
2 Civets: Common Palm and Large Indian
Slow Loris: Active only when windy
3 Squirrels: Pallas', Northern tree shrew, Three Striped Ground
3 flying squirrels: Phayre's, Indian Giant and Red Giant
Cave dwellers: Bats
2 in Ker Waw Pu cave, Bear-head and Rat-head
3 in Khoe Kay cave

OTHER ANIMALS

66 Bird species
20 Reptile and Amphibian species
32 Fish Species
35 Insect Species
4 Spider species (Note: No spider-specific survey, observed during other surveys.)
2 Other species (Scorpion and Snail)

4.6.2 Endemism

Endemism refers to species that are located in only one place. Defining endemism for an area like Khoe Kay is challenging. The area is not completely isolated from adjacent areas. On the other hand, located on a large oxbow of the deep and fast-moving Salween, and being a rugged hilly area deeply dissected by many streams, endemism in the area cannot be ruled out and should be further researched.

The research site is an area in which terrestrial species can easily migrate through. This fact is confirmed by the existence of least eight such "visitor" species (including Fea's muntjac and Eastern Hoolock gibbon, for example). Furthermore, the area is bordered by the Salween River, which is a migration corridor for a host of fish and other aquatic species. Thus, an "endemic" species probably has a range far beyond the immediate Khoe Kay area. This is certainly true of the eight fish identified by Dr. Chavalit of WWF that are believed to be endemic to the Salween River and its tributaries found in Table 3; all of these common species were identified after being caught by fishermen. This is probably true as well for the three unidentified fish species. There are about twenty other unidentified species that should be studied for evidence of endemism.

Table 3 – Endemic Fish Species Found by KESAN
(See Appendix D for pictures.)

ENDEMIC SPECIES - FISH	
Species – Local Name	Latin Name (source)
Subfamily Cyprininae – Systomini	*Mystacoleucus argenteus* (Day 1888)
Subfamily Cyprininae – Poropunti	*Hypisbarbus salweenensis* (Rainboth 1996)
Plaa King (Thai)	*Chagunius baileyi* (Rainboth 1986)
Family Cobitidae Loach	*Botia rostrata* (Gunther 1868)
Family Bagridae Bagrid Catfish	*Aoriichthys seenghala* (Sykes 1841)
Bagrid Catfish	*Mystus cavasius* (Hamilton 1822)
Family Schilbeidae Schilbeid Catfish	*Clupisoma pratteri* (Hora 1937)
Blackfin Sisorid-catfish	*Gagata dolichonema* (He 1996)

Source: Southeast Asian International Rivers Network (SEARIN); see http://www.searin.org/Th/SWD/sw_tb_book2sum_en.pdf; or write SEARIN at riversiam@csloxinfo.com.

It is possible to compare the number of potentially endemic species found by KESAN to previous research on the Indo-Burman bioregion. Ovadia (2003) provides data on the number of endemic plants and vertebrates for several global hotspots, including Indo-Burma, Brazil's Atlantic Coast, and Polynesia and Micronesia. Khoe Kay has an area of about 90 sq.km, If we assume that our unknown species (Table 5) are endemic, then there are two endemic plant species in the Khoe Kay area, which agrees reasonably with Ovadia's 7.0 plant species per 100 sq.km.

However, the same comparison does not work well for vertebrates, especially when fish are included. With the unknown species, the KESAN team identified 12 vertebrates that are either proven or potentially endemic to the Salween Basin. Ovadia provides a value of 0.5 /100 sq.km. for Indo-Burma. This indicates that the Khoe Kay area is not isolated enough (i.e. animals migrate in and out) to define endemism with sufficient certainty to provide valid results. This is especially true for the fish species, which currently migrate up and down the Salween River and tributaries, and make up the vast majority of species identified as endemic.

4.7 Endangered Species

The Khoe Kay area is home to at least 41 endangered species, of which 20 species are on the IUCN Red List of Endangered Species, including 11 mammals, 2 birds and 3 herptiles. The endangered species also include 32 found in the Appendices of the Convention on International Trade in Endangered Species (CITES). All of these species are dependent on the forest for survival, and their endangerment is directly linked to the loss of forest habitat. Past logging has increased the danger to these species, and proposed dam building will exacerbate the problems faced.

An obvious omission from this list of endangered species is data on aquatic species. This is not to say that aquatic species are not in peril. Rather, the freshwater aquatic species of Southeast Asia lack comprehensive scientific study, so that the conservation status of these species has not been properly determined. According to Prof. Chavalit Witdhayanon, an aquatic biologist with WWF, there has been no study or research specifically investigating the declining stocks of fish in the Mekong river. "Such research takes time, manpower and a lot of budget," Chavalit told the Bangkok Post.[28] Scientific knowledge of the Salween River is even more lacking, given its more isolated and less developed state and ongoing conflict in the area. This is apparent from the sixty recently discovered endemic species in Salween and

[28] "Mekong yielding diminishing returns" Bangkok Post, January 26, 2003.

tributaries.[29] Further field and laboratory studies of Salween River aquatic species are necessary to determine what species are endangered, and how they can be conserved. In addition, educating the local people about aquatic species and habitat conservation would contribute to these species' survival.

4.7.1 Endangered Species Ratio and Ecosystem health.

One possible measure of ecosystem health is the ratio of endangered species to total species,

R = (# of Endangered Species)/(# Total Number of Species).

Areas with a high ratio indicate that many species are endangered and the ecosystem itself is at risk. On the other hand, if the ratio is low, then the underlying ecosystem is providing each species with its necessities, and the system is healthy.

The KESAN research team has reviewed the available information concerning this ratio for a number of taxa in three places, Slovenia (46 degrees north latitude, in a temperate zone; data for two years available[30]); South Africa (29 degrees south latitude, a dry subtropical area[31]); and South Australia (30 degrees south latitude, also generally dry subtropical[32]) and compares this information with their observed data on Khoe Kay (tropical, 18 degrees north).

[29] "Chavalit Vidthayanon, head of World Wildlife Fund Thailand's Marine and Freshwater Unit, voiced concern about the ecological impact of the dams. The Salween, which flows for more than 2,000km from the Himalayas, has a diverse ecosystem that supplies food to millions of people in the region, he said.
According to a study by Prof. Chavalit, at least 170 fish species inhabit the river, of which 60 are endemic species. The proposed five-dam mega-project would devastate fish habitat, he said, sharp decreasing the fish populations on which people along the Salween rely."
Salween dams 'will push up electricity costs' Bangkok Post (Eng) March 07, 2006

[30] Data online at http://kazalci.arso.gov.si/kazalci/index_html?lang=1&Kaz_id=10&Kaz_naziv=Ogro%C5%BEene%20vrste&Sku_id=1&Sku_naziv=NARAVA%20IN%20POVR%C5%A0JE&tip_kaz=1.

[31] Data in South Africa National Biodiversity Strategy and Action Plan, Ch. 4, pp. 60-61

[32] Data online at http://www.environment.sa.gov.au/reporting/biodiversity/speciesthreats/noofextinct.html.

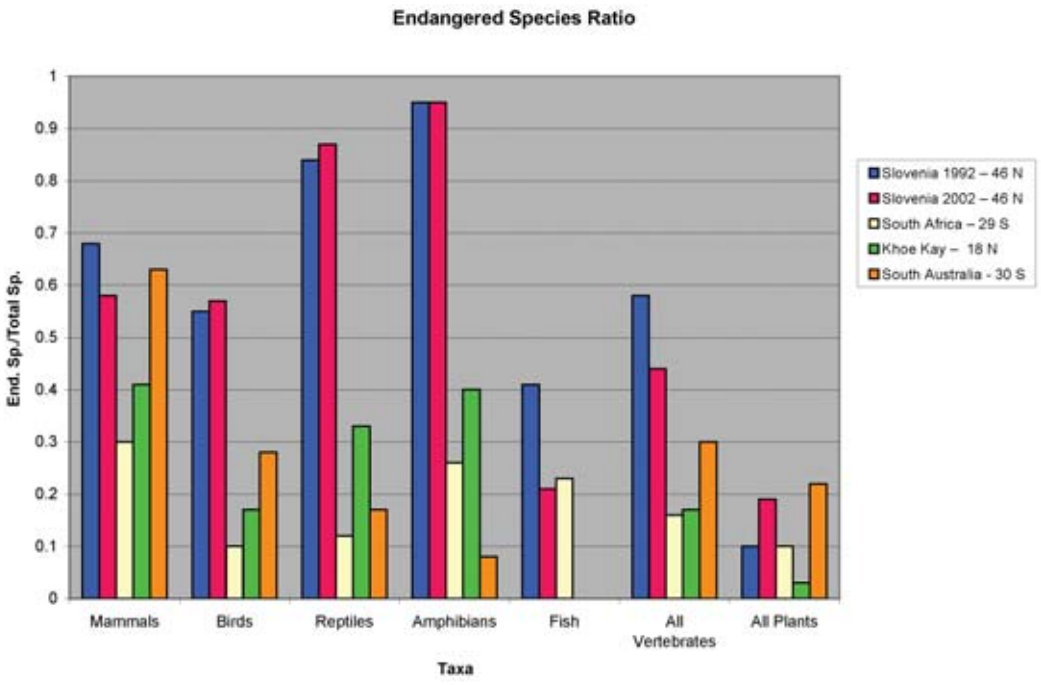


Figure 13 – Endangered Species Ratios for Khoe Kay and Other Places

Looking at these results, the Khoe Kay area has a relatively low ratio of endangered species. There are at least two possible reasons for this. First, the limited resources and time for this research probably mean that there are still many unrecorded species. For example, in all of these places the endangered fish ratio is significantly lower than the ratio for terrestrial taxa. Moreover, both Khoe Kay and South Australia lack any data on endangered fish. This indicates that it is likely that many freshwater habitats are under-surveyed and the status of many fish species remains unsettled.

Second, Khoe Kay is both smaller and far less developed than the other places, and exists in a far more robust tropical ecosystem. Therefore, it is possible that the lower endangered species ratio does in fact mean that the ecosystem is in better health. If this is the case, and more study would contribute to this understanding, then this relatively intact ecosystem deserves to be conserved for its biological diversity, which is increasingly rare in the rapidly developing world.

Table 4 - Endangered Species (Either IUCN Red List or CITES Appendices)*

Animal Species – Common or Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status (Local, Global)
MAMMALS					
Serow	*Capricornis sumatraensis* (Bechstein 1799)	Wild goat	Cave Cliffs	From hunter	Common IUCN VU, CITES Appendix I
Long-tailed Goral	*Naemorhedus caudatus* (Milne-Edwards 1867)	Wild goat	Cave Cliffs	From hunter.	Common IUCN VU, CITES Appendix I
East Asian Porcupine	*Hystrix brachyura* (Linnaeus 1758)	Porcupine	Burrows, Forest	Burrows, foot print and from hunter	Common IUCN VU
Asiatic Black bear	*Ursus Thibetanus* (Cuvier 1823)	Bear	Forest, caves	Habitat	Common IUCN VU, CITES Appendix I
Sun Bear	*Ursus malayanus* (Raffles 1821)	Bear	Forest, caves	Habitat.	Common CITES Appendix I
Eastern Hoolock Gibbon	*Hoolock leuconedys* (Mootnick and Groves 2005)	Gibbon	Forest	Loud vocalization	Rare IUCN VU, CITES Appendix I
Rhesus Macaque	*Macaca mulatta* (Zimmermann 1780)	Monkey	Forest	Binoculars, vocalization	Hunted to near extinc-tion IUCN NT, CITES Appendix II
Assamese Macaque	*Macaca assamensis* (McClelland 1840)	Monkey	Forest, especially rocky areas.	Observed, Vocalization.	Common, IUCN VU, CITES Appendix II
Phayre's Langur	*Trachypithecus phayrei* (Blyth, 1847)	Monkey	Forest	From hunter.	Rare CITES Appendix II

* For information about these lists, See www.iucnredlist.org and www.cites.org/eng/app/appendices.shtml. EN = endangered; VU = vulnerable; NT = nearly threatened

Animal Species – Common or Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status (Local, Global)
Slow loris	*Nycticebus coucang* (Boddaert 1785)	Loris	Forest	Observed directly, especially when wind blowing.	Common CITES Appendix I
Dhole	*Cuon alpinus* (Pallas 1811)	Wild Dog	Forest, travels in packs	Footprints, hunter information.	Uncommon, IUCN EN
Eurasian otter	*Lutra lutra* (Linnaeus 1758)	Otter	Salween River	Sound, stools	Common IUCN NT, CITES Appendix I
Sunda pangolin	*Manis javanica* (Desmarest 1822)	Pangolin	Forest	Burrow, from hunter	Common IUCN NT, CITES Appendix II
Chinese pangolin	*Manis pentadactyla* (Linnaeus 1758)	Pangolin	Forest	Burrow, hunter	Rare IUCN NT, CITES Appendix II
Banded Linsang	*Prionodon linsang* (Hardwicke 1821)	Linsang	Forest	Preys on villagers' chickens.	Common CITES Appendix II
Common Palm Civet	*Paradoxurus hermaphroditus* (Pallas 1777)	Civet	Forest		Common, CITES Appendix III
Large Indian Civet	*Viverra zibetha* (Linnaeus 1758)	Civet	Forest	Smell, foot print and stools.	Common, CITES Appendix III
Blah Khay Hairy-faced bat	*Myotis annectans* (Francis 1996)	Bat	Khoe Kay village cave	Directly observed with torch light in caves.	Common, IUCN NT
BIRDS					
Great Hornbill	*Buceros bicornis* (Linnaeus 1758)	Bird	Forest	Sound.	Rare IUCN NT, CITES Appendix I

Animal Species – Common or Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status (Local, Global)
Oriental Pied Hornbill	*Anthracoceros albirostris* (Boosong Lekagul 1991)	Bird	Forest	Sound	Rare CITES Appendix II
Rufous-collared Kingfisher	*Actenoides concretus* (Temminck 1825)	Bird	Stream banks	From hunter	Rare IUCN NT
Black-Backed Forktail	*Enicurus ruficapillus* (Temminck 1823)	Bird	Stream	Stream side on Rock	Fairly common IUCN NT
Common Hill Myna	*Gracula religiosa* (Linnaeus 1758)	Bird	Forest	Feeding on the ficus fruit.	Common CITES Appendix II
Grey-headed Parakeet	P*sittacula finschii* (Hume 1874)	Bird	Forest	On dead tree.	Hunting prohibited locally CITES Appendix II
Spot-bellied Eagle-owl	*Bubo nipalensis* (Hodgson 1836)	Bird	Forest	From hunter.	Hunting prohibited to control rats, CITES Appendix II
Spotted Owlet	*Athene brama* (Temminck 1821)	Bird	Forest	On tree.	Common CITES Appendix II
Little Egret	*Egretta garzetta* (Linnaeus 1766)	Bird	Salween River and sbanks	On tree beside Salween River.	Common CITES Appendix III
Oriental Bay Owl	*Phodilus badius* (Horsfield 1821)	Bird	Forest	From hunter	CITES Appendix II
White Bellied Woodpecker	*Dryocopus javensis* (Tristan 1879)	Bird	Forest	On dead tree	Common CITES Appendix I
REPTILES					
King Cobra	*Ophiophagus hannah* (Cantor 1836)	Snake	Beside stream	On the ground stream side	Unknown CITES Appendix II

