# 3.2 BIOLOGICAL RESOURCES

## Ecological Characteristics of the River

**Box 8**

### Ecological Characteristics of the Nam Ou Basin

The Nam Ou Basin lies within the Northern Indochina sub-tropical terrestrial ecoregion as defined by World Wide Fund For Nature (WWF) (Olson and Dinerstein 2002). The basin also lies within the moist, sub-tropical broadleaf forest biome and is recognized to have special karst features. Under the classification system for river reaches developed for the Greater Mekong sub-region (Lehner and Ouellet Dallaire 2014), which uses three groups of classes, the following may be noted about the Nam Ou Basin's hydrologic, physio-climatic, and geomorphologic features:

**Hydrologic:**

- The tributaries of the Nam Ou can be classified as medium-sized rivers based on their mean annual flow of 10-100 $m^3$/sec.
- The Nam Ou mainstem from the Nam Khang confluence to Pak Ou can be classified as a large river with a mean annual flow of 619 $m^3$/sec (range 100-1,000 $m^3$/sec).
- The peak monthly discharges are about three times the mean annual flow, which put the tributaries in the category of high seasonal flow variability. The upper reaches have a slightly lower flow variability because of the lower rainfall compared to the lower reaches and tributaries.

**Physio-climatic:**

- The tributaries and the mainstem are in the high (above 750 masl) and low (below 750 masl) moist broadleaf forests.
- There is significant presence of karst in the lower parts of the river.

**Geomorphologic:**

- The tributaries and the mainstem have high stream gradient.
- The tributaries and the mainstem have presence of sediment but no floodplain.

## Habitat Surveys

**Box 9**

### Habitat Survey – Ban Vangle, Pak Ou

A detailed habitat survey was carried out on the sand and gravel island upstream of Ban Vangle, near Pak Ou (see also Figure 6). The Google Earth image of the area shows the widening of the river channel at this point with two channels, both of which are fast-flowing. The left-bank channel is wider with exposed rocks and shrubs at the upstream and downstream ends. This channel has some small rapids and riffles. The right-bank channel is about 30-40 m wide with a sharp bend at the end of the island where it rejoins the main channel. There is an area of rock and sand deposition at this point, used extensively by the small village on the right bank.

The island itself is 580 m long by 190 m wide, consisting of deposited sand, gravel, and pebble beds, laid down in channels that are inundated in the high flow season. The higher banks of the island are vegetated with tall grasses and shrubs, especially Mimosa pigra. The left bank of the river has larger trees and shrubs, while the right bank has riverbank gardens and smaller trees and shrubs.

A macroinvertebrate survey of the sand, gravel, and bank vegetation on the island showed relatively sparse populations of Crustacea (crabs and shrimps), mayflies, bugs and beetles, molluscs, and small fish. The biodiversity index showed a score of 6.5, indicating a moderately modified stretch of the river in fair condition. The populations of macro-invertebrates in the upper bank layers sampled were probably depressed because of changes in water level due to a recent storm and flow changes from upstream dams.

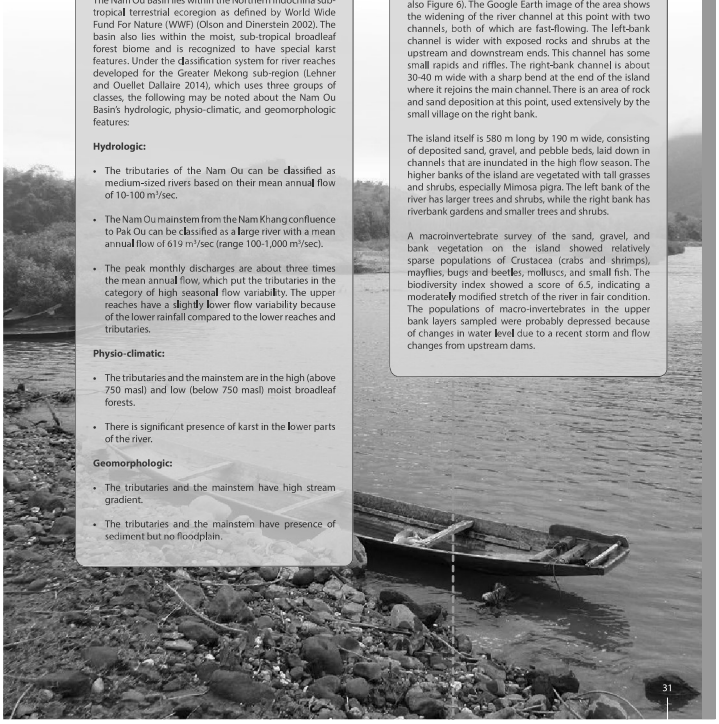
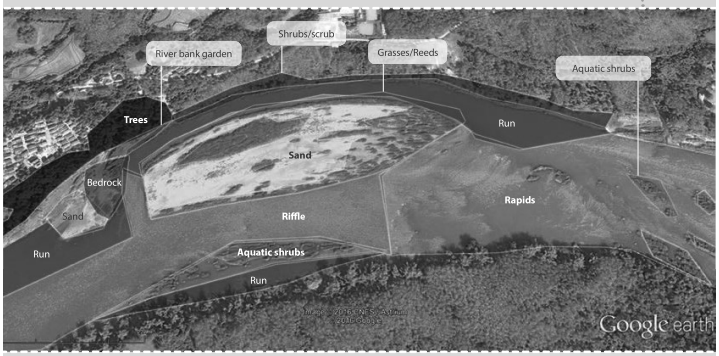




