mid-montane bioregions have higher species numbers than the higher montane areas, a well-known phenomenon in mountain avifauna. This mid-altitude region is an overlap zone where the ranges of montane and lowland species intersect.

Plate 5.8: Superb fruit dove

Migratory birds are concentrated in the coastal areas and wetlands in the Kikori Lowlands but the area does not appear to be significant for migratory waterbirds, as it lacks the open wetland habitats these species prefer.

There are 61 species of reptiles recorded so far and there is a distinct reduction of reptile diversity with increasing altitude since few species tolerate the cold, wet climates of the mountains. Most of the reptile species are small- to medium-sized skinks inhabiting forest or forest clearings and they are the only lizards found so far in the high montane karst areas. Crocodiles and freshwater turtles are restricted to the lowland rivers. Arguably, the most important reptile occurring in the Upstream Project Area is the New Guinea freshwater crocodile *Crocodylus novaeguineae* discovered by the Project surveys in the Western Lowlands bioregion in 2008. While the reptile fauna is depauperate, there are 13 new species at present only known from the Upstream Project Area. Like amphibians and plants, new species of reptiles are to be expected in well-conducted surveys of remote parts of New Guinea.

Plate 5.9: Green tree python *Morelia viridis* at Juha

Plate 5.10: The agamid *Hypsilurus modestus*

There are 107 species of frogs recorded so far and the tree frogs (Hylidae) and the Microhylidae dominate the fauna. The availability of standing water has dramatic effects on frog community composition. The Microhylidae have a reproductive strategy independent of free-standing water, laying their eggs in terrestrial environments humid enough for their embryos to develop, and have radiated extensively in the constantly moist, montane habitats. Because Hylidae need water, the Microhylidae can dominate in situations of high humidity with no standing or flowing water.

Altitude plays an important role in determining the distributions of most frogs because, at very high elevations, the temperatures are too cold for most species. Maximum frog diversity occurs in the low mountain zone between 500 and 1,500 meters above sea level. Those that live at high altitudes are specialized cloud forest species, e.g., most of the species of *Albericus.*

Plate 5.11: The tree frog *Litoria pronimia*

The fish fauna comprises 115 species. The PNG fish fauna is largely derived from marine fish that entered fresh water in recent geological times. With the exception of Lake Kutubu, the fish fauna has few specialist types that are restricted to a single food or habitat type, so most of the resident species are widely distributed. This overlap in diet and habitat requirements is an important mechanism for fish survival since floodplain habitats (e.g., swamps of the lower Kikori River floodplain) may dry out during severe El Niño-Southern Oscillation drought years. Altitude, habitat type and sediment regime appear to be the primary factors controlling the diversity and abundance of fish and other aquatic fauna in the rivers of the Upstream Project Area. At the highest altitudes, e.g., the Juha and Karius areas, only the fimbriated gudgeon *(Oxyeleotris fimbriata)* occurs. In lower altitude rivers and streams, the fish assemblages are generally more diverse.

Overall, the faunal communities are intact, reflecting the generally undisturbed nature and isolation of most of the KICDP area. Many rare species persist next to the Kutubu Petroleum Development Project facilities, a result of the small footprint of facilities and the strict environmental controls that have been maintained to date. Though overall diversity decreases at higher altitudes, faunal assemblages are most specialized and restricted in the high montane bioregions, i.e., the Western Volcanics and Northern Montane Karst bioregions and the proportion of primary-forest specialist birds, marsupials and specialist amphibians increases with altitude. The species-rich lowland regions tend to include many taxa that are widespread and adapted to disturbed habitats. The consensus of the scientists conducting the Project surveys was that it is unlikely that many faunal species will be found to be restricted to small, localized areas of the Upstream Project Area, although cavernicolous bats may roost or breed only in certain caves.