Animal Species – Common or Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status (Local, Global)
Reticulated python	*Python reticulates* (Schneider 1801)	Snake	Bank of Salween River	Catch with fish men net	Common CITES Appendix II
Yellow or Elongate Tortoise	*Indotestudo elongata* (Blyth 1853)	Tortoise	Forest close to stream	Beside the stream	Uncommon IUCN EN, CITES Appendix II
Southeast Asian Soft Shelled Turtle	*Amyda cartilaginea* (Boddaert 1770)	Turtle	On the stream and Salween River	Caught with fishing hook	Common IUCN VU, CITES Appendix II
Clouded Monitor lizard	*Varanus bengalensis* nebulosus (Grey 1831)	Lizard	Beside Salween River	Bathing Beside Salween	Common CITES Appendix I
Asian water monitor	*Varanus salvator salvator* (Laurenti 1788)	Monitor lizard	Salween River	In Salween river.	Common CITES Appendix II
AMPHIBIANS					
Blyth's River Frog	*Limnonectes blythii* (Boulenger 1920)	Frog	Stream side and wet land	Stream side	Fairly common IUCN NT

PLANTS

Local / Common Name	Latin Name	Forest Type	Forest level	Status
Htaw law Klaw	*Afzelia xylocarpa* (Kurz) Craib	Mix-deciduous forest	Woody vine	IUCN EN
Palm – Kar	*Cycas pectinata* (Buchanan-Hamilton 1826)	Forest floor	Palm-like shrub	IUCN VU, CITES Appendix II
Dipterocarp tree	*Dipterocarpus costatus* (Gaertner 1805)..	Primary forest.	Emergent from canopy.	IUCN EN
Paw Shwe Meh - Orchid	*Rhynchostylis retusa* (Blume 1825)	Mixed deciduous forest, flowers from March to June	Epiphytes	CITES Appendix II
Paw mo lah – Blue orchid	*Vanda coerulea* (David P. Banks)	Deciduous/Evergreen	Epiphytes	CITES Appendix II
Paw Khey Htee ko pun wah – Orchid	*Dendrobium aphyllum* (Roxb. C. E. C. Fisch)	Deciduous/Evergreen	Epiphytes	CITES Appendix II

4.8 Uncertain or unidentifiable species

Of 420 total species identified, about 23 could not be assigned Latin names. All of these species were known to the Karen, but expert sources were unavailable to the research team or the experts could not identify the species from the data obtained. The list includes six fish (plus 2 identified as endemic to genus level), five insects, two plants, three frogs, one mammal, one birds nest with eggs, one snake, one snail, and one fungus.

Intriguing unidentified species include:

- One unknown frog species is similar in size to Kuhl's creek frog, but it looks bonier and the skin is rougher. The head is arrow-like and the color is a uniform brown. (See Figure 14 below)
- One unknown snake is a gray colored species with longitudinal stripes. This snake is about three feet long and two inches wide.
- There are many unknown insects. This research focused mostly on butterfly species, all of which are common. These insects include agriculture pests because they are commonly seen from September to December, and are found mostly in the paddy fields. For this reason, local people prohibit the hunting of insectivore birds.
- Two unknown plant species were found, one flower and one wetland palm species.
- One unknown fungus, a purple mushroom (Figure 15), is found mostly on dead bamboo trunks. It is popular in the local area because the villagers use this mushroom medicinally, mixing it with honey to treat worm infections.

Figures 14, 15, 16, 17 - Some unknown species: frog (*Day Shu Ko)*, mushroom *(Khu Kaw)*, Red spot butterfly and flower *(Thu Ker May)*.

Table 5 - Unknown Species

Local or Other Name	Known Identifiers*	Where Seen	How Seen	Food Source	Resident/ Migrant
Creek Frog 1	**UNIDENTIFIED**	In the stream	Near Bank	Insectivore	Resident
Creek Frog 2	**UNIDENTIFIED**	In the stream	Near Bank	Insectivore	Resident
Frog, Day Shu Ko	**UNIDENTIFIED**	In the stream	Decayed leaves	Insectivore	Resident
Fish, Subfamily *Alburninae*	**UNIDENTIFIED SPECIES** *Paralaubuca* sp.	Salween	Caught by net	Omnivore	Resident
Fish, Subfamily *Danioninae - Oxygastrini*	**UNIDENTIFIED SPECIES** *Opsarius* sp.	Salween Tributaries	In Stream	Omnivore	Resident
Fish, Nya Plar	**UNIDENTIFIED SPECIES** *Neolissochilus* sp.	Salween Tributaries	Caught by net	Omnivore	Resident
Fish, Nya tho wah	**UNIDENTIFIED SPECIES** *Hypisbarbus* sp.	Salween	Caught by net	Omnivore	Resident
Fish, Nya per tay	**UNIDENTIFIED SPECIES** *Garra* sp	Salween	Caught by net	Algae eater	Resident
Fish, Bun Per Loo	**UNIDENTIFIED SPECIES** *Schistura* sp	Salween Tributaries	Stream	Omnivore	Resident
Fish, Hta Kat	**UNIDENTIFIED SPECIES** *Schistura* sp.	Salween Tributaries	Stream	Omnivore	Resident
Bird nest with eggs	**UNKNOWN EGG**	Forest	Bamboo	Unknown	Uknown
Unknown snake	**UNIDENTIFIED**	Near bamboo clump	Observed	Unknown	Unknown
Beetle. Shwee Ka Kher	**UNIDENTIFIED**	Forest	On young leaves	Juice sucker	Resident
Unknown Larva	**UNIDENTIFIED**	Forest	In Bamboo Shoot	Bamboo	Resident
Scorpion, Pay ter klet	**UNIDENTIFIED**	In the house	On floor	Unknown	Resident

Local or Other Name	Known Identifiers*	Where Seen	How Seen	Food Source	Resident/ Migrant
Banded snail	**UNIDENTIFIED SPECIES** *Cepaea* sp.	Forest	On ground	Omnivore	Resident
Butterfly, *Shoe ker pay*	**UNIDENTIFIED SPECIES** *Argyreus* sp.	Forest	On plant	Omnivore	Unknown
Single red spot wing butterfly	**UNIDENTIFIED SPECIES** *Argyreus* sp.	Forest	On plant	Omnivore	Unknown
Black spotted wing moth, Shaw bee lar ka	**UNIDENTIFIED**	Forest	Bamboo shoot	Omnivore	Resident
Hairy white antenna tip moth	**UNIDENTIFIED**	House or Forest	On Shrub	Omnivore	Resident
Mushroom, *Khu Khaw*	**UNIDENTIFIED**	Forest	On dead Bamboo	N/A	N/A
Flower, *Thu Ker May*	**UNIDENTIFIED SPECIES** Ruellia sp.	Forest	Forest floor	N/A	N/A
Palm, *Ker Haw*	UNIDENTIFIED	Wetlands	In wet areas	N/A	N/A

* Fish identified to the genus level by Prof. Chavalit. Further research is warranted.

4.9 Megafauna

The WWF[33] lists threatened mammal species in the Kayah-Karen ecoregion, which includes the Khoe Kay area. These species are listed below, with evidence of their existence (or not) in the research area and adjacent territory, and other information. Three general areas are considered for location: 1) the immediate research site at Khoe Kay(90 Sq. km.), 2) an area of Dawna Range foothills within a 20-km. radius west of Khoe Kay, and 3) the Dawna Range itself. The list below also includes information about other interesting mammals as well as related notes.

Generally speaking, the area west of Khoe Kay rises in increasingly high layers of hills toward the Dawna Range, which itself is a north-south running extension of the Shan Hills to the north. To the west of the Dawna Range is the Sittang River valley and Burma proper, and to the east is the Salween and beyond that Thailand. The terrain is rough and very sparsely populated, with likely some of the highest biodiversity in Burma. This is of necessity conjectural, given the inaccessibility of this militarily contested terrain, but it is reasonable to say generally that terrestrial

[33] http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im0119_full.html

mammal species observed in the Khoe Kay area are more common as one moves west into even more remote terrain.

A brief discussion of some of these species follows.

- **Tiger** (*Panthera tigris*)
  Location: Visitor throughout the larger area
  Evidence: The lead author of this report personally observed tiger pug marks on a sand bank of the Salween in December 2005. Khoe Kay villagers report occasionally hearing tiger vocalization at night in the foothills.
  Note: The tiger is extremely rare in Khoe Kay, but more common in the western Dawna Range.

- **Asian elephant** (*Elephas maximus*)
  Location: Two locations, in the Dawna Range about 100 km north and south of Khoe Kay.
  Evidence: Reported by the KNU Forest Department as well as online map of their range from the Smithsonian Institute.[34]
  Note: KESAN will conduct future research concerning wild elephant populations in Karen State.

- **Gaur** (*Bos gaurus*) and **Banteng** *(Bos javanicus).*
  Location: Dawna Foothills, 3-4 km from Khoe Kay.
  Evidence: Reported by KNU Forest Department.
  Note: Specimens of both were killed by local hunters and sold to Thais across the border.

- **Wild water buffalo** (*Bubalus arnee*) – No information.

- **Southern serow** (*Naemorhedus sumatraensis*)
  Location: In Khoe Kay, common.
  Evidence: Footprints, vocalizations.
  Note: Killed by local hunters and sold to Thais. One was seen crossing the river to Thailand.

- **Clouded leopard** (*Pardofelis nebulosa*)
  Location: Khoe Kay area, more common in surrounding foothills.
  Evidence: Killed villagers' goats, vocalizations.

- **Malayan tapir** (*Tapirus indicus*)
  Location: Southern Dawna range.
  Evidence: Reported by KNU Forest Department.
  Note: Very tame, can be approached for photographs.

[34] http://nationalzoo.si.edu/ConservationAndScience/ConservationGIS/projects/asian_elephants/images/08_01distribution.jpg

- **Dhole** (*Cuon alpinus*)
  Location: Khoe Kay area.
  Evidence: Footprints (smaller than domestic dogs).
  Note: Travels in packs.

- **Asiatic black bear** (*Ursus thibetanus*)
  Location: Common in Khoe Kay area.
  Evidence: Sleeping area observed in local bat cave.
  Note: Claw marks and broken branches seen in fruit trees.

- **Assamese macaque** (*Macaca assamensis*)
  Location: Khoe Kay area, but rare – only one group remaining.
  Evidence: Stole food from villager's farms – i.e. cucumbers.

- **Stump-tailed macaque** (*Macaca arctoides*)
  Location: Dawna Range foothills.
  Evidence: Observed by villagers.

- **Smooth-coated otter** (*Lutrogale perspicillata*)
  Location: Khoe Kay area.
  Evidence: Footprints near Salween River, vocalizations.
  Note: Migratory, eats fish.

- **Large Indian civet** (*Viverra zibetha*) – No Information.

- **Particoloured flying squirrel** (*Hylopetes alboniger*)
  Location: Khoe Kay area.
  Evidence: Caught by hunters/poachers.

Mammals of note that were identified in these three locations but not listed by WWF include:

- **Sumatran Rhinoceros** (*Dicerorhinus sumatrensis*)
  Location: Lower Salween River.
  Evidence: Observed by villagers and KNU Forest Department.
  Note: In 2005, villagers found a rhinoceros that was injured by a landmine. They asked the KNU Forest Dept. for permission to kill it.

- **Long Tailed Goral** (*Naemorhedus caudatus*)
  Location: Khoe Kay area.
  Evidence: Hunters killed and sold meat to Thais.
  Note: Formerly very common, now less common.

- **Sun bear** (*Helarctos malayanus*)
  Location: Common in Khoe Kay.
  Evidence: Hunters killed and sold meat to Thais.
  Note: Population steady at this time.

- **Eastern/Western Hoolock gibbon** (*Hoolock leuconedys/hoolock*)
  Location: Dawna Range foothills, visits Khoe Kay area.
  Evidence: Vocalization.
  Note: Hoolock is found only on Burma side of Salween River, Thai gibbons are different.

- **Sunda pangolin** (*Manis javanica*) and **Chinese pangolin** (*Manis pentadactyla*)
  Location: Khoe Kay area, Sunda (larger) is common, Chinese (smaller) is more rare.
  Evidence: Killed by hunters and sold to Thais.
  Note: Subject to severe overhunting and smuggling throughout Southeast Asia and China.

- **Slow Loris** (*Nycticebus coucang*)
  Location: Khoe Kay area.
  Evidence: Killed by hunters.
  Note: Only active when windy.

- **Red Muntjac** (*Muntiacus muntjak*) and **Fea's Muntjac** (*Muntiacus feae*)
  Location: Red is common in Mixed Deciduous forests, Fea's is common in evergreen forest.
  Evidence: Killed by hunters and sold to Thais.

Figures 18 - Slow Loris

5 Discussion

This study was undertaken to increase understanding of the biodiversity in the Khoe Kay area, and more generally, the Salween River basin. The KESAN research team has attempted to be as comprehensive as possible, and it is hoped that these efforts have also produced some vigor in the results. However, because this is a preliminary study, and the researchers have limited resources and knowledge, there are some gaps in the results of the study. These gaps suggest opportunities for further research in the future.

This section first discusses the strengths and weaknesses of this study, with proposals for further research. It then relates some of the potential impacts to biodiversity due to dam construction, militiarization and local hunting. Some basic findings by the research team are addressed, and finally, recommendations based on these findings are presented.

5.1 Strengths

The KESAN team initially spent three months in the Khoe Kay area, living with local people while they observed and cataloged the area's biodiversity. They returned several times for shorter periods. This time and effort provided depth to the study, while proving to the local people that the research team was committed to producing a report that would provide a significant boost to both the knowledge of the area and efforts to conserve the biodiversity.

