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## The Congo River basin

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The Congo River has the second greatest discharge of any river in the world after the Amazon. It drains 3.7 million km<sup>2</sup> of the African continent. Through its middle course from Boyoma Falls near Kisangani to Malebo Pool at Kinshasa/Brazzaville, the river drops only 115 m over 1740 km as it crosses the *cuvette centrale congolaise*, a vast, shallow depression along the equator in the heart of Africa (Hughes & Hughes 1992). Throughout the *cuvette centrale*, great swamps extend behind the river's levees and along the banks of the numerous tributaries that drain it (Fig. 5.1). These swamps and other wetlands are estimated to cover at least 69 000 km<sup>2</sup> in the Congo and 120 000 km<sup>2</sup> in the Democratic Republic of Congo (D. R. Congo, formerly Zaire; Hughes & Hughes 1992), for a total of c. 190 000 km. To put these swamps in perspective, they are larger than the states of Louisiana and Mississippi put together or over four times the size of Switzerland. This makes them the fourth- to fifth-largest area of wetlands in the world.

In contrast with their striking size, these swamps are poorly studied and understood. Older reviews of African wetland ecology hardly mention them (Thompson & Hamilton 1983, Denny 1985). Most of the primary research on the swamps themselves dates from the colonial era and is found in obscure publications in France and Belgium. In recent years, scientists in the Congo, and to a lesser extent the D. R. Congo, have been conducting research in African tropical rain forests, but with apparently little emphasis on swamps.<sup>1</sup>

<sup>1</sup> Several bibliographies exist on science and conservation of central African rain forests in general: Job (1994), Institut Royal des Sciences Naturelles de Belgique and Centre d'Echange

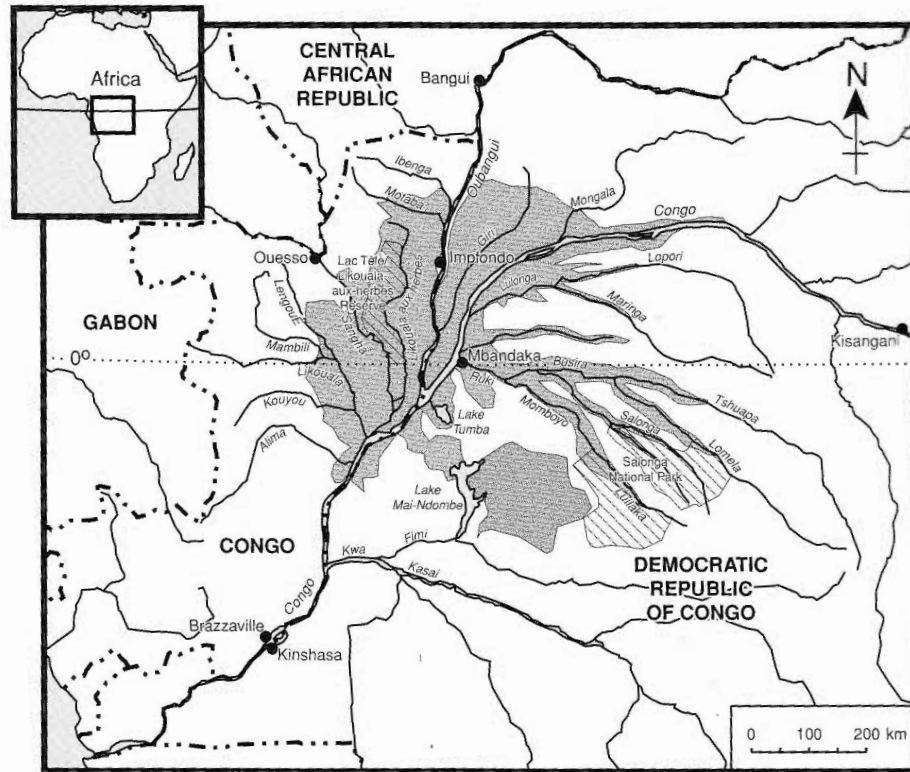


Figure 5.1 The location of swamps within the *cuvette centrale congolaise* based on De Grandi *et al.* (2000b). Areas with a mosaic of swamp and *terra firme* forest are also included. Protected areas are hatched: they include the Salonga National Park in D. R. Congo, which is one of the largest national parks in the world, and the Lac Télé/Likouala-aux-herbes Community Reserve in the Congo.