Plate 5.12: A new species of microhylid *Xenobatrachus sp.* from Juha South

5.2.1.4 New Species

The surveys in the Upstream Project Area have discovered numerous species new to science, a reflection of the poor biological documentation of the region prior to 1995. Five species of mammals, 11 of lizards and 50 of frogs new to science were discovered by the WWF surveys while the Project surveys added a further 3 lizards, at least 10 frogs and possibly 2 new bats. The Project surveys also found 31 plants new to science. Recent exploration on Mount Bosavi has added 16 new frogs and possibly 3 new mammals[14]. No bird species new to science have been recorded in the Upstream Project Area.

[14] http://www.guardian.co.uk/environment/2009/sep/07/discovery-species-papua-new-guinea.

5.2.1.5 Endemic Species

The Upstream Project Area is especially significant for endemic species. Seventy-five percent of the non-volant mammal species so far recorded from the Upstream Project Area are New Guinea endemics and there is a trend for increasing endemism with increasing altitude.

One hundred sixty-one species of birds in the Upstream Project Area are endemic to the island of New Guinea and a further 53 endemic to Melanesia. The Upstream Project Area lies entirely within two endemic bird areas (EBAs), the Central Papuan Mountains and the South Papuan Lowlands, that support a high concentration of what is termed 'restricted range species' (geographic ranges less than 50,000 square kilometers) found nowhere else (Stattersfield et al., 1998). The Central Papuan Mountains have the second highest number of restricted-range species of all EBAs in the Southeast Asian island region and includes nine endemic genera (BirdLife International, 2003). Eighteen restricted-range species of the Central Papuan Mountains have been recorded in the Upstream Project Area and a further 16 could occur there. All but five of them are high-mountain specialists. There are far fewer restricted-range species within the South Papuan Lowlands EBA but two have been recorded in the Upstream Project Area and two more could occur.

There are notable concentrations of nationally endemic birds in the Western Foothills, Western Volcanics and Northern Montane Karst bioregions.

Well over 90 percent of the amphibians and reptiles recorded from the Upstream Project Area are endemic to New Guinea (S. Richards, pers. com.) and many of the frogs and reptiles discovered on the WWF and Project surveys are known only from the Upstream Project Area so far. However, experience from these surveys indicates that it is too early to be able to say these species do not occur elsewhere. All of the Project surveys extend the ranges of species previously known only from one or two localities, e.g., successive EIS surveys extended the ranges into the Juha and/or Homa Deviation areas of six undescribed species known previously from only one locality each in the Upstream Project Area. The EIS surveys also extended the range of *Litoria* sp. nov. 14 (cf Ok Menga), previously only known from the Star Mountains, into the Upstream Project Area. Endemism is unlikely to be so localized in the Upstream Project Area that development of Project facilities and infrastructure would negatively impact any one species.

A total of 15 fish species are endemic to the Kikori River catchment, 12 of which occur in Lake Kutubu. This high level of lacustrine endemicity exceeds that of any other lake in the New Guinea–Australian region. Five of these endemics *(Hephaestus adamsoni, Mogurnda furva, M. spilota, M. variegata and M. vitta)* comprise up to 40 percent of the artisanal fishery and subsistence fish catches in the lake.

5.2.1.6 Unique Assemblages of Species

The Upstream Project Area contains notable assemblages of species. Among these is the high diversity of birds-of-paradise with at least half of the 40 living species and nearly two-thirds of the 31 species recorded in New Guinea and its satellite islands occurring in the Upstream Project Area. They are diverse in upland regions and many, such as the blue bird-of-paradise *(Paradisea rudolphi)*, have restricted distributions.

An important find in the Upstream Project Area is the greater melampitta *(Melampitta gigantea)*, one of New Guinea's most enigmatic birds, which is restricted to rugged limestone country where it roosts and nests below ground (the world's only passerine to do so).

The Upstream Project Area, in which one third of the New Guinea frog fauna has been recorded, has the most diverse assemblage of amphibians documented yet recorded for a catchment in New Guinea.

Lake Kutubu stands out as having a remarkable assemblage of fishes.