Perhaps the most significant strength of this study is that the research team has knowledge and experience from University training, as well as local knowledge of species identification methods. The team leader is a Karen man who grew up in the Salween basin, spending his childhood in the forest with his elders. He also received formal education a major university in Bangkok, where he learned modern techniques and scientific species identification. In addition, as a native Karen speaker, he was able to speak freely with the local people, and convert the locals' indigenous knowledge to a western framework. The other team members were also Karen, and so able to

communicate freely with local people. Furthermore, the local people shared their significant indigenous knowledge about species and were enthusiastic about the study.

For many species, local knowledge and university training were insufficient to provide proper identification. In these cases, this study is bolstered by assistance from experts is certain taxa. For example, many of the fish were identified with assistance from Prof. Chavalit of WWF, while plant identification was assisted by Prof. J.F. Maxwell of Chiang Mai University. Richard Burnett helped identify rattan species, and Prof. Phillip Round of Mahidol University provided help with birds. Finally, Dr. Rattanawat Chaiyarat of Mahidol University's Kanchanaburi Research Station assisted with frog identification.

In performing the plant transect survey, three transects in separate areas were performed to make sure that the distribution of plants is dependable. The results indicating the distribution of forest types by altitude shows that this is the case. In addition, this study is broad enough to identify species in many different taxa, and provides a first glimpse of the biodiversity in Khoe Kay.

5.2. Weaknesses – Opportunities for more research

The most significant limits to this study are the lack of time and resources to undertake a complete survey of species. Related to this is the lack of experience in identifying some taxa, such as insects, especially in English. As a result, many endemic species and interspecies relationships remain undiscovered. However, in defense of this study, it must be noted that KESAN is a small community-based organization based on the Thai-Burma border and Khoe Kay is a remote area with significant barriers to biological study, not least of which is the ongoing conflict in eastern Burma.

Taxa which had limited or no study include spiders, which did not have specific surveys, but were only identified when observed during other surveys such as transects or forest walks. Furthermore, no surveys were performed for aquatic invertebrate such as mollusks, crayfish, shrimps and insect larvae. Also, terrestrial invertebrate such as ants, termites, and vertebrates such as small lizards and salamanders were also largely overlooked.

While three transects were performed uphill, additional transects along streams or the Salween River would give better results of riparian vegetation patterns. In addition, perception factors such as brightness of sunlight or extraneous noise may have impeded efforts to properly identify species using sight or sound.

As a result of these limits, the unexplored area remains large, both in Khoe Kay and the larger Salween basin. Finally, many times Khoe Kay plant species were compared to those found in Thailand's Khao Yai National Park. Khao Yai, one of the best-studied places in Southeast Asia, is dominated by montane evergreen forests, while

Khoe Kay contains more dry dipterocarp forest. So, while some species identifications may need clarification, the KESAN team is confident that the species are still similar.

5.3 Threats

5.3.1 Impacts of Dam construction

There is no doubt that dam construction and operation have a largely negative effect on biodiversity.[35] There are at least 5 dams proposed for the Salween River in Burma,[36] with Khoe Kay situated between the proposed locations of the Wei Gyi and Dagwin dams. Given the flourishing biodiversity currently found in both the river and the surrounding mountains, proceeding with dam construction without appropriate analysis will likely predicate a decline in Khoe Kay's ecosystems.

Unfortunately, the impacts of these dams have not been analyzed in an Environmental Impact Assessment (EIA) prior to the start of construction. Some efforts at EIA preparation have been indicated, but there has been no comprehensive effort that includes public participation, so the results are bound to be heavily skewed. In order to determine the actual impacts and whether these impacts can be mitigated, an EIA process that includes public participation is indicated.

The following is a brief consideration of the potential biological impacts of dams on Khoe Kay, based partially on the World Commission on Dam's 2000 report. Each of these issues should be comprehensively studied in an EIA. For further information on the WCD, the entire report can be found online at http://www.dams.org/report.

a. Terrestrial Ecosystems and Biodiversity

Dam construction such as that proposed for the Khoe Kay area involves large-scale industrial destruction of what is currently a natural landscape. "The construction of a storage dam and subsequent inundation of the reservoir area effectively kills terrestrial plants and forests and displaces animals.…"[37]

Khoe Kay has a high level of biodiversity that is vulnerable to dam construction. Terrestrial plant and animals species will face threats from deforestation due to dam and road construction, as well as reservoir inundation. This will impact not only riparian forests, but also montane and mixed deciduous forests, including resident and migratory fauna.

[35] "The current state of knowledge indicates that large dams have many mostly negative impacts on ecosystems." World Commission On Dams, Dams and Development: A New Framework for Decision-Making (November 2000) at p. 74. Hereinafter WCD, found online at http://www.dams.org/report/contents.htm.

[36] From north to south, they are Upper Thanlwin, Ta Sang, Wei Gyi, Dagwin and Hat Gyi. Salween Watch Newsletter, August 2007.

[37] WCD at p. 75.

Dam construction involves widespread deforestation and industrial excavation, which results in exposed soil and subsequent erosion and sedimentation. "The resulting loss of vegetative cover leads to increases in sedimentation, stormflow, and annual water yield; decreases in water quality; and variable changes in the seasonal timing of water yield."[38]

Furthermore, forest fragmentation occurs due to road construction, making wildlife more vulnerable to hunters and poachers. Attempts to prevent or mitigate these impacts have failed in other places:

"Efforts to mitigate the impacts on fauna have met with little success… Some large dam projects have tried to mitigate terrestrial impacts on biodiversity by physically rescuing animals from the area to be flooded or by anticipating that mobile species will simply move to neighbouring areas. Operation Noah and Operação Curupira are two examples undertaken at Kariba and Tucurui dams. The respective WCD Case Studies show that neither programme yielded tangible benefits for the wildlife involved."

Thus, there is little in the way of past success in overcoming the impacts of dam construction to terrestrial ecosystems. If the dams are constructed on the Salween River, it is likely that similar impacts will occur as have been seen elsewhere and related in the WCD Report.

b. Greenhouse Gas Emissions

The global impacts of climate change are becoming more apparent every year. Recent droughts and floods in Burma have affected livelihoods,[39] and may be linked to global warming.[40] The WCD report indicates that dams produce emissions of greenhouse gases, and that these may be a significant contribution to climate change.

A first estimate suggests that the gross emissions from reservoirs may account for between 1% and 28% of the global warming potential of GHG emissions… All large dams and natural lakes in the boreal and tropical regions that have been measured emit greenhouse gases (carbon dioxide, methane, or sometimes both)."[41]

Given the tropical location of the Salween River and the nature of the link between dams and climate change,[42] more study of these impacts is necessary prior to beginning dam construction.

[38] Id.

[39] www.fas.usda.gov/pecad2/highlights/2005/03/sedrought/seasiadrought.htm; http://www.abc.net.au/news/newsitems/200610/s1763680.htm.

[40] www.abc.net.au/science/news/stories/s796319.htm

[41] WCD at p. 75.

[42] One Brazilian agency has estimated that 4% of human's contribution of greenhouse gases comes from dams and associated reservoirs. http://www.news.com.au/story/0,23599,22360233-2,00.html.

c. Downstream Aquatic Ecosystems and Biodiversity

Dam construction and operation will disrupt water flow downstream, and change the natural daily and seasonal flows that the Salween River. This will impact both terrestrial and aquatic ecosystems in many ways, including increased erosion and sedimentation as well as preventing migration of aquatic species.

"Introduction of non-native species, modified water quality (temperature, oxygen,nutrients), loss of system dynamics, and loss of the ability to maintain continuity of an ecosystem result in ecologically modified river systems."[43]

For further information on downstream effects of Salween dams, see **In the Balance**, a report by the Mon Youth Progressive Organization, available at http://salweenwatch.org/downloads/IntheBalance.pdf.

d. Flow Changes

The impact of daily and seasonal flow changes will be felt by riparian plants and wildlife, and significantly more by fish and other aquatic species. "Storage dams, particularly hydropower peaking plants, can significantly disrupt the whole flow regime, resulting in both high seasonal and day-to-day fluctuations that differ greatly from natural flow levels."[44]

The impacts of these flow changes will include colder temperatures, changes in sediment delivery and species' populations and habitats. For example, with lower flows in the wet season due to storage, and higher flows in dry season for power generation, the seasonal evolutionary adaptations of the Salween's aquatic life will suddenly fail to protect them. Migratory fish will be particularly affected. An example the effects of flow changes from Africa is the explosion of water hyacinth and water fern in reservoirs due to lower periodic flushing flows.

e. Trapping sediments and nutrients

The Salween River near Khoe Kay is a winding river with sandy beaches and rock outcrops. These features provide habitat for a wealth of riparian species, and will be lost due to construction and operational changes in flow. According to the WCD:

"Reduction in sediment moving downstream from the dam leads to degradation of the river channel below the facility. This can lead to the elimination of beaches and backwaters that provided native fish habitat, and the reduction or elimination of riparian vegetation that provides nutrients and habitat for aquatic and waterfowl species, among others."[45]

[43] WCD at p. 78.

[44] Id.

[45] WCD at p. 81.

> [T]he Pak Mun (Thailand) Case Study reports a drastic decline in upstream fish catch once the dam had effectively blocked fish migration from the Mekong River upstream into tributaries of the large Mun River watershed. World Commission on Dams.

f. Floodplain Ecosystems

Residents of Khoe Kay rely on floodplain agriculture and fishing for their wellbeing, and riparian species are similarly reliant on annual silt inputs. The WCD states:

"The direct loss of annual silt and nutrient replenishment as a consequence of upstream impoundment is thought to have contributed to the gradual loss of fertility of formerly productive floodplain soils as used in agriculture and flood-recession agriculture.

Dramatic reductions in bird species are also known, especially in downstream floodplain and delta areas, where wetlands may not be replenished with water and nutrients once a dam is installed. Finally, recharge of groundwater in floodplain areas is severely diminished once floods are eliminated.

In Africa, the changed hydrological regime of rivers has adversely affected floodplain agriculture, fisheries, pasture and forests that constituted the organising element of community livelihood and culture."[46]

g. Fisheries

The 32 fish species identified in this survey largely came from fishermens' catch. Thus there can be no doubt that there is a healthy seasonal fishery on the Salween River. This important resource is at high risk due to dam construction and operation. The WCD asserts:

"Along with subsistence agriculture, fisheries constitute an important livelihood activity among large rural populations in the developing world. Many of these households depend on fisheries either as a primary or supplementary source of livelihood.

In areas of rich fish species diversity, such as the lower Mekong region in East Asia, community livelihoods and culture are woven around fisheries. The Pak Mun Case Study reports a drastic decline in upstream fish catch once the dam had effectively blocked fish migration from the Mekong River upstream into tributaries of the large Mun River watershed."[47]

Fish and other aquatic species will be affected by blocked migration routes, changes in temperature and flow, sediment delivery, turbidity, and dissolved oxygen. Further,

[46] WCD at p. 83.

[47] WCD at p. 84.

endemic fish species will lose essential breeding and feeding habitats as well as the ability to migrate seasonally. Losing these vital fisheries will greatly affect the livelihoods of local people.

Fish Ladders are Unlikely to Prevent Loss of Fish Species

One of the promised mitigation measures for the Salween Dams is the intallation of fish ladders that will in theory provide a method for migration. However, fish ladders will not provide sufficient mitigation unless they are properly designed and implemented. As noted by the World Commission on Dams:

"The Glomma and Laagen Case Study reports that there are 34 fish passes on the 40 dams in this Norwegian basin. Of these only 26% work with 'good efficiency,' 41% work less well, and as many as 32% are not working at all. In general, the efficiency is considered low, and fish migrations are severely affected. ***At Pak Mun Dam in Thailand, the case study documents the ineffectiveness of the fish pass, especially for the large migratory species in the Mekong that may be up to two metres long and cannot fit through the 15x20 cm slots…***

"Recent research in Australia, the United States, and Japan has shown that fish passes need to be modified to meet the needs of each species and the particular situation at each dam. They cannot simply be considered an easily transferable technology, ***as shown by the Pak Mun fish pass, which used a design appropriate for leaping trout and salmon in mountain streams, but which was ineffective for species living in the slower-flowing Mekong***."

There is little reason to believe that the engineers who are designing the Salween dams have the expertise to create a fish ladder that will provide passage for all of the 170 species found in the river. The fish range in size from a few centimeters to two meters, with as widely varying physiologies. In fact, it is doubtful that any fish ladder design would function properly in the tropics, where fish diversity is at its highest. It is therefore incumbent upon the appropriate authorities that they fully explain how their mitigation plans will protect the fisheries of the Salween River, or withdraw their dam plans.

How will any fish ladder help both the 2-cm loach (Gagata gasawyuh) and a 2-meter catfish?

h. Cumulative Impacts

Perhaps the most destructive element of the dams proposed for the Salween River is the cumulative impact of building five dams in Burma and up to 13 more in China. The ecological impact of multiple dams on large rivers is unequivocally bad. "Many of the major catchments in the world now contain multiple dams. Within a basin, the greater the number of dams, the greater the fragmentation of river ecosystems."[48]

"…[O]n the Columbia River, the cumulative impact of an additional dam on salmon migrations is significant. It is estimated that 5–14% of the adult salmon are killed at each of the eight large dams they pass while swimming up the river."[49]

Furthermore, besides the dams themselves, every dam site will be subject to road building, forest clearcutting, and multiple other injuries. This will also result in increased access for loggers, miners, and other industrial development in a previously pristine forest. The cumulative "steamroller" effect of multiple dams and associated infrastructure development in an unspoiled ecosystem will have devastating consequences for the native biodiversity.

i. Anticipating and Responding to Ecosystem Impacts

The WCD report indicates that past dam engineers **refused to acknowledge environmental impacts**.

"[E]fforts to counter the ecosystem impacts of large dams in the WCD Knowledge Base indicates that they have met with limited success owing to: the lack of attention paid to anticipating and avoiding impacts; the poor quality and uncertainty of predictions; the difficulty of coping with all impacts; and partial implementation and success of mitigation measures.

[F]or the 87 projects that provided data on ecosystem impacts, almost 60% of the impacts identified were unanticipated prior to project construction, largely due to inadequate studies."

Unfortunately this seems to be the case for the proposed dams on the Salween river as well. In an interview in November 2007, an engineer designing the Tasang Dam in Shan State stated flatly that "There will be no environmental impacts."

When asked for specifics about flow changes and village inundation, the engineer refused to reply.[50]

[48] WCD at p. 88.

[49] WCD at p. 89.

[50] Salween Watch Interview with Mr. Noppol Prapaitrakul, the Ta Sang Project Manager , MDX Corp, Bangkok, Nov. 20, 2007. http://salweenwatch.org/downloads/sapawa_press_Release.doc

5.3.2 Militarization of Khoe Kay

Besides the risk to researchers, the increased SPDC militarization also has an impact on wildlife populations. In one case near Khoe Kay around 2004, an endangered rhinoceros was injured by a landmine and ultimately killed. It must be noted that there are multiple parties responsible for the wide use of landmines in Karen State.