**Figure 6** **Google Earth image of the island opposite Ban Vangle (top), overlay of aquatic habitats, bank type, and bank vegetation types on island upstream of Ban Pak Ou (bottom).**




## Fisheries & Aquatic Resources

**Box 10**

### Fisheries Resources in the Nam Ou Basin

There have been several studies of the fishes of the Nam Ou Basin, notably by Kottelat (2009) for WWF. Surveys were conducted for the environmental impact assessment (EIA) of the Nam Ou cascade and noted that because of the diverse range of aquatic habitats, the Nam Ou supports a high diversity of fish species that have adapted to fill the different ecological niches in the river (Warren 2010).

Kottelat (2009) identified a total 84 fish species of 23 different families in the Nam Ou Basin. At least three species are exotic, having been introduced for aquaculture, such as the Nile Tilapia (*Oreochromis niloticus*), or for stocking, such as Rohu (*Labeo rohita*) and Common Carp (*Cyprinus carpio*). Golden Barb (*Puntius semifasciolatus*) and Spotted Steed (*Hemibarbus maculatus*) may also have been introduced into the basin through the Nam Noua from Vietnam (Kottelat, 2009). Dr. Phouvin Phousavanh (NUOL) conducted a series of fisheries surveys between 2007 and 2011, identifying a total of 139 species in the Nam Ou and its tributaries.

The Mekong Giant Catfish (*Pangasianodon gigas*), a critically endangered species, is reported as being present in the area of the confluence with the Mekong but not in the Nam Ou itself. The lower part of the Nam Ou from Meuang Ngoy to Pak Ou is listed as a key biodiversity area (KBA) by the International Union for Conservation of Nature (IUCN) (https://www.iucn.org/key-biodiversity-areas) because of the presence of another critically endangered species, the Giant Barb (*Catlocarpio siamensis* or *Pba Chok*). Respondents at provincial validation workshops held in Phongsaly and Luang Prabang in 2017 confirmed that this species is found in the Nam Ou as far up as Pak Ban where fish of up to 10 kg have been caught, but it is not found in Oudomxay Province.

Two other endangered fish species, the Mekong Freshwater Stingray (*Dasyatis laosensis*) and Seven-striped Barb (*Probarbus jullieni*), are also found throughout the Nam Ou. A spawning ground of the Seven-striped Barb and its spawning behaviors have been recorded at Ban Hatkhe, which is 41 km upstream from the confluence with the Mekong and 27 km upstream of the proposed Nam Ou 1 hydropower project site.

Respondents at the 2017 provincial validation workshops also noted the presence of one of the longest distance migratory species, *Pangasius krempfi*, which migrates from the Mekong Delta to spawn and returns with its young. It was noted as far upstream as Meuang Samphan where fish of up to 30 kg have been caught. By contrast, the Marbled Eel (*Anguilla marmorata*) is the only truly catadromous fish of the Mekong migrating from the river to breed in the sea.

Fish migrations are an important part of the seasonal cycle. Fish move upstream from the Mekong into the Nam Ou and from the Nam Ou mainstream into the tributaries to breed. There are two main migration seasons: late in the dry season when the waters and flow rates are low and the smaller fish can move upstream easily; and in the flood season, when there is more water and the larger, stronger swimming fish, such as catfish, migrate. At the end of the flood season, many fish migrate back downstream again (Poulsen, et al. 2004, Warren 2010).

Table 2 shows the number of species falling into different fish guilds (or groupings) as described by (Welcomme et al. 2006). There are 28 rhithron resident guild species, which are typical of fast-flowing rocky, mountainous rivers. There are 48 main channel migratory species, including one migratory main channel and tributary resident guild species (*Bangana behri (8)*), 27 migratory main channel spawner guild species, and 20 migratory main channel refuge seeker guild species. Generally known as white fish species, they migrate from the Mekong mainstream into the tributaries such as the Nam Ou and from there into its tributaries, either to spawn or to seek refuge during the dry season.