The Congo basin has had a dark, turbulent history since pre-colonial times (Hochschild 1998, Bobb 1999). The resultant political instability, social unrest, and poor infrastructure may account in part for the scientific inattention. Another great obstacle is the difficult terrain in these swamps. It is easy to understand why they have remained so unexplored. Modern-day explorers recently crossed the Congo basin on foot to the Atlantic Ocean; taking over 15 months to document and bring attention to the unexplored rain forests of this region before they are cleared or lumbered (Quammen & Nichols 2000, 2001a, 2001b). Even so, their progress was so poor in the swamps because of bad terrain that they had to skirt around them. Another telling image of our knowledge of these

d'Informations de la République Démocratique du Congo (1998–2002), Wilkie *et al.* (2001b), Royal Museum for Central Africa (Undated).

swamps is the "Mokele-Mbembe," a 9-m-long sauropod dinosaur reputed to live in the swamps around Lake Télé in northern Congo (Agnagna 1983). The vast, unexplored nature of these swamps gives credence to the suggestion that such a creature might exist beyond the spiritual realm.

### Location

Remote sensing has led to the greatest recent advances in our knowledge of the swamps of the *cuvette centrale congolaise*. Previously, vegetation maps only roughly delimited the area of swamps in the region (White 1983). Within the last decade, remote sensing has provided an accurate picture of forest cover in the region. Early efforts failed to distinguish between swamp forests and lowland rain forest because of the resemblance of the two (Mayaux *et al.* 1997a, 1997b, Laporte *et al.* 1998). Recent advances using combinations of satellite imagery have succeeded in identifying swamp forests (De Grandi *et al.* 2000a, Mayaux & Malingreau 2000, Mayaux *et al.* 2000) and can even distinguish between periodically flooded and permanently flooded swamps (De Grandi *et al.* 2000b, Mayaux *et al.* 2002). Although they have yet to be ground-truthed, and the actual area of swamp has not been published, these maps provide a revolutionary glimpse of the extent and location of swamps in central Africa.

The swamps and wetlands of the *cuvette centrale* occur within a vast matrix of lowland rain forest, and both habitats often intermix in a mosaic (Fig. 5.1; De Grandi *et al.* 2000b). To the northwest from the Congo River, wetlands extend in an almost contiguous block to a rather abrupt limit in northern Congo and D. R. Congo. Several river systems slowly drain this area, many of which anastomose near their confluences with the Congo River. Southwest of the Congo River, swamps extend far upstream along rivers but form less of a continuous block and are most often separated from adjacent river systems by terraces of lowland tropical forest. Extensive swamps also occur adjacent to two large shallow lakes south of the Congo River, Lake Tumba, and Lake Mai-Ndombe.

### Environmental history

The tropical forests of central Africa, including these swamps, have greatly changed their distribution and extent over recent millennia. They have repeatedly undergone episodes of expansion and contraction since the Middle Pleistocene epoch, around 1.05 Ma (Dupont *et al.* 2001). The underlying climate change was induced by glaciation cycles in higher latitudes. During glacial maxima, central Africa became cooler and more arid (Preuss 1990, Jahns 1996, Maley 1996, Dupont *et al.* 2001), and the tropical forests of the central basin retreated



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towards the highlands of east and west equatorial Africa. These repeated climate shifts may also be responsible for the relatively low proportion of endemic species in the central parts of the Congo basin as compared with the Cameroon highlands to the west and the Albertine Rift highlands in eastern D. R. Congo, Rwanda, Burundi, and Uganda to the east – which are biodiversity hotspots (Diamond & Hamilton 1980, Kingdon 1989, Sayer *et al.* 1992, Linder 2001, de Klerk *et al.* 2002). However, there is some evidence for a lowland refugium in the central basin during arid glacial periods, based on the present-day distribution of plants and primates (Ndjele 1988, Kingdon 1989, Colyn *et al.* 1991). Swamps appear to have persisted in the lowlands of the *cuvette centrale* through these arid phases but to a greatly reduced extent.