Furthermore, military bases near Khoe Kay are located up in the mountains, and the military patrols follow the streams down to the Salween River in the area where animals drink. The presence of the military at these locations prevents animals from drinking. Furthermore, the military does not dispose of their garbage (including toxic substances) appropriately, leading to injury of some species.

According to one KESAN Researcher: "Research in this area is a great risk to our lives because it is an active revolution area. *Unexpected situations such as land mines and military patrols are always waiting somewhere close to you when you are in the area."*

5.3.3 Militarization of Protected Areas

Over the last 10 years, there has been a large increase in the number and size of protected areas in Burma.[51] Unfortunately, this effort has been extremely top-down, with little consideration (and sometimes overt terror) for local people. Protected areas in Burma often become outposts for the military; they also provide access to industrial extraction and development. According to Zao Noam:[52]

> "Re-zoning for conservation provides an apparently legitimate reason for the state to relocate populations, to control and patrol previously inaccessible areas of contested territory, and to claim state/military ownership of natural resources. In this way, abuses against ethnic people may continue under the guise of conservation enforcement…
>
> "Creation of the Myinmoletkat Biosphere Reserve in Karen State in the 1990s led to violent oppression of Karen communities living in the area. Within a few months of signing the MoU to establish the reserve, the Burmese army launched one of its biggest and most successful military offensives to secure territory away from the Karen National Union (KNU) for inclusion in the proposed reserve…

[51] See Birdlife International, Myanmar: Investment Opportunities in Biodiversity Conservation, page 56, available at http://birdlifeindochina.org/report_pdfs/page_1_62.pdf.

[52] Noam, Z., "Eco-authoritarian conservation and ethnic conflict in Burma", Policy Matters: Conservation and Human Rights, 15: 2007, available at http://www.iucn.org/themes/ceesp/Publications/newsletter/PM15.pdf, pp272-287

> "The state may appropriate environmentalism to establish resource sovereignty out of line with the conservation goals desired by practitioners and their donors… There is no room for participatory decision-making, access to environmental information, media freedom to report on environmental issues, or support for 'pro-people' conservation."

Given the poor conservation and human rights outcomes of the nearby Myinmolektat Biosphere Reserve,[53] as well as the absolute lack of public participation in dam planning,[54] the Karen of Khoe Kay feel that they, not the SPDC, are the appropriate party to undertake planning and conservation in the area.

5.3.4 Impact of Local Hunting

Villagers in Khoe Kay forbid the hunting of large and rare species such as guar, bateng, gibbons, rhinoceros, hornbills and other small birds, eagles, elephants, and slow loris. On the other hand, some large species are hunted legally, such as pangolin, bear, muntjac and others. When local people notice a large drop in a species' population, they will try to stop hunting it until the species rebounds – this happened for the Phayre's langur.

Traditional practice among the Karen requires that anyone (local or outsider) who kills one of these animals must bring it back to the village and perform a religious ceremony, and share it with the entire village. These traditional practices have tended to reduce the impact of local hunting on wildlife populations. But now, many outsiders do not follow the local rules. Local people find it difficult to enforce their traditions, leading to increased pressure on wildlife.

Thus, many of the large mammals like slow loris, black bear, goral, serow, and pangolins are subject to hunting by outsiders. Much of the poaching pressure comes from rich countries like China and Thailand, where meat and other organs from endangered species can bring significant income.[55] Burma is certainly acknowledged

[53] The reserve was recently referred to as "defunct." http://www.irrawaddy.org/opinion_story.php?art_id=9206

[54] "Controversial plans to dam the Salween River, Southeast Asia's longest natural free-flowing waterway, will proceed without a standard environmental-impact assessment study, despite serious concerns about the effect the infrastructure project will have on the area's people and natural surroundings….Plans for the study were finally abandoned to avoid meddling in Myanmar's internal affairs." Asia Times Online, Dam the Salween, Damn its People, by Will Baxter, available at http://www.atimes.com/atimes/Southeast_Asia/HI15Ae01.html

[55] "Smugglers Nabbed At Russian-China Border With Tiger Pelts, Hundreds Of Bear Paws" online at http://www.enn.com/animals/article/22694. The article notes that "[t]he value of the goods is estimated at $36,000 in Russia. This would have been far higher in China's thriving illegal wildlife trade markets. The bear gall bladders, whose bile is used in Traditional Chinese Medicine, would have been smuggled separately, as the value of the bile exceeds that of the paws. The paws are from Himalayan black bears (Ursus thibetanus), recognized by the International Union for Conservation of Nature-World Conservation Union (IUCN) as globally Vulnerable due to habitat loss and poaching."

as a source for Chinese endangered species trafficking.[56]

According the the KESAN team's conversations with locals and personal observations, the hunters tend to be from outside Khoe Kay. Also, there is significant pressure from hunting by SPDC troops, who are required to be self-sufficient. This is another indicator of lax enforcement of hunting laws in Burma. Finally, many of the animals being poached in Khoe Kay are sold across the border to neighboring countries, where it is either consumed or trafficked to more distant China.

5.4 Findings

While this study is preliminary, there are some basic conclusions that can be reached, based on the observations and knowledge of the KESAN team and the local people.

First, the Salween River is the most significant dynamic force affecting biodiversity in the area. It is a barrier for some species (Hoolock Gibbon) but migratory corridor for others (migratory fish, and perhaps birds). Thus, dam construction and associated industrial development will have profound long-term affects on the ecology of the area.

In addition, while study needs more work, in that researchers abilities are lacking and security issues are acute, it remains that the biodiversity is so important, and threats are so critical, that the area needs much more time and study to fully understand the ecology. There is also still a lot of raw data, in terms of pictures, unidentified species, etc, available for other researchers.

Furthermore, this is a place where local indigenous knowledge is still robust, as seen from the medicinal and food uses of many of the species. Across the river in Thailand, where modern amenities are more available, local indigenous knowledge about useful species is in decline.

Khoe Kay is also special because it is very close to Thailand's Salawin Wildlife Sanctuary across the river, which is accessible, secure and relatively similar. Thus, ecological links and comparisons of biodiversity from both sides of the river can be made. It is also interesting that Khoe Kay provides a bridge between Dawna range (inhabited by rich wildlife) and Salween river.

[56] "Burma is being raped in terms of its natural resources -- trees, plants and animals. They've got to get a hold of the situation quickly before it becomes a barren ground," said Steven Galster, Bangkok-based director of the Wildlife Alliance. "There's a huge flow of illegal wildlife going into China, through whatever porous border points there are. This is definitely one of them, mainly because the Burmese government just doesn't have a handle on the situation." Reuters, Sept. 3, 2007, online at http://www.alertnet.org/thenews/newsdesk/BKK62017.htm.

Finally, around 2004, the lead researcher of this study received a report from a KNU official that villagers 100 kilometers south of Khoe Kay had asked officials for permission to kill a rhino that had lost a leg to a land mine. While the fate of this individual animal seems sealed, stories like this suggest that some of the great endangered mammals of Asia still exist in the area, and these reports are also worthy of further investigation.

5.5 Recommendations

This study is important because it is the first close look at the biodiversity of Khoe Kay, and perhaps even the first in-depth survey of plant and animal species along the entire Salween River. However, given KESAN's time and resource constraints, it is incomplete in several ways. Suggestions on follow-up research are as follows.

Of primary importance, academics and NGOs with substantial resources can and should undertake a more intensive study of aquatic biodiversity *before* any dam construction begins. This should include efforts aimed at the following:

a Identify the unknown fish species from this study.
b A complete survey of the entire length of the river for fish species, including efforts to determine the migratory habits of endemic fish species. This will begin to provide the information necessary to determine what species will be impacted by the dams, and how.
c A survey for aquatic invertebrates, including clams and mussels, crayfish, and aquatic insects and larvae. This should also include the areas downstream of the proposed dams, including the Salween River's estuaries near the Gulf of Martaban, as these areas would be greatly affected by changes in freshwater flows.

Second, the unidentified terrestrial species should be studied. Frogs and other amphibians, insects and reptiles all remain elusive, and surveys during all seasons would be helpful in filling the gaps.

Third, the ecological function and value of many trees has not been studied. In addition, many plants are used by locals for medicine, and should be studied in the laboratory for their medicinal value.

Fourth, tree species like teak and padauk (Burmese ebony *Pterocarpus macrocarpus*) are valuable in the timber trade, losing the places they inhabit would drain the local people's ability to make a living. The local economic impacts of dam construction and operation must be analyzed and considered as well.

Fifth, efforts must be made to reduce the impact of hunting and poaching on endangered wildlife. This pressure comes mostly from outside of Khoe Kay. Increased enforcement, both locally and cross-border, is needed to address this problem.

Finally, the pristine state of Khoe Kay and the Salween River are unique in Southeast Asia. As such, dam planning and construction need to wait until more complete studies of the area are completed.

6 Conclusion

This first survey of Khoe Kay is unique and valuable because it combines Western technical identification methods with local people's knowledge of their environment. The results indicate that the Salween River basin remains relatively intact and highly diverse, but the area faces severe threats from imminent dam construction, as well as ongoing threats from militarization and local poaching. These threats will impact not only biodiversity, but also the people who depend on a healthy, funcitoning ecosystem for their livelihoods.

Since the Karen are some of those people, KESAN continues to study the biodiversity of Karen State, and maintains a significant cache of additional data and pictures. Further study is encouraged, and KESAN will do all it can to assist outside researches to go beyond this study. Of course, the ongoing conflict creates difficulties, but KESAN is willing and able to provide assistance to researchers, such as collaboration with local people who understand the risks and avoid them on a daily basis. Alternatively, KESAN can assist by providing training, capacity building and field work to local people who can then undertake the necessary work and share the results.

Please contact KESAN if you are interested in furthering the understanding of the Salween River and Khoe Kay.

Appendices

A. Tables

- Plant Species
- Fungus Species
- Animal Species

B. References

C. Questionnaire for Villagers

D. Selected Pictures of Species

- Endangered Species
- Endemic Species
- Other Interesting Species

PLANT SPECIES OBSERVED IN KHOE KAY

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
WOODY VINES			
Po Thwee Chaom	*Acacia pennata* (Linnaeus 1758) Willd.	Mix-deciduous forest	Food and medicine for teeth treatment.
Klay Ka	*Albizia Myriophylla* (Benth.1844)	Mix-deciduous forest	
Klay Mu Poison vine	*Derris elliptica* (Roxb.1860) Benth.	Deciduous/ Evergreen	Antibacterial – Khan et al, Antimicrobial activity of the Derris elliptica, Derris indica and Derris trifoliata extractives.Fitoterapia Volume 77, Issue 4, June 2006, Pages 327-330
Htaw Law Klaw	*Afzelia xylo-carpa* (Kurz 1912) *Craib*	Mix-deciduous forest	IUCN EN
Saw Law Dee Der	*Thunbergia grandiflora* (Roxb.1820)	Deciduous/ Evergreen Close to stream side	Extract used as eye drops
Khee Po Mu	*Pueralia mirifica* (Airy Shaw & Suvatabandhu 1952)	Mix-deciduous forest	Used for breast enlargement, http:// www.news.bbc.co.uk/2/hi/health/ 4361563.stm. Prevents bone loss in rats, Maturitas 2008 Feb 20;59(2):137-48. Epub 2008 Mar 4
Htay Ku Paw	*Congea tomentosa* (Roxb.1819)	Evergreen/ Deciduous	
Ker Po Mu –	*Thunbergia laurifolia* (Lindl.1856)	Mix-deciduous forest Close to stream and rocky area	Protects against ethanol induced liver injury in rats, Pramyothin et al. Hepatoprotective activity of Thunbergia laurifolia extract in rats treated with ethanol: In vitro and in vivo studies. Journal of Ethnopharmacology Volume 02, Issue 3, December 2005, Pages 408-4

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Gac Puu Kuu Dote	*Momordica cochinchinen-sis* (Lour. 1790) *Spreng.*	Mix-deciduous forest Close to stream	High in fatty acids, carotene and lycopene. Ishida, B.K., et al (2004). Fatty acids and carotenoid composition in gac (momordica cochinchinensis spreng) fruit. Journal of Agricultural and Food Chemistry. Vol 52, p. 274–279.
Kaw Ka Dote	*Momordica charantia* (Linnaeus 1753)	Deciduous	Good for eating
Maw Keh	*Entada phaseoloides* (Linnaeus 1754) Merr.	Deciduous/ Evergreen	Well cooked young leaves are edible
Hta Kat dote	*Cephalandra indica* (Wight & Arn.1834) Naudin	Mix-deciduous Close to stream	Considered a valuable plant during famines. http://www.hort.purdue.edu/newcrop/FamineFoods/ff_families/CUCURBITACEAE.html
Thaw Ker Ah	*Smilax* spp.	Deciduous/ Evergreen	
Ker Plarn Lar	*Schefflera leucantha* (Viguier 1909)	Deciduous/ Evergreen	Highly active biological properties: B. Potdaung et al , Biological Activities Of Schefflera Leucantha, African Journal of Traditional, Complimentary and Alternative Medicines, Vol 4, No. 2, 2007, pg. 57-64.
Law Lu Mu	*Tinospora crispa* (Linnaeus 1763) Hook. F. & Thomson	Deciduous/ Evergreen	Treats diabetes – Noor and Ashcroft, Journal of Ethnopharmacology, Volume 62, Issue , pp. 7-3, August, 998. Pharmacological characterisation of the antihyperglycaemic properties of Tinospora crispa extract.
Nyen Mee	*Dioscorea villosa* (Linnaeus 1753)	Mix-deciduous forest	Edible roots.