Thirty species are characterized as generalists, which live and breed under wide ecological conditions. Six species are floodplain residents, generally known as black fish species. Only one species, the Marble Goby (*Oxyeleotris marmorata (127)*), is semi-anadromous (living both in brackish and estuarine conditions). There are no catadromous (moving back down to the sea to breed) or marine species, as is to be expected. There are five non-native species and six whose guild is not known. Three exotic species reported are widely distributed throughout the basin.

This analysis of fish guilds found in the Nam Ou shows that it is dominated by species that are characteristic of fast-flowing rocky mountain rivers as well as migratory species that move from the Mekong mainstream into the Nam Ou and its tributaries. The proportion of generalist species and black fish species is lower than in some other tributaries where there are greater lengths of slower-moving lowland rivers.



**Table 2** **Distribution of fish species by fish guilds in the Nam Ou Basin.**

| Guild | Description | No. of species | % of species |
|---|---|---|---|
| Guild 1 | Rhithron resident guild | 28 | 22.6 |
| Guild 2 | Migratory main channel and tributaries resident guild | 1 | 0.8 |
| Guild 3 | Migratory main channel spawner guild | 27 | 21.8 |
| Guild 4 | Migratory main channel refuge seeker guild | 20 | 16.1 |
| Guild 5 | Generalist guild | 30 | 24.2 |
| Guild 6 | Floodplain resident guild (Blackfish) | 6 | 4.8 |
| Guild 7 | Estuarine resident guild | 0 | 0.0 |
| Guild 8 | Semi-anadromous guild | 1 | 0.8 |
| Guild 9 | Catadromous guild | 0 | 0.0 |
| Guild 10 | Marine guild | 0 | 0.0 |
| NG | No Guild appropriate | 0 | 0.0 |
| NK-NI | Not Known or No Information | 6 | 4.8 |
| NN | Non-Native | 5 | 4.0 |
| **Total** | | **124** | **100.0** |

A number of threatened fish species are found in the river, according to the IUCN Red List of Threatened Species (Red List). One species, *Scaphognathops theunensis (71)*, is considered critically endangered; three are endangered, including *Luciocyprinus striolatus (37)*, *Probarbus jullieni (56)*, and *Probarbus labeamajor (57)*; and five are considered vulnerable, namely *Bangana behri (8)*, *Crossocheilus reticulatus (15)*, *Hypsibarbus lagleri (31)*, *Mystacoleucus lepturus (44)*, and *Pseudohemiculter dispar (58)*.

The critically endangered *Scaphognathops theunensis* is only found in the Nam Theun and Nam Gnouang rivers, which are a long way from the Nam Ou. Identification of specimens collected from the Nam Ou is being conducted to confirm that this species is indeed more widespread than reported in the IUCN Red List, and/or if villagers had erroneously identified the fish. Another similar species found in the Nam Ou, *Scaphognathops stejnegeri (72)*, was recorded in two locations – Ban Pakban and Ban Paknga – and is of least concern on the IUCN Red List.

When the Nam Ou 4 dam is built, the five endangered species identified by villagers at Ban Pakban will probably disappear. When the Nam Ou 1 dam is built, the two endangered species at Ban Paknga will also likely disappear, especially *Probarbus jullieni (56)*, which has a recognized low-flow spawning area at Ban Hatkhe that will be inundated after the construction of the dam.

Table 3 lists the distribution of fish guilds reported by villagers in the eight villages for case studies.

**Table 3** **Number of fish species reported at 8 villages from the Nam Ou and associated tributaries. Fish species are grouped based on their guilds[1], and their origin. Number of Species of Concern (IUCN/Red List)[2] are listed.**

| | Village | Waterbody | Fish groups (guilds)[1] | | | | | Origin | | | IUCN (Red List)[2] | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | D | E | Endemic | Native | Exotic | CR | EN/VU | NT | |
| 1 | Ban Nagnao | Nam Ou | 19 | 12 | 14 | 4 | 3 | 19 | 35 | 3 | | 3 | 3 | 52 |
| 2 | Ban Homsang[3] | Nam Ou | 14 | 12 | 7 | 4 | 3 | 10 | 29 | 3 | 1 | | 2 | 41 |
| | | Reservoir | 1 | 3 | 3 | | 2 | 2 | 4 | 2 | | | | 9 |
| 3 | Ban Pakban | Nam Ou | 16 | 25 | 14 | 1 | 3 | 18 | 40 | 3 | 1 | 5 | 6 | 59 |
| | | Nam Ban | 4 | 5 | 2 | | | 4 | 7 | 0 | | | 2 | 11 |
| 4 | Ban Buamsom | Nam Phak | 11 | 11 | 16 | 3 | 1 | 16 | 29 | 1 | 1 | | 2 | 42 |
| 5 | Ban Sopnao | Nam Noua | 7 | 9 | 8 | 3 | 2 | 9 | 19 | 2 | 1 | | 2 | 29 |
| 6 | Ban Sopkhong | Nam Ou | 9 | 18 | 14 | 6 | 2 | 13 | 36 | 2 | 1 | 1 | 2 | 49 |
| 7 | Ban Pak Nga | Nam Ou | 12 | 21 | 11 | 2 | 3 | 14 | 35 | 3 | 1 | 2 | 4 | 49 |
| | | Nam Nga | 2 | 3 | | | | 3 | 2 | 0 | | | | 5 |
| 8 | Ban Pak Ou | Nam Ou | 1 | 20 | 10 | 2 | 2 | 7 | 26 | 2 | 1 | 2 | 4 | 35 |
| | **Total** | | **28** | **48** | **30** | **6** | **5** | **35** | **86** | **5** | **1** | **8** | **8** | **117** |