### Climate and hydrology

The climate of the *cuvette centrale congolaise* and its hydrology have been well studied. The region has a wet tropical climate and a permanent Atlantic monsoon (Leroux 1983). Mean annual temperatures are 25 to 27°C, and there is little seasonal change (Bernard 1945, Leroux 1983). Annual rainfall is high; it exceeds 1600 mm throughout the basin and exceeds 2000 mm in the central region over the Momboyo and Busira rivers (Bernard 1945, Bultot 1971, Leroux 1983). Rainfall tends to have a bimodal seasonal pattern throughout the central basin with two wet seasons and two dry seasons, but their timing alternates and their extent changes on either side of the equator (Bultot 1971, Leroux 1983). Annual evaporation is also high as a result of evapotranspiration from the forest cover and direct evaporation from water bodies and swamps. Evaporation is of the order of 1050 mm, which leaves between 600 and 900 mm of water to drain as annual runoff (Bultot 1971).

The hydrological system of the *cuvette centrale congolaise* is complex; it is comprised of the Congo River, the numerous tributaries, and these extensive swamps. The rivers have an extremely low gradient; they drop 3 cm km<sup>-1</sup> on average in the central basin. Water flows between watersheds during high-water periods and flow can even reverse within water courses (Laraque *et al.* 1998a, 1998b). Furthermore, the pattern of river discharge differs across the *cuvette centrale*. North of the equator, tributaries such as the Oubangui and the Giri show unimodal patterns of discharge with peaks in October and November (Rosenqvist & Birkett 2002), while other tributaries such as the Sangha or the Likouala show bimodal patterns with a lesser peak in May (Laraque *et al.* 1998a, 2001). Southern-hemisphere tributaries have bimodal discharge patterns as they cross the central Congo basin with a peak from November to January and a lesser peak in March to May (Rosenqvist & Birkett 2002). The Congo River itself shows

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### Soils and

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a strong bimodal pattern as a result of the alternating patterns and timing of discharge from either side of the equator.

A major consequence of the bimodal discharge is the low amplitude of water-level fluctuations in the *cuvette centrale congolaise* relative to other tropical river systems. For instance, the Congo River at Mbandaka has an average annual amplitude of 1.8 m; contrast this with up to 15 m at Manaus on the Rio Negro in the Amazon basin (Marlier 1973). Water-level fluctuations are, however, greater along tributaries toward the edges of the *cuvette*. In 1996 for example, the difference between high- and low-water stages on the Congo River at Mbandaka was of the order of 2.5 m, while on the Oubangui near the mouth of the Giri River, it was 5.5 m (Rosenqvist & Birkett 2002).

#### Soils and water quality

The soils underlying these swamps vary from mineral to organic depending on the deposition of alluvium from rivers, the progression of river meanders across the floodplains, and the accumulation of organic matter, mineral to organic soils underlie these swamps (Evrard 1968). Coarser mineral material accumulates near rivers to form levees, while finer materials are deposited away from the rivers. However, river meanders shift across the floodplain with time and rework these sediments, thereby creating diverse sediment deposits across floodplains. In the D. R. Congo for instance, wide and active alluvial plains form along the Congo River, the Oubangui, and the Giri (Evrard 1968). Their soils range in texture from coarse sands to clays, often with high organic matter. Along tributaries to the south of the Congo, sands dominate. In backwater areas that remain waterlogged, organic matter accumulates, forming extensive muck and peat deposits. These peat deposits are variable in depth, typically around 1 m deep, but can extend to 17 m (Evrard 1968). Organic deposits are acidic (pH 3.9 to 5.2) with high carbon:nitrogen ratios (C:N = 10) and low exchangeable mineral cations.