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
RATTANS			
Khey Kar	*Calamus viminalis (Willd. 1799)*	Secondary, wet areas	3 Species noted, used for furniture, roofing, and food.
Khey Khay –	*Daemonoropsjenkinsiana* (Griff. 1830) Mart.	Primary Moist Area	Well cooked shoot is edible-Used for weaving basket
Khey Pkun	*Calamus rudentum* (Thwaites 1864)	Primary Moist Area	Well cooked shoot is edible-Used for weaving baskets
MUSACAE – BANANAS			
Colony Wild Banana	*Musa acuminate* (Linnaeus 1758)	Mix-decidous forest/ Evergreen	
Single Trunk Wild Banana	*Musa glauca* (Roxb. 1814)	Mix-deciduous forest	
Bananas	*Musa sapientum* (Linnaeus 1759)	Mix-deciduous forest Moist area	
EDIBLE STARCHY ROOTS			
Khu Htee Taro,	*Colocasia esculenta* (Linnaeus 1753) Schott	Deciduous/ Evergreen Wet area	Edible and highly marketable root.
Khu Tar Thu Giant taro	*Colocasia gigantea* (Blume 1844) Hook F	Deciduous/ Evergreen Moist area	
Kuhn Me	*Amorphophallus konjac* (Karl Koch 1906)	Deciduous/ Evergreen, Moist area dried up during winter/summer	Edible stem and roots

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Kuhn Mee	*Amorpho-phallus campanula-tus* (Blume 1834 ex Decne)	Forest floor	
Hor To Plo	*Lasia spinosa* (Linnaeus 1753) Thwaites	Deciduous/ Evergreen Wet areas	Thorny plant, well cooked young leaves are edible. This plant is used for medicine and also sells in markets of Burma and Thailand.
GINGER			
Por Shee (Roscoe's turmeric)	*Curcuma roscoeana* (Wallich 1830)	Mix-deciduous forest forest floor	Widely used spice. *Kha Min Daeng* in Thailand.
Ter Yaw Turmeric	*Curcuma longa* (Linnaeus 1753)	Mix-deciduous forest forest floor	Widely used spice.
Plern Ko	*Zingiber purpureum* (Roscoe 1807)	Mix-deciduous forest forest floor	Spice. Kills larvae. K. Bandara et al, Bruchid (Coleoptera: Bruchidae) Ovicidal Phenylbutanoid from *Zingiber purpureum.* Journal of Economic Entomology, Vol 98, pp. 63–69, August 2005.
Po Ner Pwa Domestic turmeric.	*Curcuma domestica* (Valeton 1918)	Mix-deciduous forest forest floor	Widely used spice.
Ter Aye Shey (ginger)	*Alpinia nigra* (Gaertn. 1788) B.L. Burtt	Deciduous/ Evergreen forest floor	Widely used spice. Potentially useful in treating tuberculosis. http:// www.freepatentsonline.com/ 2002092262.html
Polee, Ma ee (ginger)	*Amomum uliginosum* (Koenig 1820)	Deciduous/ Evergreen forest floor	Widely used spice.

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Por Ter Raw - Chinese ginger – Krachai	*Boesenbergia rotunda* (Linnaeus 1753) Mansf.	Deciduous Forest Floor	Widely used spice.
Paw Day Yah St John's lily	*Crinum asiaticum* (Linnaeus 1753)	Deciduous Forest Floor	
PALMS			
T' khaw	*Wallichia siamensis* (Becc. 1934)	Shade Place	Palms used for roofing, weaving, food
Kloko	*Phoenix loureiri* (Kunth 1821)	Shade Place	
Ker Yeh	*Caryota mitis* (Lour. 1790)	Shade Place	
Maw	*Pinanga sylvestris* (Lour.) Hodel (1998).	Shade Place	
Lo por khen Fan Palm	*Licuala spinosa* (Wurmb. 1780)	Shade Place and open areas.	
Ker Haw	Unknown	Wet-land palm	Edible fruits, shoots, leaves uses for roofing especially hill tribes areas
Lu Kween Kewra	*Pandanus odoratissimus* (Linnaeus 1781) f.	Shade plant	
BAMBOO	Many species common insecondary forests, few or absent in primary forests. Shrub and/or Canopy depending on species.		Highly versatile: used for food, building, weaving, and household items.

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Wa Klu Giant Bamboo	*Dendrocalamus brandisii* (Munro 1868) Kurz	Evergreen/ Deciduous forest	
Wa Me	*Bambusa marginata* (Munro 1868)	Deciduous forest	
Wah Bwin	*Bambusa vulgaris* (Schrad. 1808 ex J.C. Wendl.)	Deciduous forest	
ORCHIDS – Generally epiphytic.			
Paw Shwe Meh	*Rhynchostylis retusa* (Blume 1825)	(Mixed deciduous/ Evergreen forests) flowers from Febuary to June	CITES Appendix II. www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?3765
Paw Hto Key	*Dendrobium thwaitesii* (Veitch 1874)		
Paw Lo Kaw	*Dendrobium chrysotoxum* (Lindley 1847)		
Paw Bee Bay	*Ascocentrum curvifolium* (Schlechter 1933)		
Paw Thet Bow	*Dendrobium lindleyi* (Steud.1840)		
Paw Mo Lah Blue orchid	*Vanda coerulea* (Griff. 1847 ex Lindl.)		CITES Appendix II. www.cites.org/eng/cop/3/cop3checklist.pdf
Paw Say Baw	*Tropidia angulosa* (Lindl.1833) Blume		Seen near caves

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Paw Bu Klee –Dragon orchid	*Dendrobium draconis* (Reichb.f. 1862)	Seen at stream-banks or in oak forest.	http://www.orchidspecies.com/dendraconis.htm Most common Dendrobium in the world.
Paw Ker Moo Eh	*Dendrobium infundibulum* (Lindley 1859)		
Paw Bun Klee Wah	*Dendrobium cariniferum* (Reichb.f. 1869)		
Paw Khey Htee Ko Pun Wah	*Dendrobium aphyllum* (Roxb. 1795) C.E.C. Fisch.		CITES Appendix II. http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?40459
Paw Daw Nyar Farmer's Dendrobium	*Dendrobium farmeri* (Paxton 1849)		
Paw Khey Htee Ko Pun Baw	*Dendrobium crystallinum* (Reichb. F. 1868)		
FERNS – EPIPHYTIC			
Ta Khor Shu Bird's nest fern	*Asplenium phyllitidis* (D. Don 1825)	On Tree	
Ker Shor Wa Na Staghorn fern	*Platycerium holttumii* (Jonch. & Hennipman 1970)	On Tree	(Platycerium holttumii)
Yu Kay Daw	*Aglaomorpha coronans* (Wall. ex Mett. 1856) Copel.	On Tree	

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
FERNS – NON-EPIPHYTIC			
Kee Ku Htee Doh	*Diplazium esculentum* (Retz. 1791) Sw.	Wet Area	Widely used as food. http://www.efloras.org/florataxon.aspx?flora_id=&taxon_id=233500586
Ka Shor Dee	*Brainea insignis* (Hooker 1853) J. Sm.	Shaded Plant Evergreen	
Kee Ko Per Yaw – Thinleaf brake	*Pteris biaurita* (Linnaeus 1753)	Stream side and shady area	Good for curry
Ke Ko Thay – Giant Fern	*Cibotium barometz* (Linnaeus 1753) J. Sm.	Moist Area	Used in traditional Chinese medicines. Overuse of wild populations and habitat loss led to a Chinese proposal to add to CITES Appendix in 2003. www.cites.org/common/prog/criteria/flora/C_barometz_CN.pdf
Ko Do Khey Wah	*Cyathea gigantean* (Hooker 1844)	Shade plant	
Ko do Khey Khaw	*Cyathea spp* (Hooker 1844)	Shade plant	
Kar Bee Shue – Bat's wing fern	*Histiopteris incisa* (Thunb. 1875)	Forest floor	
Hto Bwar Mah	*Plagiogyria communis* (Ching 1958)	Forest floor	
Htoe Kar False staghorn fern	*Dicranopteris linearis* (Burm. f. 1768) Underw.	Forest floor/ Evergreen	Used as water pipe

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Dweh Thee Thon Spike moss	*Selaginella chrysorrhizos* (Spring 1850)	Primary forest	
Kee Ko Po Climbing fern	*Lygodium salicifolium* (Presl. 1845)	Forest floor	Used in weaving. The Use of Climbing Fern, Lygodium, in Weaving. C.V. Morton American Fern Journal, Vol 56, No.2 (Apr. - Jun., 966), pp. 79-8
Kar	*Cycas pectinata* (Buchanan Hamilton 1826)	Forest floor	IUCN Vulnerable, CITES App. II..
SHRUBS			
Paw Kwor Wah	*Clerodendrum infortunatum* (Linnaeus 1758)	Evergreen/ Deciduous	Used to treat tumors and skin diseases. N. Rajakaruna et al, Antimicrobial Activity of Plants Collected from Serpentine Outcrops in Sri Lanka. Pharmaceutical Biology, Vol 40, No. 3, pp. 235–244 (2002).
Paw Bwa	*Phyllodium longipes* (Craib 1910) Schindl.	(Shade plant)	
Paw Kwor Ghaw Pagoda flower	*Clerodendrum paniculatum (*Linnaeus 1767)	Evergreen/ Deciduous Forest floor	
Kwe Doe Soe	*Clerodendrum spicatum* (Thunb. 1825)	Evergreen/ Deciduous Forest floor	Medicinal plant
Htaw Klaw Wah	*Leea indica* (Burm.f.) Merr. 1919	Evergreen/ Deciduous Forest floor	
Chay Po Kwin Siam weed	*Chromolaena Odorata* (Linnaeus 1753)	Evergreen/ Deciduous Forest floor or distur -bed area disturbed forest and farm land area.	Invasive weed from Central America. http://www.issg.org/database/species/ecology.asp?si=47&fr=&sts

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Thay Ka Shu	*Sambucus javanica* (Linnaeus 1753)	Stream Sides	Medicine/ local people use it to heal injury and grastric
Ko paw Aye Cyperus	*Cyperus rotundus* (Linnaeus 1753)	Wet area	
Ter Po	*Andropogon chinensis* (Nees 1836) Merr.	Stream Sides	
Kay	*Thysanolaena latifolia* (Roxb. 1819 ex Hornem)	Field area/ rotational farm area	
Be Bay Pah Khor	*Sterculia lanceolata* (Cav. 1788)		Very delicious nut
Htaw Klaw Ghaw	*Leea rubra* (Linnaeus 1767)	Forest floor	
Thu Lae – Crepe ginger	*Costus speciosus* (J. Koenig 1783) Sm.	Forest floor	
Htoe Klow Wah - Elder-berry	*Leea guineensis* (Linnaeus 1767)	Forest floor	
Kar Lah At	*Melastoma polyanthum* (Blume 1831)	Forest floor	Good fruit to eat
Ter Kaw Yo Turkey berry	*Solanum torvum* (Sw. 1788)	Cultivated Area	Good fruit to eat
Paw Kaw Lar	*Cosmos bipinnatus* (Cav. 1791)	Cultivated Area	

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
HERBS – edible plants, often used as spices, or in curries or salads.			
Nor Shoe Bee	*Desmodium triquetrum* (Linnaeus 1753) DC.	Ground Level	Heals wounds. Shirwaiker et al Wound healing activity of *Desmodium triquetrum* leaves. Indian Journal of Pharmaceutical Sciences, Vol 65, p. 46. (2003).
Ler Hti Doh	*Alysicarpus nummularifolius* (Linnaeus 1753) DC.	Ground Level	Local people uses it for treating Kidney disease especially stone in Kidney
Naun Mee Kay Mayarap (Thai)	*Minosa pudica* (Linnaeus 1753)	Ground Level	Medicine
Mon Bonsay Dok Din Daeng (Thai)	*Aeginetia indica* (Linnaeus 1753)	Ground Level	Medicinal – stimulates T-cells. Chitsomboon, B. et al Immunomodulation by Dok Din Daeng (*Aeginetia indica* Roxb.) extracts in female B6C3F mice. (I): Stimulation of T cells. International Immunopharmacology, 2004 (Vol 4) (No. 0/) 367-379.
Naun Plaw Plu Fireweed	*Erechtites valerianifolia* (Wolf 1837)	Ground Level	
Hor Ter	*Spilanthes acmella* (Linnaeus 1753)	Ground Level	Medicinal plant www.herbaltransitions.com/materiamedica/Spilanthes.htm
Ta Ner Shee (Chamel-eon plant)	*Houttuynia cordata* (Thunb. 1783)	Wet land/ Marshes	Leaves and roots used as food.
Thu Ker May	*Ruellia* sp. Unknown	Forest floor	
Paw Ple Wah	*Thunbergia fragrans* (Roxb. 1795)	Forest floor	

Karen / Common Name	*Latin Name*	Forest Type Deciduous/ Evergreen Primary/ Secondary	Notes
Paw Thee Mu Wild mint – Yerba buena	*Mentha cordifolia* (Opiz. 1828)	Wet land/ Marshes	Possible medicinal uses. www.stii.dost.gov.ph/pjsweb/data/antiteratogenicity.htm
Shor Eu Ka (Yaa Pak King Thai)	*Murdannia loriformis* (Hassk. 1852)	Rice field	Medicinal uses: http://ecologyasia.com/news-archives/2003/may-03/bangkok post_030529_2.htm

TREES Identified by Prof. J. F Maxwell and KESAN Team		
Per - Tung tree Sawbya (Burma), Sompong (Thailand).	*Tetrameles nudiflora* (R. Br. 1838)	Primary forest
Khawn Dipterocarp	*Dipterocarpus costatus* (Gaertner 1805*).*	Primary forest
Per He Common teak	*Tectona grandis* (Linnaeus 1781)	Primary forest
Thin Khaw	*Castanopsis armata* (Roxb. 1802) Spach	Evergreen Primary/ Secondary forest
Thay May Lah Nyo	*Sindora siamensis* (Teijsm. 1867 ex Miq)	Deciduous
Plo Ker Sher	*Capparis grandis* (Linn.f 1753)	Deciduous
Nor Day Law	*Nelsonia canescens* (Lam. 1825) Spreng.	Deciduous
Men kyi	*Marrisonia perforata* (Blanco 1837) Merr.	Deciduous
Thu Ker Men	*Semecarpus cochinchinensis* (Engler 1883)	Evergreen/Deciduous
Per Nyern	*Anogeissus acuminata* (Roxb. ex DC. 1832)	Deciduous
Thay Htaw Naw	*Miliusa velutina* (Hook. f. & Thomson 1768)	Deciduous
Mor Maon	*Litsea monopetale* (Roxb. 1798)	Evergreen/Deciduous
T' Ku Hor	*Terminalia mucronata* (Craib & Hutch. 1909)	Deciduous
Thay Po Mu Pwa	*Lagerstroemia cochinchinesis* (Pierre 1918)	Deciduous
Ka Lay Waw	*Berrya mollis* (Wall. ex Kurz 1877)	Deciduous
Thay Yaw	*Grewia eriocarpa* (Juss 1804)	Deciduous
Lee Lu Po Dee	*Stereospermum neuranthum (*Kurz 1873)	Deciduous