[1] Fish grouping: (A) Rhithron resident (guild-1); (B) Migratory main channel, resident, spawner, and refuge seeker species (Guild 2-4); (C) Generalist (Guild-5); (D) Floodplain resident/blackfish (Guild-6); and (E) Non-Native.
[2] IUCN Red List species of concern: (CR): Critically Endangered; (EN/VU): Endangered or Vulnerable; & (NT) Near Threatened.
[3] Ban Homsang: a relocated village previously known as Ban Phoumuang.

### Fisheries & Fishing Gear

The fishery specialist report for the EIA of the Nam Ou cascades included surveys with fishermen in 18 villages along the length of the river (Warren 2010). The surveys revealed that a single fisherman could on average catch between 0.5 kg and 3.0 kg of fish per day using whatever gears appropriate to the time of year. During the upstream fish spawning migrations between April and June, daily landings can rise considerably, and reports of individual fishermen catching in excess of 10 kg per day are not uncommon (sometimes as high as 30 kg per day). When fish landings exceed what is necessary for daily household consumption, fish are sold for cash if they are medium-sized (1 or 2 kg) or large (>5 kg) and processed –fermented, smoked, or sun-dried – if they are small (Warren 2010).

In December and January, men from the Luang Prabang districts of the Nam Ou may catch 5-10 kg of fish per day using a cast or scoop net and women may catch 2-5 kg per day using different gear. The transition to wet season is the most productive period, with about 70% of the catch sold and 30% used domestically.

Further upstream in Phongsaly, fish catches tend to be lower in Gnot Ou. A fisherman normally catches around 2-3 kg per day during dry season. Most fish are consumed domestically rather than sold. Before the impoundment of the Nam Ou 5 hydropower project, fish catches in Ban Pak Ban between February and March could be as high as 20-30 kg per day, while fewer fish were caught between August and October. During impoundment, when the river levels were very low, they caught many fish including large ones. Now fish catches have been reduced to less than 0.5 kg per day. In Ban Homsang, during the impoundment of the Nam Ou 6 reservoir, they caught 10-20 kg of fish per day and sold 70% of them in Ban Hatsa and Meuang Khoa markets while consuming the rest.

The main fishing gears used include fixed and drift gillnets, beat-nets, cast-nets, "Jun" traps, long-lines, single hooks, "Sai" traps, "dtawn", "Oo" traps, home-made spear guns, "Son", "Dtoom", and "Scoup-nets". Some of the gears are seasonal and others are used year-round (Warren 2010).

Fish conservation zones (FCZ) have been established with assistance from WWF at several villages along the Nam Ou and its tributaries. These zones are sections of the river that are recognized by local fishermen as important habitats for fish; usually they are deep pools that provide refuge for fish during the dry season and serve as spawning areas or fish nursery grounds. Participating fishermen from surrounding villages agree to abide by the rules and regulations restricting fishing activities in these zones, which are often marked with a string of flags across the river at the beginning and end of the reach that may be 500-m or 1-km long. Most fishermen agree that FCZ are effective in helping to protect and increase fish stocks.

Warren (2010) identified 15 villages with established FCZ on the Nam Ou mainstem. In the Luang Prabang districts of the Nam Ou Basin, there are 30 FCZ, with 25 on the Nam Ou (Ngoy – 10, Nam Bak – 11, Pak Ou – 4) and five on the Nam Nga as of 2016. In the Oudomxay districts along the river, more than 90 villages have 35 conservation pools and 101 protection pools, figures from the 2017 provincial validation workshops show. Local regulations prohibit the use of explosives, electrofishing, and biocides (poison) to catch fish; however, these activities are still undertaken in some communities

### Other Aquatic Animals (OAA)

Several OAA species, especially freshwater prawns, river weed (*Cladophora* spp.), amphibians, and reptiles are important in the local subsistence economy and in livelihoods of communities along the Nam Ou. However, no systematic studies of OAA, which include benthic invertebrates, zooplankton, phytoplankton, molluscs, crustaceans, and aquatic insects, have been conducted in the Nam Ou Basin.