Swamps and lakes, as well as the rivers that drain predominantly swamp watersheds, have tea-colored waters with high dissolved organic matter content. Their "black waters" are strongly acidic (pH 3.5 to 5.2), with low conductivity (10 to 140  $\mu\text{S cm}^{-1}$ ) and very low mineral content ( $<1 \text{ mg l}^{-1}$ ) (Marlier 1958, Dubois 1959, Berg 1961, Matthes 1964, Moukoulou *et al.* 1993, Laraque *et al.* 1998a, 1998b). Where rivers first enter the *cuvette centrale*, their waters have higher pH and mineral content and lower dissolved organic matter content (Probst *et al.* 1992, Moukoulou *et al.* 1993, Laraque *et al.* 1998a). Smaller tributaries mix with waters from swamps and soon become acidified, especially during high-water periods

(Berg 1961). However, the Congo, and major rivers such as the Oubangui, have higher pH and mineral content (Berg 1961, Moukoulou *et al.* 1993).

**Vegetation**

The botany of these swamp forests is poorly explored (Ndjele 1988, Hughes & Hughes 1992). The swamps are thought to harbour a diverse flora, although they are somewhat poorer in species numbers relative to other African rain forests (Evrard 1968, White 1983). Trees are mostly evergreen and many have adaptations to withstand the prolonged flooding, including stilt roots and pneumatophores (Evrard 1968). The canopies of mature communities are commonly 30 m tall, with emergents reaching 45 m. Lianas and epiphytes are common.

The vegetation of these swamps has only been characterized broadly. The best studies are those of Lebrun and Gilbert (1954) and Evrard (1968), who provide phytosociological syntheses of swamp plant communities in the D. R. Congo, but even they considered their studies to be preliminary. There has been little published work on the swamp vegetation since that time, and no equivalent is available for the Congo, although the swamp vegetation there is similar (Hughes & Hughes 1992).

According to Lebrun & Gilbert (1954), three main ecological factors control the forest vegetation: the water-level variation, including water depth and hydroperiod; the degree of alluvial deposition; and the intensity of dry-season drainage. They identify four general classes of wetland forest in the central basin: (1) pioneer riparian associations; (2) riverine forests; (3) permanently flooded swamp forests; and (4) periodically flooded forest (Table 5.1). The pioneer riparian associations are variable. They occur along rivers and shores, usually in high-energy environments with periodically fast-flowing waters and large water-level fluctuations. The numerous aerial roots and pneumatophores in these pioneer riparian associations help to trap sediments and form land. The second general vegetation class is the riverine forests. They occur in slightly higher, more-stable situations along rivers where flow still occurs, such as on river levees. These riverine forests often flood, but they will drain periodically during low-water periods. Swamp forests form the third major class of vegetation and dominate the *cuvette centrale congolaise*. They occur in stagnant, permanently flooded depressions. The swamp forests are variable in terms of dominant species, ground cover, and canopy height. Finally, there are the periodically inundated forests, which occur higher in the floodplain and are only periodically flooded during high waters. These forests grade slowly into upland *terra firme* forests through extensive transitional areas because of the flatness of the land.

Table 5.1 Broad vegetation types in swamps of the central Congo basin (from Lebrun & Gilbert 1954, Evrard 1968, and Jay *et al.* 1989).