Thay Sha	*Stereospermum colais* (B. - H. ex Dillw. 1978)	Deciduous
Thay Hto Bwer	*Mitragyna hirsuta* (Hav. 1897)	Deciduous
Per Noin Poe	*Siphonodon celastrineus* (Griff. 1844)	Deciduous
Thay Kar	*Stereospermum colais* var *puberula* (Dop 1990) D.D. Tao	Deciduous
Ter Lay Day	*Sapindus rarak* (DC. 1824)	Evergreen/Deciduous
Ter lo Hto	*Radermachera ignea* (Kurz 1871) Steenis	Deciduous
Thay Kay	*Derris robusta* (Roxb. ex DC.) Benth 1860	Deciduous
Thay May Taw	*Shorea obtuse* (Wallich 1805)	Deciduous
Khaw Bo	*Terminalia alata* (Hey. ex Roth 1821)	Deciduous
Per Taw May	*Vitex limoniifolia* (Wallich 1828)	Deciduous
Tha Ker Blee	*Schleichera oleosa* (Lour. 1841) Oken.	Deciduous
Tha Htu	*Holarrhena pubescens* (Wallich ex G. Don 1837)	Evergreen/Deciduous
Ywa Mo Ker Du	*Cleidion Javanicum* (Blume 1862)	Deciduous
They Ker Hsor Sha	*Streblus asper* (Lour 1790)	Deciduous/Close to river
Tha Ker Wa	*Croton robustus* (Kurz 1873)	Deciduous
Hor Shar	*Antidesma sootepense* (Craib 1911)	Deciduous
Per Tru	*Aporosa villosa* (Wall. ex Lind 1858)	Evergreen/Deciduous
Per Yo	*Cassia fistula* (Linnaeus 1753)	Deciduous
Pway Redwood	*Xylia xylocarpa* (Taub. 1891)	Deciduous
Per Kay Khart	*Quercus semiserrata* (Roxb. 1832)	Evergreen/Deciduous
Taw Thwet	*Grewia eriocarpa* (Juss. 1804)	Deciduous
T'Pee Hto Lo	*Spondias pinnata* (Linnaeus f. Kurz. 1781)	Evergreen/Deciduous
Shor Mu	*Sterculia urens* (Roxb. 1795)	Deciduous
Thay Kay	*Albizia lebbeck* (Linnaeus) Benth. 1844	Evergreen/Deciduous
Te Pee	*Protium serratum* (Linnaeus ex Colebr. 1883)	Evergreen/Deciduous
Doh Kar	*Oroxylum indicum* (Linnaeus) Kurz. 1877	Evergreen/Deciduous
Ko	*Duabanga grandiflora* (Roxb. ex DC.) Walp. 1843	Evergreen/Deciduous
Khoen	*Bombax anceps* (Pierre 1888)	Deciduous
Ter Yan	*Phyllanthus emblica* (Linnaeus 1753)	Evergreen/Deciduous

Shern Ko	*Erythrina stricta* var. *suberosa* (Roxb.) Niyomdham 1992	Evergreen/Deciduous
Thin Ter Du	*Castanopsis calathiformis*(Skan) Rehder & E.H. Wilson 1916	Evergreen
Thin Thu	*Castanopsis diversifolia* (King ex Hook. f. 1888)	Evergreen
Ter Kun	*Terminalia belerica* (Roxb. 1805)	Evergreen/Deciduous
Tu Ter Plaw	*Anneslea fragrans* (Wall. 1829)	Evergreen
Ter Pay	*Flacourtia indica* (Burm. f.) Merr. 1917	Evergreen/Deciduous
Ter Lah Aw	*Dipterocarpus tuberculatus* (Roxb. 1814)	Deciduous
Ter May	*Syzygium fruticosum* (Roxb. Ex DC. 1828)	Evergreen/Deciduous
Khor	*Dillenia aurea* (J.E. Smith 1798)	Deciduous
Taw Plar Wah	*Pterospermum semisagittatum* (Roxb. 1814)	Deciduous
Thay Hu Nee	*Phyllanthus columnaris* (Müll. Arg. 1863)	Deciduous
Der	*Anthocephalus chinensis* (Lam. 1843)	Deciduous
Lar Baw	*Shorea siamensis* (Wilhelm Miquel 1887)	Deciduous
Thay Kwen Sor	*Cratoxylum formosum* (George Bentham 1884)	Deciduous
Khoe Baw	*Wendlandia tinctoria* (Roxb.) DC. 1830	Evergreen/Deciduous
Mana	*Terminalia chebula* (Retzius 1789)	Deciduous
Kay Law	*Trevesia palmata* (Roxb. ex Lindl.) Vis. 1842	Deciduous
No Mu	*Alstonia scholaris* (Linnaeus) R. Br. 1810	Evergreen/ Deciduous
No Kwa	*Alstonia rostrata* (C.E.C. Fisch. 1929)	Evergreen/Deciduous
A Ter Ree	*Millingtonia hortensis* (Linnaeus f. 1782)	Deciduous
Per Dah	*Macaranga denticulata* (Blume) Müll. Arg. 1866	Secondray forest
Ter Kote	*Mangifera sylvatica* (Roxb. 1814)	Evergreen/Deciduous
Kla Eu	*Strychnos nux-blanda* (Hill 1917)	Deciduous
Tha Ko Kwee	*Garcinia pedunculata* (Roxb. ex Buch.-Ham. 1827)	Evergreen
Ter You Thart	*Schima wallichii* (Choisy 1854)	Evergreen

Shor Bu	*Aesculus assamica* (Griff. 1854)	Deciduous
Htie Thu	*Balakata baccata* (Roxb.) Esser 1999	Evergreen/Deciduous
Ter Wee	*Ficus variegate* (Blume 1825)	Evergreen/Deciduous
Ter She	*Rhus chinensis* (Mill. 1768)	Evergreen secondary
Koh Lay	*Cinnamomum iners* (Reinw. ex Blume 1825)	Evergreen/Deciduous
Ter Eun Na	*Ficus hispida* (Linnaeus f. 1781)	Evergreen secondary/ Deciduous
Taw Plar	*Microcos paniculata* (Linnaeus 1753)	Deciduous
Hor Htie	*Crateva magna* (Lour.) DC. 1872	River sides
Tha Wee Htu	*Ficus racemosa var. racemosa* (Linnaeus 1753)	Evergreen/Deciduous
Tha Per Shu Burmese Grape	*Baccaurea ramiflora* (Lour. 1790)	Evergreen/Deciduous
*Klaw Klay*Burma padauk	*Pterocarpus macrocarpus* (Kurz. 1874)	Mix-deciduous forest

FUNGUS SPECIES OBSERVED IN KHOE KAY

Karen / Common Name	*Latin Name*	Where observed	Notes
Ku Khaw Purple mushroom	*Unknown*	On dead bamboo	Used for treating worm infection
Ku Hto Pri colony-rooting basidio-mata	*Termitomyces albuminosus.* (Berk.) R. Heim (1942)	Forest floor/termite rich area	Tasty
Ku bler Gill colony-rooting basidio-mata termite hill mushroom	*Termitomyces spp* (Berk.) R. Heim (1942)	Forest floor/termite rich area	
Ku Hto Pri brown colony-rooting basidio -mata	*Termitomyces spp* (Berk.) R. Heim (1942)	Forest floor/termite rich area	
Ku Ee	*Schizophyllum commune* (Fr. 1815)	On dead tree/Bamboo	
Ku Su wah	*Pleurotus ostreatus (*Fries, 1821)	On Dead tree	
Ku wah ko	*Lentinus squarrosulus* (Mont. (1842)	On dead bamboo	
Ku bun Single-rooting basidiomata	*Termitomyces* spp.(Berk.) R. Heim (1942)	Forest floor	
Judas's Ear	*Auricularia auricula – judae*(Bull.) Wettst., (1897)	On dead tree/Bamboo	Prevalent in Oriental restaurants. http://botit.botany.wisc.edu/toms_fungi/apr2004.html
Ku thay poo Khat ma ma Blushing Bracket	*Daedaleopsis canfragosa* (Bolton: Fr.Schroet. 1888)	On dead tree/Bamboo	

ANIMAL SPECIES OBSERVED IN KHOE KAY

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
ANIMAL SPECIES OBSERVED IN KHOE KAY							
Red Muntjac	*Muntiacus muntjak* (Zimmernann 1780)	Barking Deer	Mixed Deciduous Forest	Foot print, sound, and stools; killed by hunters.	Common	Herbivore, occasional scavenger	Resident
Fea's Muntjac	*Muntiacus feae* (Thomas & Doria 1889)	Barking Deer	Rain Forest	Foot print, sound, and stool.	Common	Herbivore, occasional scavenger	Visitor
Sambar	*Cervus unicolor* (Kerr 1792)	Deer	Forest	Foot print and sound.	Common	Herbivore	Resident
Southern Serow	*Capricornus sumatraensis* (Bechstein 1799)	Wild goat	Caves and Cliffs	Foot print and sound. From hunter.	Common CITES App. I	Herbivore	Resident
Long-tailed Goral	*Naemorhedus caudatus* (Milne-Edwards 1867)	Wild goat	Cave Cliffs	From hunter.	Common IUCN VU,CITES App. I	Herbivore	Resident
East Asian Porcupine	*Hystrix brachyura* (Linnaeus 1758)	Porcupine	Burrows, Forest	Burrows, foot print and from hunter.	Common IUCN VU	Herbivore, bones	Resident
Asiatic Brush-tailed Porcupine	*Atherurus macrourus* (Linnaeus 1758)	Porcupine	Caves, Forest	From hunter, Stools and hairs.	Common	Herbivore, bones	Resident
Eurasian Wild pig	*Sus crofa* (Linnaeus 1758)	Wild Pig	Forest	From hunter, foot print and stools.	Common	Herbivore, occasional scavenger	Resident
Dhole	*Cuon alpinus* (Pallas 1811)	Wild Dog	Forest, travels in packs	Footprints, hunter information.	Uncommon, IUCN EN	Carnivore	Visitor