A few turtle species are found in the basin, many of which are captured for sale and consumption. Some species are critically endangered, including the Asian Box Turtle (*Cuora amboinensis*) and the Indochinese Box Turtle (*C. galbinifrons*) – both of which have been captured in Phongsaly. There is one endangered amphibian species, the Yunnan spiny frog (*Nanorana yunnanensis*). These species are threatened primarily by human consumption and habitat loss.

**Box 11**

#### Littoral macroinvertebrates bio-survey

Littoral (shoreline) macroinvertebrates are good indicators of a river's general health because different taxonomic groups respond differently to changing flow and chemical conditions in the river. During field studies conducted in developing this Profile, the South African miniSASS system was used to sample and analyze macroinvertebrates. Littoral macroinvertebrates are probably the easiest aquatic fauna to sample from the banks and can be sorted on site, preserved, and identified at leisure. However, the choice of sampling sites is important: usually banks and river beds with gravel, pebbles, and boulders are the most effective for sampling, as sand and mud tend to be too dense for many species.

The bio-survey index results showed that three sites in the upper river – the Nam Ou source stream, a natural site above Gnod Ou, and the Gnod Ou Bridge – are considered the most natural, despite some disturbance from agricultural runoff and pollution from Gnod Ou town. Stoneflies were found in all three sites, which increased their scores.

Downstream sampling was not possible until Ban Sopkhong, which was considered to have a good macroinvertebrate index despite a rather low number of groups and indicators showing higher sensitivity. Below Ban Paknga, Ban Hatkhe, and Ban Vangle, the macroinvertebrate index revealed fair to poor conditions possibly due to a combination of high rainfall, drying-up, occasional releases from the dams, and sediment releases as a result of dam construction.

Three sites were sampled in the tributaries of the Nam Kor, the Nam Phak, and the Nam Nao. The first two were in poor to fair conditions largely because of sewage releases from Oudomxay town. From the macroinvertebrate sampling results, the Nam Noua appeared to be in fair condition though the diversity of species was relatively low (see Table 4 for detailed results).



**Box 12**

#### Freshwater Prawn Fishery in the Nam Ou

An important prawn fishery is found in the limestone karst mountainous areas near Meuang Ngoy. Several limestone caves in this area have streams flowing out into the Nam Ou mainstream, especially the Tham Paho caves near Ban Sopchem. The waters found in these streams are cool-cold and are very clear. There is a species of prawn (*Macrobrachium yui*) that lives in the Nam Ou where it grows to sexual maturity (Kounthongbang et al. 2015). When the mainstream becomes turbid at the beginning of each wet season, prawns move up and into the clear-water streams issuing from the caves. According to researchers at the Living Aquatics Research Center in Vientiane, the prawns reside in this area during their spawning migration. During this seasonal migration period, certain villages close to these caves are able to exploit the fishery by setting special traps to catch the prawns as they move into the caves. Most landings are made at night. Following capture, the prawns are either eaten by villagers or sold to local restaurants and traders who have specialized marketing outlets in large cities such as Luang Prabang.

There are four villages active in the prawn fishery: Huay Chong, Nong Khiaw, Meuang Ngoy, and Sopchem. From July to September, the villagers may catch up to 50 kg of prawns per day, with individuals reaching a size of 0.5 kg. An estimate of the total prawn catch has been put at 170,000 kg per year, according to information presented at the 2017 Luang Prabang provincial validation workshops.

**Box 13**

#### River Weed in the Nam Ou

River weed (*Cladophora* spp.) is a freshwater alga collected throughout the main channel and the tributaries of the Nam Ou Basin. There are several different algae species that grow on underwater rocks and thrive in clear, shallow water. River weed is collected during the dry season when flows are low and the water has less sediment. Known as "Mekong weed" in English, it is dried in flat sheets and eaten as a delicacy. Most families living in riverside villages harvest river weed; for example, there are 80 such families in Ban Pak Ou and each could collect up to 25 kg of weed in wet weight per day between January and May. In recent years, however, river weed collection has become more difficult and less productive because of river-level fluctuations and increased sediment due to hydropower construction.

Families in the Nam Ou tributaries in Oudomxay collect 10-15 kg of river weed per day from January to May. This yields 2-3 kg of dry river-weed sheets, which measure 40x80 cm each. There are about three to five sheets per kg and each sheet sells for 3,000 kip (or 8,000-10,000 kip per kg). Thus, a full day's collection of river weed in Oudomxay might provide an income of 45,000 kip per day. This can make a significant contribution to household income in the villages.