Vegetation type	Landscape position	Hydrology	Substrate	Physiography	Dominant species
Pioneer riparian forests	Along rivers, lakes, and other water bodies; on bars of sand or silt in large rivers; in floodplains	Flooded to wet, often high-energy environments with strong variation in water levels (2-8 m)	Coarser sediments with active deposition. Rapid land-building zones.	Evergreen heliophytic shrubs and small trees with tangled root systems and/or pneumatophores. Several vegetation associations are present. Canopy is 2-5 m tall, but taller in floodplains.	<i>Alchornea cordifolia</i> , <i>Brielia</i> spp., <i>Picra asperifolia</i> , <i>Parungana robusta</i> , <i>Macaranga lanceolata</i> , <i>Mimosa</i> spp., <i>Artocarpus congensis</i> , <i>Raphia</i> spp., <i>Sonneratia laurifolia</i> , <i>Sesbania acuta</i> , <i>Uapaca</i>

Table 5.1 Broad vegetation types in swamps of the central Congo basin (from Lebrun & Gilbert 1954, Evrard 1968, and Fay et al. 1989).

Vegetation type	Landscape position	Hydrology	Substrate	Physiography	Dominant species
Pioneer riparian forests	Along rivers, lakes, and other water bodies; on bars of sand or muck in large rivers; in alluvial deposits of large valleys.	Flooded to wet, often high-energy environments with strong variation in water levels (2-5 m).	Coarser sediments with active deposition. Rapid land-building zones.	Evergreen heliophytic shrubs and small trees with tangled root systems and/or pneumatophores. Several vegetation associations are present. Canopy is 2-5 m tall, but taller in stands of <i>Raphia seze</i> (to 15 m) and <i>Uapaca heudelotii</i> (10-12 m).	<i>Alchornea cordifolia</i> , <i>Bridelia</i> spp., <i>Ficus asperifolia</i> , <i>Harungana robynii</i> , <i>Macaranga lancifolia</i> , <i>Mimocylon</i> spp., <i>Parinarium congensis</i> , <i>Raphia</i> spp., <i>Sakeria laurentii</i> , <i>Sesbania sesban</i> , <i>Uapaca heudelotii</i> .
Riverine forests	Alluvium-depositing river shores; along large islands; in minor flooded valleys.	High water-level variation. Mostly flooded with one or two drained periods per year.	Silt to clay soils; moderate land-building ability.	Multi-layered, mostly evergreen forest, with a 20-25 m canopy. Many epiphytes and lianas. Usually sparse herbaceous layer.	<i>Cleistanthus patens</i> , <i>Elaeis guineensis</i> <i>Ficus mucosa</i> , <i>Lannea welwitschii</i> , <i>Mimusops warneckeii</i> , <i>Octoknema affinis</i> , <i>Oxytigma buchholzii</i> , <i>Pseudospondias microcarpa</i> , <i>Spondianthus preussii</i> var. <i>glaber</i> .
Permanently flooded swamp forest	Permanently flooded depressional areas in floodplain.	Soils remain saturated. Lacks a drained period.	Peaty to muck soils, but not mineral in nature. Land building by organic matter accumulation only.	Many types of forest. Canopy is often 30-35 m tall with taller emergents. Many canopy gaps occur. Herbaceous layer is important. Many monocots are present. Stilt roots are common, others have pneumatophores.	<i>Acacia dewevrei</i> , <i>Afromomum angustifolium</i> , <i>Alstonia congensis</i> , <i>Belvischmidia corbisteri</i> , <i>Berlinia heudelotiana</i> , <i>Coelocaryon botryoides</i> , <i>Diospyros</i> spp., <i>Entandrophragma palustre</i> , <i>Eriocaulum microsperrum</i> , <i>Erisma delphus exsul</i> , <i>Garcinia</i> spp., <i>Gutbourtia demusei</i> , <i>Kaoué germainii</i> , <i>Klainedoxa</i> spp., <i>Lasiorhiza senegalensis</i> , <i>Lophira alata</i> , <i>Macaranga</i> spp., <i>Manilkara</i> spp., <i>Mitragyna ciliata</i> , <i>M. stipulosa</i> , <i>Pandanus candelebrum</i> , <i>Raphia</i> spp., <i>Symphonia globulifera</i> , <i>Syzygium guineense</i> var. <i>palustre</i> , <i>Trichilia</i> spp., <i>Uapaca guineensis</i> , <i>Uapaca heudelotii</i> , <i>Xylocopa rubescens</i> .
Periodically flooded forests	Upper floodplain.	Regularly flooded during high water (once or twice per year). Well drained during low-water periods.	Sandy to fine-textured soils. Poor land building ability due to low sediment inputs (some fine matter only).	Relatively low density of trees, but numerous lianas. Canopy reaches 20-25 m with taller emergents. Few herbs. Few monocots.	<i>Diadlotia unifoliolata</i> , <i>Diospyros</i> spp., <i>Garcinia</i> spp., <i>Gutbourtia demusei</i> , <i>Monopetalanthus pteridophyllum</i> , <i>Mitragyna stipulosa</i> , <i>Oubangia africana</i> , <i>Pachystela longepedunculata</i> , <i>Parinari congensis</i> , <i>Scytopetalum pierreanum</i> , <i>Uapaca</i> spp.