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
House rat	*Mus musculus* (Linnaeus 1758)	Rat	Farmland	Under a pile of straw.	Common	Herbivore, grain eating	Resident
Long tail mountain rat	*Niviventer rapit* (Bonhote 1903)	Rat	Caves	Seen at night while eating wild fruit.	Common	Omnivore	Resident
Large Bamboo Rat	*Rhizomys sumatrensis* (Raffles 1821)	Bamboo Rat	Large bamboo stands	Seen at night in forest.	Common	Herbivore, occasional scavenger	Resident
Hoary Bamboo Rat	*Rhizomys pruinosus* (Blyth 1851)	Bamboo Rat	Small bamboo stands in secondary forests	In local trap.	Common	Herbivore, occasional scavenger	Resident
Bay Bamboo Rat	*Cannomys badius* (Hodgson 1841)	Bamboo Rat	Small bamboo, open ground	Local people's observation.	Common	Herbivore, worms	Resident
Hog Badger	*Arctonyx collaris* (F.G. Cuvier 1825)	Badger	Forest, burrows	Foot print and smell.	Common	Herbivore	Resident
Asiatic Black bear	*Ursus thibetanus* (G. Cuvier 1823)	Bear	Forest, caves	Habitat.	Common IUCN VU, CITES App. I	Herbivore	Resident
Sun Bear	*Ursus malayanus* (Raffles 1821)	Bear	Forest, caves	Habitat.	Common CITES App. I	Herbivore	Resident
Eastern Hoolock Gibbon	*Hoolock leuconedys* (Mootnick and Groves 2005)	Gibbon	Forest	Loud vocalization, different from Thai gibbons.	Rare IUCN EN, CITES App. I	Herbivore	Visitor
Pharyre's Langur	*Trachypithecus phayrei* (Blyth 1847)	Monkey	Forest	From hunter.	Rare CITES App. II	Herbivore	Resident
Rhesus Macaque	*Macaca mulatta* (Zimmermann 1780)	Monkey	Forest	Binoculars, vocalization.	Hunted to near extinction, IUCN NT, CITES App. II	Herbivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Assamese Macaque	*Macaca assamensis* (McClelland 1840)	Monkey	Forest, especially rocky areas.	Observed, Vocalization.	Common, IUCN VU, CITES App. II	Herbivore	Resident
Slow loris	*Nycticebus coucang* (Boddaert 1785)	Loris	Forest	Observed directly, especially when wind blowing.	Common, CITES App. I	Herbivore	Resident
Banded Linsang	*Prionodon linsang* (Hardwicke 1821)	Linsang	Forest	Preys on villagers' chickens.	Common, CITES App. II	Carnivore	Resident
Common Palm Civet	*Paradoxurus hermaphroditus* (Pallas 1777)	Civet	Forest		Common, CITES App. III	Carnivore	Resident
Large Indian Civet	*Viverra zibetha* (Linnaeus 1758)	Civet	Forest	Smell, foot print and stools.	Common, CITES App. III	Omnivore	Resident
Phayre's Flying Squirrel	*Hylopetes phayrei* (Blyth 1859)	Flying Squirrel	Hollow tree trunk	Observed eating fruit.	Common	Herbivore	Resident
Indian Giant Flying Squirrel	*Petaurista philippensis* (Lee 1998)	Flying Squirrel	Hollow tree trunk	From hunter.	Rare	Herbivore	Resident
Red Giant Flying Squirrel	*Petuarista petaurista* (Pallas 1766)	Flying Squirrel	Treetop nests	From hunter and seeing the nest.	Rare	Herbivore	Resident
Pallas's Squirrel	*Callosciurus erythraeus* (Pallas 1778)	Squirrel	Hollow tree trunks and treetop nests	Seen in trees with binoculars.	Common	Herbivore, seed dispersal	Resident
Burmese Striped Squirrel	*Tamiops mcclellandi* (Horsfield 1840)	Squirrel	Forest on ground level	Forest beside streams.	Common	Herbivore, mainly on fruit	Resident
Three Striped Ground Squirrel	*Lariscus insignis* (F. Cuvier 1821)	Squirrel	Hollow tree trunks and treetop nests	Forest beside streams.	Common	Herbivore, seed dispersal	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Northern Tree Shrew	*Tupaia belangeri* (Wagner 1841)	Squirrel	Hollow tree trunks and treetop nests	Any part of the forest.	Common	Omnivore	Resident
Eurasian Otter	*Lutra lutra* (Linnaeus 1758)	Otter	Salween River	Sound, stools.	Common, IUCN NT, CITES App. I	Fish eater	Raining Season Visitor
Sunda Pangolin	*Manis javanica* (Desmarest 1822)	Pangolin	Forest	Burrow, from hunter.	Common, IUCN NT, CITES App. II	Insectivore	Resident
Chinese Pangolin	*Manis pentadactyla* (Linnaeus 1758)	Pangolin	Forest	Burrow, from hunter.	Rare, IUCN NT, CITES App. II	Insectivore	Resident
Blah Tar Thu – Lesser False Vampire Bat	*Megaderma spasma* (Francis 1977)	Bat	Baw Kah Der village, Cave of Ker Waw Pu	Directly observed with torch light in caves.	Common	Omnivore	Resident
Blah Yu Ko - Large Bent-Winged Bat	*Miniopterus magnater* (Francis 1998)	Bat	Baw Kah Der village, Cave of Ker Waw Pu	Directly observed with Torch light in caves.	Common,	Omnivore	Resident
Blah Khay Hairy-Faced Bat	*Myotis annectans* (Francis 1996)	Bat	Khoe Kay village cave	Directly observed with torch light in caves.	Common, IUCN NT	Omnivore	Resident
Blah Ka Ya Doe Intermediate Horseshoe Bat	*Rhinolophus affinis* (Francis 1996)	Bat	Khoe Kay village cave	Directly observed with Torch light in caves.	Common	Omnivore	Resident
Blah Ka Nar Great Round Leaf Bat	*Hipposideros armiger* (Humphrey 1980)	Bat	Khoe Kay village cave	Caves.	Common	Omnivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
BIRDS							
Great Hornbill	*Buceros bicornis* (Linnaeus 1758)	Bird	Forest	Sound.	Rare, IUCN NT, CITES App. I	Frugivore	Visitor, formerly resident
Sooty-Headed Bulbul	*Pycnonotus aurigaster* (Vieillot 1818)	Bird	Forest	On tree.	Common	Omnivore	Resident
Black-Crested Bulbul	*Pycnonotus melanicterus* (Gmelin 1789)	Bird	Forest	On ficus.	Common	Omnivore	Resident
Thick Billed Green Pigeon	*Treron curvirostra* (Gmelin 1789)	Bird	Forest	Feeding on the ficus fruit.	Common	Omnivore	Resident
Common Hill Myna	*Gracula religiosa* (Linnaeus 1758)	Bird	Forest	Feeding on the ficus fruit.	Common, CITES App. II	Omnivore	Resident
Black- Hooded Oriole	*Oriolus xanthornus* (Linnaeus 1758)	Bird	Forest	On ficus tree.	Common	Omnivore	Resident
Silver Pheasant	*Lophura nycthemera* (Linnaeus 1758)	Bird	Forest floor	Beside stream.	Common	Omnivore	Resident
Rufous-Throated Partridge	*Arborophila rufogularis* (Blyth 1850)	Bird	Forest floor	From hunter.	Common	Omnivore	Resident
Coppersmith Barbet	*Megalaima haemacephala* (Muller 1776)	Bird	Forest	On tree.	Common	Omnivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Oriental Turtle Dove	*Streptopelia orientalis* (Latham 1790)	Bird	Forest	On dead tree.	Common	Seed eater	Resident
Emerald Dove	*Chalcophaps indica* (Linnaeus 1758)	Bird	Forest	On forest floor.	Hunting prohibited locally	Seed Eater	Resident
Grey-Headed Parakeet	*Psittacula finschii* (Hume 1874)	Bird	Forest	On dead tree.	Hunting prohibited locally, CITES App. II	Seed eater	Resident
Crimson Sunbird	*Aethopyga siparaja* (Raffles 1822)	Bird	Forest	On wild banana flower.	Common	Nectarivore	Resident
Grey Wagtail	*Motacilla cinerea* (Tunstall 1771)	Bird	Salween River and stream bank	On dead tree.	Common	Insectivore	Resident
White Wagtail	*Motacilla alba* (Linnaeus 1758)	Bird	Stream banks	Beside Salween River.	Common	Detritus or Omnivore	Resident
Intermediate Egret	*Mesophoyx intermedia* (Wagler 1827)	Bird	Salween River and stream banks	On tree beside Salween River.	Common	Detritus/ Fish Eater	Resident in rainy season
Little Egret	*Egretta garzetta* (Linnaeus 1766)	Bird	Salween River and stream banks	On tree beside Salween River.	Common, CITES App. III	Fish eater	Resident
Chinese Pond Heron	*Ardeola bacchus* (Bonaparte 1855)	Bird	Salween River and stream banks	On tree beside stream.	Common	Fish eater	Resident
Little Heron	*Butorides striatus* (Linnaeus 1758)	Bird	Salween River and stream banks	Beside stream.	Common	Fish eater	Resident
Blue-Eared Kingfisher	*Alcedo meninting* (Horsfield 1821)	Bird	Salween River and stream banks	On Bamboo beside Salween River.	Common	Fish eater	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Rufous-Collared Kingfisher	*Actenoides concretus* (Temminck 1825)	Bird	Stream banks	From hunter.	Rare, IUCN NT	Fish eater	Resident
White-Throated Kingfisher	*Halcyon smyrnensis* (Linnaeus 1758)	Bird	Salween River and stream banks	On tree.	Common	Fish eater	Resident
Spot-Bellied Eagle-Owl	*Bubo nipalensis* (Hodgson 1836)	Bird	Forest	From hunter.	Hunting prohibited locally to control rats, CITES App. II	Carnivore	Resident
Spotted Owlet	*Athene brama* (Temminck 1821)	Bird	Forest	On tree.	Common, CITES App. II	Carnivore	Resident
Greater Racket-Tailed Drongo	*Dicrurus paradiseus* (Linnaeus 1766)	Bird	Forest	On tree.	Hunting prohibited locally to control paddy-eating insects	Insectivore	Resident
Chestnut-Headed Bee-Eater	*Merops leschenaulti* (Vieillot 1817)	Bird	Forest	On tree.	Hunting prohibited locally to control paddy-eating insects	Insectivore	Resident
Green Bee-Eater	*Merops orientalis* (Latham 1801)	Bird	Forest	On dead tree.	Common	Insectivore	
White-Rumped Shama	*Copsychus malabaricus* (Scopoli 1788)	Bird	Forest	On tree.	Hunting prohibited locally to control paddy-eating insects	Insectivore	Resident
Scarlet Minivet	*Pericrocotus flammeus* (Forster 1781)	Bird	Forest	Tree	Hunting prohibited locally to control paddy-eating insects	Insectivore	Resident
White-Browed Scimitar Babbler	*Pomatorhinus schisticeps* (Hodgson 1836)	Bird	Forest	On grass	Hunting prohibited locally to control paddy-eating insects	Insectivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Oriental Magpie Robin	*Copsychus saularis* (Linnaeus 1758)	Bird	Forest	From hunter	Common	Insectivore	Resident
Lesser Necklaced Laughing Thrush	*Garrulax monileger* (Riley 1930)	Bird	Forest	From hunter	Common	Insectivore	Resident
Common Flameback	*Dinopium javanense* (Ljungh 1797)	Bird	Forest	On Dead tree	Common	Insectivore	Resident
Golden-Fronted Leaf Bird	*Chloropsis aurifrons* (Temminck 1829)	Bird	Forest	On dead tree	Common	Insectivore	Resident
Common Stone-Chat	*Saxicola torquata* (Linnaeus 1766)	Bird	Forest	On siam weed	Common	Insectivore	Resident
Slender-Billed Oriole	*Oriolus tenuirostris* (Blyth 1846)	Bird	Forest	On tree	Common	Insectivore	Unknown
Wood Sandpiper	*Tringa glareola* (Linnaeus 1758)	Bird	Forest	On tree	Common	Ominivor	Winter visitor
India Roller	*Coracias benghalensis* (Linnaeus 1758)	Bird	Forest	On tree	Common	Insectivore	Resident
Common Green Magpie	*Cissa chinensis* (Boddaert 1783)	Bird	Forest	On tree	Common	Insectivore	Resident
Asian Fairy-Bluebird	*Irena puella* (Latham 1790)	Bird	Forest	On dead tree	Locally prohibited from hunting, believed to be the spirit of grains.	Insectivore	Resident
Black Drongo	*Dicrurus macrocercus* (Vieillot 1817)	Bird	Forest	Dead tree	Locally prohibited	Insectivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Crested Tree Swift	*Hemiprocne coronata* (Tickell 1833)	Bird	Forest	Tree top	Common	Insectivore	Resident
White-Crested Launghing-Thrush	*Garulax sannio* (Swinhoe 1867)	Bird	Forest	On ground	Locally prohibited	Insectivore	Resident
Banded Bay Cuckoo	*Cacomantis sonneratii* (Latham 1790)	Bird	Forest	On tree	Fairly Common	Insectivore	Resident
Hto Taw Mu Grey-Breasted Prina	*Prinia hodgsonii* (Blyth 1844)	Bird	Paddy Field	On paddy	Common	Unknown	Unknown
Unknown Bird Egg	Unknown	Bird	Forest	On the ground	Unknown	Unknown	Unknown
Bar-Backed Partridge	*Arborophila brunneopectus* (Blyth 1855)	Bird	Forest floor	On the ground	Fairly Common	Insectivore	Resident
Barred Cuckoo Dove	*Macropygia unchall* (Wagler 1827)	Bird	Forest	Tree	Common	Seed eater	Resident
Black-Backed Forktail	*Enicurus ruficapillus* (Temminck 1823)	Bird	Stream	Stream side on Rock	Fairly common IUCN NT	Omnivore	Resident
Black-Collared Starling	*Sturnus nigricollis* (Paykull 1807)	Bird	Forest	On tree	Fairly common	Omnivore	Resident
Blue Whistling Thrush	*Myophonus caeruleus* (Scopoli 1786)	Bird	Stream	On Rock	Rare	Omnivore	Resident
Blue-Bearded Bee-Eater	*Nyctyornis athertoni* (Jardine & Selby 1830)	Bird	Forest	On Tree	Common	insectivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Common Hoopoe	*Upupa epops* (Linnaeus 1758)	Bird	Salween River	On tree	Common	Omnivore	Resident
Greater Coucal	*Centropus sinensis* (Stephens 1815)	Bird	Grass area	On Grass	Common	Insectivore	Resident
Green-Billed Malkoha	*Phaeni-cophaeus tristis* (Lesson 1830)	Bird	Forest	On Tree	Common	Insectivore	Resident
Dark-Necked Tailorbird	*Orthotomus atrogularis* (Temminck 1836)	Bird	Forest	On shrub	Common	Omnivore	Resident
Large-Tailed Nightjar	*Caprimulgus macrurus* (Horsfield 1821)	Bird	Forest	On forest floor	Common	Omnivore	Resident
Little Cuckoo Dove	*Macropygia ruficeps* (Temminck 1834)	Bird	Forest	On Macaranga denticulata tree	Common	Onminvore	Resident
Long-Tailed Broadbill	*Psarisomus dalhousiae* (Jameson 1835)	Bird	Forest	On Banboo	Common	Onminivore	Resident
Oriental Bay Owl	*Phodilus badius* (Horsfield 1821)	Bird	Forest	From hunter	Unknown CITES App. II	Carnivore	Resident
Oriental Pied Hornbill	*Anthracoceros albirostris* (Shaw & Nodder 1807)	Bird	Forest	Sound	Rare CITES App. II	Frugivore	Resident
Blue Magpie	*Urocissa erythrorhyncha* (Boddaert 1783)	Bird	Forest	Salween Side	Common	Insectivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Red Junglefowl	*Gallus gallus* (Linnaeus 1758)	Bird	Forest	On the ground	Common	Omnivore	Resident
River Lapwing	*Vanellus Duvaucelii* (Lesson 1826)	Bird	Salween River side	On the sand	Common	Fish eater	Visitor
Rufous- Fronted Babbler	*Stachyris rufifrons* (Hume 1873)	Bird	Forest	On Shrub	Common	Omnivore	Resident
White Bellied Woodpecker	*Dryocopus javensis* (Tristan 1879)	Bird	Forest	On dead tree	Common CITES App. I	Insectivore	Resident
Large Scimitar Babbler	*Pomatorhinus hypoleucos* (Blyth 1844)	Bird	Forest	On Shrub	Common	Insectivore	Resident
REPTILES							
King Cobra	*Ophiophagus hannah* (Cantor 1836)	Snake	Beside stream	On the ground stream side	Unknown CITES App. II	Carnivore	Resident
Reticulated Python	*Python reticulates* (Schneider 1801)	Snake	Beside stream and Salween River	Catch with fish men net	Common CITES App. II	Omnivore	Resident
Stream Side Lizard	*Mabuya novem-carinata* (Anderson 1871)	lizard	Forest	Stream side	Common	Insectivore	Resident
Ground Skink	*Scincella doriae* (Boulenger 1887)	Lizard	Forest	Moist area	Common	Insitivore	Resident
Agamid Flying Lizard	*Draco maculates* (Gray 1845)	lizard	Forest	On tree	Common	Insectivore	Resident
Asian Water Monitor	*Varanus salvator salvator* (Laurenti 1788)	Monitor lizard	Salween River	In Salween river.	Common CITES App. II	Carnivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Clouded Monitor Lizard	*Varanus bengalensis nebulosus* (Grey 1831)	Lizard	Beside Salween River	Bathing Beside Salween	Common, CITES App. I	Insectivore	Resident
Yellow Or Elongate Tortoise	*Indotestudo elongata* (Blyth 1853)	Tortoise	Forest close to stream	Beside the stream	Locally Uncommon, IUCN EN, CITES App. II	Mushrooms, aquatic insects, algae	Resident
Southeast Asian Soft Shelled Turtle	*Amyda cartilaginea* (Boddaert 1770)	Turtle	On the stream and Salween River	Caught with fish hook	Common, IUCN VU, CITES App. II	Mushrooms, aquatic insects, algae	Resident
Agamid Lizard	*Calotes emma* (Gray 1870)	Lizard	Forest	Stream side	Common	Insectivore	Resident
Sri Lankan Krait	*Bungarus ceylonicus* (Gunther 1858)	Snake	Forest	Stream side At night	Common	Carnivore	Resident
Khu Keh Pen Barron's Kukri Snake	*Oligodon barroni* (Smith 1916)	Snake	Forest	Forest	Common	Carnivore	Resident
Khu Law	Unknown	Snake	Forest	Forest	Common	Carnivore	Resident
Green Tree Viper	*Trimeresurus albolabris (*Gray 1842)	Snake	Forest	On the tree	Common	Carnivore	Resident
Cat Snake	*Boiga multo-maculata* (Reinwardt 1827)	Snake	In the village	Close to the Chicken hatch	Very common	Carnivore	Resident
AMPHIBIANS							
Blyth's River Frog	*Limnonectes blythii* (Boulenger 1920)	Frog	Stream side and wet land	Stream side	Fairly common, IUCN NT	Insectivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Corrugated Frog	*Limnonectes laticeps* (Boulenger 1882)	Frog	Stream side and wet land	Stream	Common	Insectivore	Resident
Unknown Creek Frogs	*Limnonectes sp*	Frog	Stream side and wet land	Stream side	Common	Insectivore	Resident
Kuhl's Creek Frog	*Limnonectes kuhlii* (Tschudi 1838)		Stream side and wet land	Stream side	Very common	Insectivore	Resident
Unknown Frog	*Brachytar-sophrys* ssp.	Frog	Stream	Stream	Unknown	Unknown	Unknown
FISH							
Subfamily Alburninae	*Paralaubuca sp.*	Fish	Salween	Caught by net	Common	Omnivore	Resident
Subfamily Danioninae Oxygastrini	*Opsarius sp.*	Fish	Salween Tributaries	Stream	Common	Omnivore	Resident
Queen Danio	*Danio regina* (Fowler 1934)	Fish	Salween Tributaries	Stream	Common	Omnivore	Resident
Subfamily Cyprinini	*Neolissochilus vittatus* (Smith 1945)	Fish	Salween Tributaries	Stream	Common	Omnivore	Resident
Nya Plar	*Neolissochilus sp.*	Fish	Salween Tributaries	Caught by net	Common	Omnivore	Resident
Nya Moe	*Tor tambroides* (Bleeker 1854)	Fish	Salween/Stream	Caught by net	Common	Omnivore	Resident
Subfamily Cyprininae – Systomini	*Osteobrama sp.*	Fish	Salween Tributaries	Caught by net	Common Endemic	Omnivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Subfamily Cyprininae – Systomini	*Steobrama sp.*	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident
Subfamily Cyprininae – Poropunti	*Hypisbarbus salweenensis* (Rainboth 1996)	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident
Nya Tho Wah	*Hypisbarbus* sp.	Fish	Salween	Caught by net	Common	Omnivore	Resident
Redtail Goatface Barb	*Chagunius baileyi* (Rainboth 1986)	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident
Subfamily Cyprininae – Labeonini	*Morulius chrysophekadian* (Bleeker, 1850)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Nya Khen	*Labeo yunnanensis* (Chaudhuri 1911)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Subfamily Cyprininae – Semiplotini	*Scaphiodo-nichthys burmanicus* (Vinciguerra 1890)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Nya Per Tay	*Garra* sp.	Fish	Salween	Caught by net	Rare	Algae eater	Resident
Family Balitoridae - Flying Fox	*Schistura desmotes* (Fowler 1834)	Fish	Salween Tributaries	stream	Common	Omnivore	Resident
Bun Per Loo	*Schistura* sp.	Fish	Salween Tributaries	stream	Common	Omnivore	Resident
Hta Kat	*Schistura* sp.	Fish	Salween Tributaries	Sream	Common	Omnivore	Resident
Family Cobitidae Salween Loach	*Botia rostrata* (Gunther 1868)	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Order Siluriformes Bagrid Catfish	*Sperata acicularis* (Ferraris & Runge 1999)	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident
Nya Pa Kat	*Mystus falcarius* (Chakrabarty & Ng 2005)	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident
Nya Mu	*Hemibagrus filamentus* (Fang & Chaux 1949)	Fish	Salween	Caught by net		Omnivore	Resident
FamilySiluridae Sheat Catfish	*Micronema apogon* (Bleeker 1851)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Nya Awn Ka	*Wallago attu* (Schneider 1801)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Family Schilbeidae Schilbeid Catfish	*Eutropiichthys burmanicus* (Day 1877)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Sisoridae	*Bagarius bagarius* (Hamilton 1822)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Nya Kwe Baw	*Bagarius yarrlli* (Sykes 1941)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Nya Kay	*Gagata gasawyuh* (Roberts & Ferraris 1998)	Fish	Salween	Caught by net	Common Endemic	Omnivore	Resident
Nya Per	*Glyptothorax dorsalis* (Vinciguerra 1890)	Fish	Salween/Salween Tributaries	Caught by net	Common	Omnivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Spiny Eel	*Mastacembelus alboguttatus* (Boulenger 1893)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Snakehead, Murrel	*Channa limbata* (Cuvier 1831)	Fish	Salween	Caught by net	Common	Omnivore	Resident
Nya Ler	*Rita sacerdotum* (Anderson 1879)	Fish	Salween	Caught by net	Common	Omnivore	Resident
INSECTS							
Soe Be Praying Mantis	*Tenodera aridifolia* (Saussure 1871)	Mantis	Forest	On plant	Common	herbivore	Resident
Stick Insect Tessellated Phasmatid	*Ctenomorphodes tessulatus* (Gray 1835)	Stick Insect	Forest	On plant	Common	Herbivore	Resident
Dweh Pay Na Sword-Tailed Crickets	*Metioche vittaticollis* (Stål 1861)	Grasshopper	Forest	On plant	Common	Herbivore	Resident
Dweh Taw Baw	*Locusta migratoria* (Linnaeus 1758)	Grasshopper	Forest	On grass	Common	Herbivore	Visitor
Dweh Khoe Baw	*Oedipoda germanica* (Latreille 1804)	Grasshopper	Forest	On grass	Common	Herbivore	Visitor
Strip-Wing Grasshoper	*Oxya yezoensis* (Shiraki 1910)	Grasshopper	Marshes	On grass	Common	Herbivore	Resident
Katydid	*Pterophylla camellifolia* (Fabricius 1775)	Grasshopper	Marshes	On grass	Common	Herbivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Small Long-Headed Grasshopper	*Atracta morpha lata* (Motschulsky 1866)	Grasshopper	Forest	On plant	Common	Herbivore	Resident
Dwe Shaw A	*Sphex argentatus fumosus* (Kohl 1890).	Grasshopper	Grass	Plant	Common	Herbivore	Resident
Long Horn Grasshopper	*Neoconocephalus* sp. (Karny 1907)	Grasshopper	Caves	Ground	Common	Herbivore	Resident
Dwe Pwo Green Bird Grasshopper	*Schistocerca shoshone* (Thomas 1873)	Grasshopper	Grass	Plant	Common	Herbivore	Resident
Cicada	*Tosena albata* (Distant 1878)	Cicada	Forest	On tree	Common	Herbivore	Resident
Honey Bee	*Apis cerana* (Fabricius 1793)	Bee	Forest	Hive on emergent tree	Common	Netarivore	Resident
Honey Bee Subspecies	*Apis cerana indica* (Fabricius 1793)	Bee	Forest	Tree hole	Common	Nectarivore	Resident
Der Ter Yu	*Apis florea* (Fabricius 1787)	Bee	Forest	Hive On small tree	Common	Nectarivore	Resident
Larged-Tail Bumble Bee	*Bombus lapidaries* (Linnaeus 1758)	Bee	Forest	On flower	Common	Nectarivore	Resident
Asian Giant Hornet Wasp	*Vespa mandarinia* (Smith 1852)	Wasp	Forest	On the ground	Common	Herbivore	Resident
Hornet Wasp	*Vespa affines* (Linnaeus 1758)	Wasp	Forest	On Shrubs	Common	Herbivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Kheekhay	Unknown larva	Wasp larva	House or forest	At night with light	Common	Omnivore	Resident
Black Fire Ant	*Monomorium minimum* (Buckley 1866)	Ant	Forest	On tree	Common	Herbivore	Resident
LEPIDOPTERA							
Shoe Ker Pay	*Argyreus* sp.	Butterfly	Forest	On plant	Common	Omnivore	Unknown
Common Archduke	*Lexias pardalis* (Boisduval 1832)	Butterfly	Forest	On plant	Common	Omnivore	Unknown
Single Red Spot Wing Butterfly	Unknown	Butterfly	Forest	On plant	Common	Omnivore	Unknown
Shaw Bee Lar Ka Black Spotted Wing Moth	Unknown	Moth	Forest	On bamboo shoot	Common	Bamboo shoot only	Resident
Hairy White Antenna Tip Moth	Unknown	Moth	House or forest	At night with light	Common	Omnivore	Resident
Skipper	*Sphinx ligustri* (Linnaeus 1758)	Skipper	Forest	On the light of Bulb	Common	Omnivore	Resident
Swallowtail Caterpillar	*Papilio glaucus* (Linnaeus 1758)	Caterpillar	Forest	On the Plant leaves	Common	Herbivore	Resident
Spotted Saw Tooth	*Prioneris thestylis* (Doubleday 1842)	Butterfly	Forest	On flower	Common	Nectarvore	Resident
Ker Shol A Khar	*Geotrupes stercorarius* (Linnaeus 1758)	Beetle	Forest	In the animal dung	Common	Dung eater	Resident
Shwe Baw Ner	*Xylotrupes Gideon* (Linnaeus 1758)	Beetle	Forest	On woody vine	Common	Herbivore	Resident