**Table 4** **Stream health assessment – littoral macro-invertebrate sampling (miniSASS) conducted on the Nam Ou Basin and tributaries.**

| Stream Health Indicator (macro-invertebrates) | Score | Nam Ou (source) | | | Nam Ou u/s–> d/s | | | | Tributaries u/s–> d/s | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S1 | S2 | S3 | B1 | B2 | B3 | B4 | T1 | T2 | T3 | T4 |
| 1. Flat worms | 3 | | | | | | | | | | | |
| 2. Worms | 2 | | | | | | | | | | | |
| 3. Leeches | 2 | | | | | | | | | | | |
| 4. Crabs and shrimps | 6 | | 6 | | 6 | 6 | | 6 | 6 | 6 | 6 | |
| 5. Stoneflies | 17 | 17 | 17 | 17 | | | | | | | | |
| 6. Minnow mayflies | 5 | | | 5 | | | | | 5 | 5 | 5 | 5 |
| 7. Other mayflies | 11 | 11 | 11 | 11 | 11 | 11 | | 11 | 11 | 11 | 11 | 11 |
| 8. Damselflies | 4 | | | | | | | | | | | |
| 9. Dragonflies | 6 | 6 | 6 | 6 | 6 | | 6 | | 6 | | 6 | 6 |
| 10. Bugs and Beetles | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 11. Caddis flies | 9 | 9 | 9 | | 9 | | 9 | | 9 | | 9 | 9 |
| 12. True flies, Diptera | 2 | 2 | | | | | | | 2 | | 2 | 2 |
| 13. Molluscs | 4 | | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | |
| 14. Megaloptera | 9 | | 9 | | | | | | | 9 | | |
| i. Tadpoles | | × | | | × | | | | | × | | |
| ii. Fish | | × | | × | × | × | × | × | × | | | |
| Total score | 85 | 50 | 67 | 48 | 41 | 26 | 24 | 26 | 48 | 40 | 48 | 38 |
| Average score (Index) | 6.1 | **8.3** | **8.3** | **8.0** | **6.8** | **6.5** | **6.0** | **6.5** | **6.0** | **6.7** | **6.0** | **6.3** |

Note: 'X' - Tadpoles and fish are not included when calculating stream health index, yet, the presence of both organisms was recorded as this is indicative of a healthy aquatic ecosystem.

| **Legend: Stream Health Index values for rocky type rivers** | **Index** |
|---|---|
| Unmodified (Natural/pristine condition) | **>7.9** |
| Largely natural/few modifications (Good condition) | **6.8–7.9** |
| Moderately modified (Fair condition) | **6.1–6.8** |
| Largely modified (Poor condition) | **5.1–6.1** |
| Seriously/critically modified (Very Poor condition) | **<5.1** |

| **Sampling locations:** | |
|---|---|
| 1. Nam Ou Source | **S1** |
| 2. Gnot Ou Town upstream('pristine' site) | **S2** |
| 3. Gnot Ou downstream of bridge | **S3** |
| 4. Ban Sopkong FCZ | **B1** |
| 5. Ban PakNga | **B2** |
| 6. Ban Hatkhe | **B3** |
| 7. Ban Vangle (island) | **B4** |
| 8. Nam Kor – fast water | **T1** |
| 9. Nam Kor – slow water | **T2** |
| 10. Nam Kor (confluence with Nam Phak) | **T3** |
| 11. Ban SopNao | **T4** |



# Terrestrial Resources

### Land Use/Cover

The most recent comprehensive land cover/land use assessment for the Lower Mekong sub-basin was carried out by the MRC in 2014 using satellite imagery from 2010 and ground-truthed throughout the basin, including the Nam Ou Basin in both Lao PDR and Vietnam (Vo, et al. 2015).

The land cover reflects both the terrain, geology, and land uses in the basin. The predominant land cover is broadleaved deciduous forests, followed by shrubland; together, they make up 86% of the total land cover in the basin. The combined natural forest lands (deciduous, evergreen, bamboo, and coniferous) make up 14,596 km$^2$, contributing 56% of the total. The industrial plantations in the northern sub-catchments reflect the recent developments of rubber plantation. Agriculture makes up 6.5% of the total land area, including annual crops, paddy rice, orchards, and shifting cultivation, which makes up 4.0% of the total. Compared to the rest of the basin, the Nam Noua sub-catchment in Vietnam stands out with much more intensive land use such as paddy, annual crops, and orchards.

### Forest Cover/Vegetation

The main forest types in the Nam Ou Basin are as follows:

**Upper mixed deciduous forest** is small patches of relatively undisturbed primary forest with a dense canopy of around 10-20 m in height. This is the most biologically diverse vegetation type in the Nam Ou Basin. Deciduous tree species represent more than 50% of the stand and bamboo occurs in some areas.