Table 5.1: Species in different IUCN red list categories and listed under the PNG legislation in the Upstream Project Area

IUCN Status	Protected under the *Fauna (Protection and Control) Act 1966*	Restricted in Trade under the *International Trade (Fauna and Flora) Act 1979*	Not Listed under PNG Legislation	Grand Total
Critically endangered			3	3
Endangered			4	4
Vulnerable	4	2	8	14
Near threatened	2	2	16	20
Data deficient			27	27
Not listed	24	26	27	77
Grand total	30	30	85	145

Table 5.2: IUCN critically endangered and endangered species in the Upstream Project Area

Common Name	Species Name	IUCN Status
Bulmer's fruit-bat (possible only)	*Aproteles bulmerae*	Critically endangered
Long-beaked echidna	*Zaglossus bartoni*	Critically endangered
Tree	*Halfordia papuana*	Critically endangered
Goodfellow's tree kangaroo	*Dendrolagus goodfellowi*	Endangered
Tree kangaroo*	*Dendrolagus notatus*	Endangered
Tree	*Bleasdalea papuana*	Endangered
Tree	*Flindersia pimenteliana*	Endangered

* In the EIS this species was recorded as *D. dorianus* and classed as vulnerable. Taxonomic changes have since split *D. notatus* from *D. dorianus*.

Box 5.2: Tree kangaroos

There are 14 species of tree kangaroos, twelve of which are endemic to New Guinea. These are the largest native land mammals in PNG and unique amongst kangaroos in that they are arboreal, although they come down to the ground frequently. They feed on leaves and fruits and tend to be solitary. They are heavily hunted and this has reduced populations of most species throughout New Guinea. Four of the New Guinea species are classified as vulnerable by the IUCN (2010), four as endangered and three as critically endangered.

Three species occur in the Upstream Project Area. The brightly colored Goodfellow's tree kangaroo, *Dendrolagus goodfellowi*, is a resident of montane forests of PNG and does not extend into West Papua, Indonesia. The subspecies most likely to occur in the Upstream Project Area is *D. goodfellowi buergersi*, which occurs along the central ranges, west to the Strickland River. It is very susceptible to hunting, and numbers have been heavily reduced by persecution and forest clearance.

Tree kangaroo *Dendrolagus notatus*

D. notatus was recently split from *D. dorianus* and occurs only in the central ranges of PNG. Its habitats and distribution are similar to the Goodfellow's tree kangaroo but generally occurs at higher elevations. It appears to exist at naturally low densities.

The lowland tree kangaroo, *D. spadix*, is classified by the IUCN as least concern. It is one of the least-known tree kangaroos and has a broad distribution in the south central lowlands of PNG centered on the Kikori River where there is little settlement. Hence, little is known of this species and the loss of habitat and hunting pressure it has experienced.

5.2.1.7 Species of Conservation Concern

One hundred forty-two[15] species of plants and animals are listed as of conservation concern by the IUCN (2010), under the PNG Fauna *(Protection and Control) Act 1966* or under the PNG *International Trade (Fauna and Flora)* Act 1979 (Table 5.1).