Non-forested wetlands also occur in the central Congo basin. Wide expanses of wet prairie occupy permanently inundated habitats along rivers, such as the lower Likouala, the Likouala-aux-herbes, and the Giri (Hughes & Hughes 1992; De Grandi *et al.* 2000b). Such prairies are dominated by the grasses *Echinochloa pyramidalis*, *Leersia hexandra*, *Oryza barthii*, and *Vossia cuspidata*, and by large sedges (Hughes & Hughes 1992). These plants root in the mud, but also can form floating rafts along river channels. Along the western edge of the *cuvette centrale congolaise*, patches of open, peaty, boggy steppe and savanna occur; these form a mosaic with swamp forest (Hughes & Hughes 1992). Some of these patches may dry out seasonally and even burn. They include the "esobes" near Lake Tumba (Bouillenne *et al.* 1955, Deuse 1960) and the "bais" of northern Congo.

### Wildlife

The Congo River basin as a whole has the second-most-diverse fish fauna in the world after the Amazon (Welcomme 1979), and this richness is evident within the *cuvette centrale congolaise* (Hughes & Hughes 1992). Several species provide locally important fishery. Diverse aquatic habitats are present: from large rivers to forest streams; from calm oxbows to great shallow lakes; and from open wet prairie to permanent forested swamp (Matthes 1964). During the high-water season, aquatic habitats expand by over 85 000 km<sup>2</sup> as the swamps flood (Hughes & Hughes 1992). With the exception of a few pelagic and benthic species of large rivers and lakes, fish species migrate toward wet prairies and swamps at the start of the flooded seasons in September and October, and to a lesser extent in May to June (Matthes 1964). They enter the swamps and marshes to breed as the waters rise. The fry then use these areas as nursery habitat until the waters recede. Some fish species remain in the permanently flooded swamps all year round, especially those in the families Protopteridae, Clariidae, and Anabantidae (Matthes 1964); they have specialized organs that allow them to breathe air in hypoxic waters.

The herpetofauna of the Congo basin is rich (LeBreton 1998), but it is not well documented in the *cuvette centrale congolaise* (Hughes & Hughes 1992). Many snakes and turtles and three species of crocodile inhabit these swamps, including the endemic African dwarf crocodile *Osteolaemus tetraspis* (Hughes & Hughes 1992, Riley & Huchzermeyer 1999). Mammals have received the greatest research interest, especially the large mammals and primates. According to Hughes and Hughes (1992), large mammals include forest elephant (*Loxodonta africana cyclotis*), hippopotamus (*Hippopotamus amphibius*) along waterways, duikers (*Cephalophus* spp.), dwarf antelope (*Neotragus batesi*), waterbuck (*Kobus ellipsiprymnus*), water chevrotain (*Hyemoschus aquaticus*), forest buffalo (*Syncerus*