**Unstocked forest** refers to areas that were once upper mixed deciduous forest, but the primary tree crown density in these areas has been reduced to less than 20% because of selective logging or shifting cultivation activities.

**Riparian forest** identifies dense forest along creeks and rivers. Most of the riparian forest along the Nam Ou and its tributaries is unstocked due to selective logging. Large emergent trees are often present above a dense mid-story and understory. Riparian forest usually does not extend further than 50 m from the creek or river edge.

**Bamboo forest** is widely distributed across the region and occurs primarily in areas previously subject to shifting cultivation. Areas classified as bamboo forest have at least 80% composition of bamboo species with canopy heights of up to 15 m.

**In-channel vegetation** occurs within the Nam Ou itself and the channel of major tributaries such as the Nam Khang. This vegetation occurs on sandbanks, sandbars, and rocky outcrops within the river channel.

In Lao PDR, protection and conservation forests are defined by the Forestry Law (2008) as follows:

- **Protection forest** is forest and forestland classified for the purposes of protecting water sources, soil quality, the environment, and strategic areas for national defense; preventing soil erosion; protection from natural disasters and so on.
- **Conservation forest** is forest and forestland classified for the purposes of conserving nature and preserving plant and animal species, forest ecosystems, and other valuable sites of natural, historical, cultural, tourism, environmental, educational, and scientific importance.

In Phongsaly, there is one national conservation forest (Phou Den Din), five provincial-level conservation forests, and four district-level conservation forests covering a total area of 327,518 ha. There are five national protection forests and two district protection forests covering a total area of 797,409 ha, and two production forests covering a total of 158,573 ha.

The Phou Pha Provincial Conservation Forest is located on forested mountain slopes adjacent to the provincial administrative center of Phongsaly and covers around 200 ha. The area is protected primarily to conserve the township's water resources. The area is also managed as a district protection forest by the Phongsaly District Agriculture and Forestry Office.

The Phou Tasan Provincial Conservation Forest is located adjacent to the Nam Ou within the Nhot Ou District. The forest covered over 14,000 ha before it was reclassified by the Ministry of Agriculture and Forests – Forest Inventory and Planning Department (FIPD) as Phu Sen National Protection Forest covering 9,495 ha.

The Phou Taleng Provincial Conservation Forest is located within the Boun Nua District. The forest currently covers around 14,310 ha, but its boundaries have been reclassified by the Ministry of Agriculture and Forests – FIPD, expanding its area to about 16,000 ha.

The Nam Lan Provincial Conservation Forest is located in the southwest corner of Phongsaly Province, adjacent to the Lao PDR-China border. Covering around 15,200 ha, the forest is a mountainous area with altitudes from 600 masl to 1,900 masl and reportedly contains significant areas of primary forest and supports a wide range of amphibian species. Tourism in this area is promoted by the Phongsaly Forest Conservation and Rural Development Project.

Oudomxay has 130,000 ha of protection forests, 133,000 ha of reservoir forests, and 64,000 ha of production forests lying within the Nam Ou Basin. In Luang Prabang, there are 198,923 ha of national protection forest, 57,540 ha of district protection forest, and 8,028 ha of district reservoir forestry.

## Fauna – Threatened Species, including Wildlife & Birds

**Box 14**

### Animals of Conservation Significance (Endangered Species) in the Nam Ou Basin

**Critically Endangered**
- Northern White Cheeked Gibbon, *Nomascus leucogenys*

**Endangered**
- Francois's Langur, *Trachypithecus francoisi*
- Phayre's Langur, *Trachypithecus phayrei*
- Banteng, *Bos javanicus*
- Sunda Pangolin, *Manis javanica*
- Chinese Pangolin, *Manis pentadactyla*
- Large Antlered Muntjac, *Muntiacus vuquangensis*
- Indochinese Tiger, *Panthera tigris corbetti*
- Fishing Cat, *Prionailurus viverrinus*
- Green Peafowl, *Pavo muticus*
- Elongated Tortoise, *Indotestudo elongata*
- Big-headed Turtle, *Platysternon megacephalum*

Source: ESL. (2010). Nam Ou Cascade Terrestrial Biodiversity and Forest Resource Use Study.

Lao PDR has 27 important bird areas (IBA; BirdLife International 2004), with only one located in the Nam Ou Basin – the Phou Den Din Important Bird Area (IBA No. LA008). This area covers around 126,880 ha and comprises the upper Nam Ou and its catchment within the Phou Den Din NPA. To be classified as an IBA, the site must fulfil at least one of the three criteria: 1) The area holds significant numbers of one or more globally threatened species, 2) is among a set of sites that together hold a suite of restricted-range species or biome-restricted species, and 3) has exceptionally large numbers of migratory or congregatory species.