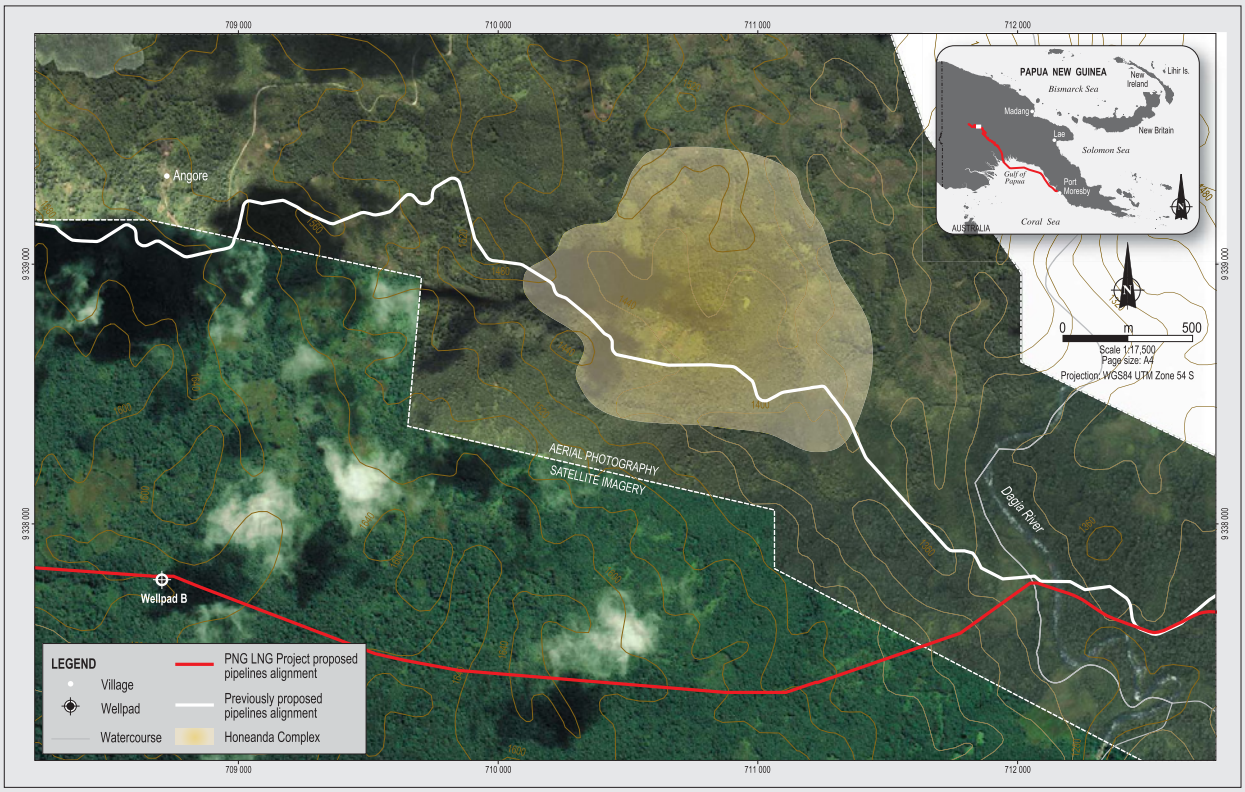
While the EIS considered impacts on listed species, the IFC Performance Standard 6 refers only to species classified by IUCN as Critically Endangered or Endangered in relation to critical habitat. These species are listed in Table 5.2 and are the biodiversity values of interest with respect to this Biodiversity Strategy.

Box 5.3: The Honeanda Complex

Another example of the link between biodiversity and the local communities is the complex of significant ritual sites on the Pagada ridgeline, including the Honeanda Complex, located in the vicinity of the onshore LNG Project Gas Pipeline route between Hides and Idauwi. This site complex represents the largest remaining series of hoop pine *(Araucaria cunninghamii)* groves in the region and possibly the largest single stand in New Guinea due to their anthropogenic nature and the fact that all other major ritual sites in the Tari region have been logged. Each grove marks the presence of one of the sites in this ritual site complex and it is a significant cultural heritage site in the Upstream Project Area. An early pipeline route option considered by the Project crossed this site; however, following consideration of the findings of cultural heritage surveys of the area and consultation with relevant clans representatives, Esso Highlands Limited realigned the onshore LNG Project Gas Pipeline ROW to avoid the Honeanda Complex and associated hoop pines. This realignment is shown in the figure below.

It is worth noting that, while the hoop pine, a species shared with Australia, has cultural significance, the New Guinea endemic congener klinki pine *(Araucaria hunsteinii)* has no cultural significance.

The Honeanda Complex



[15] Since release of the EIS, the IUCN Red List has been updated and while the species listed under the PNG *Fauna (Protection and Control) Act 1966* remain the same, the status of many species listed by IUCN has changed. This is the most recent figure.