Species – Local Name	Latin Name (source)	Taxa	Location	Evidence of presence	Status: Local and IUCN- CITES	Food Source	Resident or Visitor
Shwe Ka Kher	Unknown	Beetle	Forest	On plant	Unknown	Unknown	Unknown
Ker Loo	*Sternocera aequisignata* (Saunders 1866)	Beetle	Forest	On tree leaves	Common	Herbivore	Resident
Strip Wing Ker Loo	*Chrysochroa rajah thailandica* (Kurosawa 1978)	Beetle	Forest	On leaves	Common	Herbivore	Resident
Ko May Kha	*Cyrtotrachelus* sp.	Beetle	Forest	On bamboo shoot	Common	Herbivore	Resident
Tiger Beetle	*Mylabris cichorii* (Linnaeus 1767)	Beetle	Forest	On flower	Common	Herbivore	Resident
SPIDERS (Orb Weavers - Araneidea) Identified during transect study and forest walks – no separate surveys performed.							
Ker Paw Ta Nya Batik Golden Web Spider	*Nephila antipodiana* (Walckenaer 1841)	Spider	Forest	Nest between plants	Common	Insectivore	Resident
Red Legs Ker Paw Ta Nya	*Nephila* sp.	Spider	Forest	Nest between plants	Common	Insectivore	Resident
Multi-Coloured St Andrew's Cross Spider	*Argiope versicolor* (Doleschall 1859)	Spider	Forest	Nest between plants	Common	Insectivore	Resident
Ker Paw Hor Ko - Four-Spotted Nursery Web Spider	*Eurychoera quadric-maculata* (Thorell 1897)	Spider	Forest	Nest between plants	Common	Insectivore	Resident
OTHER SPECIES							
Unknown Scorpion	*Heterometrus* sp.	Scorpion	Forest	Under decay leaves	Common	Insectivore	Resident
Banded Snail	*Cepaea sp*	Snail	Forest	On ground	Very common	Omnivore	Resident

Appendix B
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Appendix C
Field Trip Questionnaire

Plants:

1. **Trees:**
   a) List five tree species that you see in this trip and you think is important.
   b) Give reasons on each species why you think is important.
   c) What roles each species play in different types of ecological classification by local people.
   d) How do you know this species?
   e) What senses do you use to identify these species?
      See: ----------
      Hear: ----------
      Taste: ----------
      Touch: ----------
      Smell: ----------
      Others: please be more specific: ----------

   f. In what way each species benefit you.
      * Food ----------
      * Medical ----------
      * Religious ----------
      * Others ----------

Same questions, for these species:

2. **Woody vines**
3. **Bamboos:**
4. **Rattan:**
5. **Orchids:**
6. **Mushroom:**
7. **Palm:**
8. **Musa** (wild banana)
9. **Yam and Yarrow**
10. **Birds:**
10. **Reptile:**
12. **Mammals:**
13. **Amphibian:**
14. **Insects:**
    - **(a) Bees:**
    - **(b) Wasps:**
    - **(c) Grasshopper:**
    - **(d) Lady bug:**
    - **(e) Crickets**
15. **Fern**

Appendix D
Selected Pictures of Species

Endangered Species

Hairy Faced Bat

Rhesus Macaque

Phayre's Langur

Malayan Sunbear

Rufous Collared Kingfisher

Grey Headed Parakeet

Reticulated Python

Yellow or Elongated Tortoise

Southeast Asian Softshelled Turtle

Blyth's River Frog

Dendrobium aphyllum

Clouded Monitor Lizard

Cycas pectinata

Rhynchostylis retusa

Endemic Species

Chagunius baileyi

Botia rostrata

Hypisbarbus salweenensis

Gagata gasawyuh

Mystus cavasius

Sperata acicularis

***Osteobrama* sp.**

***Steobrama* sp.**

Other Interesting Species

Large Bamboo Rat

Lesser False Vampire Bat

Pallas' Squirrel

Wood Sandpiper

Chestnut Headed Bee Eater

Green Bee Eater

Coppersmith Barbet

White Rumped Shama

Green Tree Viper

Water Monitor Lizard

Other Interesting Species

Sternocera aequisignata

Praying mantis

Four Spotted Nursery Web Spider

Katydid

Other Interesting Species

Aeginetia indica

Bee bay pah khaw
Sterculia lanceolata

Clerodendrum paniculatum

Curcuma roscoeana

Musa acuminate

Giant Taro

Paw Say Baw
Tropidia angulosa

Calamus rudentum

Diplazium esculentum

Termitomyces albuminosus

***Termitomyces* sp. *Rooting* basidiomata with gills**

About KESAN

Due to decades of war, gross human rights abuses, widespread displacement, and unsustainable resource extraction, environmental degradation is occurring at an alarming rate in Eastern Burma our Karen indigenous people are losing control over their land, and forest resources.

KESAN is a community based organisation working to increase livelihood security using a socio-environmental approach which empowers and educate communities and local institutions to revitalize existing indigenous knowledge and practices to sustainably use and manage forest resources for the long term benefit of the community; while also playing a leading role in articulating environment and development concerns in law and policy development in preparation for the post-transition period.

Vision

Karen indigenous in Burma live a peaceful life in a healthy environment and actively people demonstrate our role in maintaining ecological balance and livelihood security.

Mission

KESAN is a local organization working alongside local communities in Karen State, Burma to build -up capacities in natural resource management, rise public environmental awareness, support community based initiatives; and collaborate with organizations at all levels to advocate for environment policies and development priorities that ensure sustainable ecological, social, cultural and economic benefits.

Objectives

1) To enhance capacities of local communities and community-based organizations to enable activities for environmental protection and social development.

2) To support community-based natural resource management initiatives to preserve our environment, cultures and traditional livelihoods.

3) To develop indigenous environmental education and materials to increase children and youth awareness and participation in environmental protection.

4) To advocate for environment policies and practices and development priorities that are environmentally friendly, socially equitable, culturally beneficial and economically viable.

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