A second KBA is in the lower Nam Ou from above Meuang Ngoy to Pak Ou because the critically endangered Siamese Giant Barb (*Catlocarpio siamensis*) is found there. Villagers attending the 2017 provincial validation workshops confirmed its presence in the area.

## Non-Timber Forest Products (NTFP) in the Nam Ou

**Box 15**

### Non-Timber Forest Products (NTFP) in the Nam Ou Basin

The collection of NTFP is an important livelihood activity for all villagers living in the Nam Ou Basin, whether it is for food for home consumption or sale, or as medicinal plants. Many species have high commercial value and are sold for cash income.
NTFP species were reported as being collected in many areas of the Nam Ou River Basin; these are listed in order of widespread use:

**Most widespread**
- Galangal (*Alpinia galanga*)
- Bamboo shoots (*Bambusa* spp.)
- Fern (*Diplazium esculentum*)
- Cardamom (*Amomum krervanh*) (not in lowest area)
- Centella (*Centella asiatica*) (not in highest area)

**Common**
- Paper mulberry (*Brousonetia papyrifera*)
- Broom grass (*Thysanolaena maxima*)
- Acacia (*Acacia* spp.)
- Amorphophallus (*Amorphophallus rhizomatosus*)
- Elephant's ear fig tree (*Ficus auriculata*)
- Melientha (*Melientha suavis*)

Several tree species are used by villagers mostly for house-construction purposes. Two tree species are used throughout the Nam Ou Basin: *Duabanga grandiflora* (Maiten) and Toona sureni (Mai ngom). Two species are found throughout the basin except in the north: Grape myrtles (*Lagerstroemia* spp.) (Mai yen) and Mechelia (*Paramechelia baillonii*) (Mai sai). Two are mainly found in the middle sections of the basin: Beechwood (*Gmelina arborea*) (Mai so) and Island longan (*Pometia pinnata*) (Mai kha). Four have a less even distribution: Leichhardt tree (*Nauclea orientalis*) (Mai kan luang) is found mainly in the north, Fijian longan (*Pometia eximia*) (Mai kuang leng) and *Protium serratum* (Mai mak faen) in the middle reaches, and *Schima wallichii* (Mai ta lo) mainly in the south.



## National Protected Areas (NPA) in the Nam Ou Basin

**Box 16**

### National Protected Areas

With 222,000 ha, Phou Den Din covers about 8.6% of the Nam Ou Basin and is the oldest NPA. Phou Den Din represents about 1% of Lao PDR's total land area and about 6.4% of all 23 NPA in the country.

According to Berkmüller and Southammakoth (1995), Phou Den Din has the following characteristics:

- A mid-ranking NPA in terms of biological importance. Although being the only NPA in biogeographic sub-unit 10c, surveys of birds and herptiles to date suggest it is not particularly distinct from other northern Lao sites.
- Three bird species are not recorded from any other National Biodiversity Conservation Area (NBCA,) but none of them are key species.
- Elephants (*Elephas maximus*), gibbons (including *Nomascus leucogenys*), and a high density of Lesser Fish-eagles (*Icthyophaga humilis*) live in the area.
- High densities of deer, otter, and water-monitor tracks around the Nam Ou, upstream of the Nam Khang, suggest that this area is little affected by hunting, almost certainly due to its difficulty of access. The extent of disturbance in the other remaining block of old forest, near the Vietnamese border, is unknown.
- Reports of several species of large mammals; more extensive surveys may well yield appreciable numbers of additional species (Berkmüller and Southammakoth 1995).

In 2013, a second NPA was created in Oudomxay Province by upgrading the Phou Hiphi conservation area (MONRE, 2016), covering 87,000 ha in the area on the east bank of the Nam Kor. The Nam Kat, a tributary of the Nam Kor, flows through the center of this new NPA. It contains a mixture of pristine old-growth forest with giant dipterocarps (nyang oil tree), limestone outcrops, and mountains surrounding the eastern side of Oudomxay town.

Immediately adjacent to Phou Den Din but outside of the Nam Ou Basin is the Muong Nhe National Nature Reserve in Vietnam, covering nearly 300,000 ha. It has 47,400 ha of forest (mostly evergreen and bamboo), 204,200 ha of grassland, and 44,000 ha of shifting cultivation and scrub.

There is one Vietnamese NPA lying within the Nam Ou Basin: Muong Phang. It is an ecological and historical protected area known for being the location of General Vo Nguyen Giap's headquarters during the Dien Bien Phu campaign against the French in 1954. Lying at around 1,000 masl, Muong Phang covers an area of 92 km$^2$ mainly comprising forests with centuries-old trees. It surrounds the Pha Khoang Lake with two hydropower plants, Thac Bay and Na Loi.