*caffer nanus*), bushbuck (*Tragelaphus scriptus*, *T. spekei*), giant forest hog (*Hylochoerus meinertzhageni*), pangolin (*Manis gigantea*, *M. tetradactyla*), blotched genet (*Genetta tigrina*), golden cat (*Felis aurata*), and leopard (*Panthera pardus*). Many species of monkeys are found throughout the swamps (*Allenopithecus nigroviridis*, *Cercocebus* spp., *Cercopithecus* spp., *Colobus* spp., *Miopithecus talapoin*) (Hughes & Hughes 1992). Chimpanzees (*Pan troglodytes*) are found throughout the region, but bonobos (*Pan paniscus*), the rarest of the great apes, are only found south of the Congo River. Bonobos are endemic here and threatened, but populations remain in remote areas such as Salonga National Park (Van Krunkelsven *et al.* 2000, Van Krunkelsven 2001). In contrast, western lowland gorillas (*Gorilla gorilla gorilla*) are only found north of the Congo River, where healthy populations remain in the swamps (Fay *et al.* 1989, Blake *et al.* 1995). Unlike other gorilla populations, they use swamp habitats year-round, especially those habitats with abundant *Raphia* palms.

#### Human populations

Human populations in the *cuvette centrale congolaise* are low (mostly <25 persons per km<sup>2</sup>; Singh *et al.* 1999), and areas dominated by swamp are far more sparsely populated (Hughes & Hughes 1992). Populations are largely restricted to riverside communities as a result of the poor quality of the land for agriculture (Hughes & Hughes 1992). Mbandaka and Impfondo (Fig. 5.1) are the only cities, the remaining communities being smaller towns and villages. Most are Bantu-speaking peoples, although pygmies and related groups are also present (Colchester *et al.* 1998). Pygmies have traditionally led a hunter-gatherer existence in the forests and swamps while maintaining associations with Bantu in riverside communities; however, the traditional pygmy lifestyle is at risk. No data are available for population growth within the *cuvette centrale* itself, but the population of the entire Congo basin (Congo and D. R. Congo, and parts of Central African Republic, Gabon, Cameroon, and Angola) is growing rapidly at a compounded annualized rate of 3.3% since 1960, doubling every 22 years (Singh *et al.* 1999). This is amongst the highest rates of population growth in Africa.

#### Conservation concerns

The region remains one of the last great regions of wilderness on Earth (Myers *et al.* 2000). The rate of deforestation in tropical Africa – in terms of forest area lost per year – is modest compared with Latin America and southeast Asia (Achard *et al.* 2002), although the high population growth in the region will increase this pressure. The swamps themselves have not experienced much



fish movement, the main impact of dams to wetlands is to prevent the regular inundation of floodplains downstream (Welcomme 2003), which would disrupt the hydroperiods and the distribution of sediments and nutrients in these swamps.

Other resource-extraction activities may have future consequences on swamp habitats. The Congo basin in general has great potential for mining (Moody 1998), but little information is available on the prospects in the central basin. This is not the case for oil and gas. The outlook for oil and gas in the central Congo basin is promising (Lawrence & Mbungu-Makazu 1988). Oil and gas exploration and exploitation may have a significant impact on swamp communities in the coming years.

Recent civil war in the D. R. Congo and the Congo has had serious environmental consequences in the central Congo basin. In the short term, civil war may limit the exploitation of timber and mineral resources in this region; however, the availability of automatic weapons over the past decade has dramatically escalated the hunting of wildlife, including apes, in part to feed guerrilla armies (Dudley *et al.* 2002). The poaching of elephants for ivory has also increased in regions of conflict as a consequence of the weaponry and lawlessness (Van Krunkelsven *et al.* 2000, Vogel 2000, Dudley *et al.* 2002). Over the longer term, even once the fighting is over, lasting political instability may impede the sustainable exploitation of resources in the central basin and the efforts to conserve its biodiversity (Dudley *et al.* 2002).

Several national parks and reserves with swamp habitats have been established in the central Congo basin. In the D. R. Congo, Salonga National Park was created in 1970 in the central basin (Fig. 5.1) (UNEP World Conservation Monitoring Centre 2001). At 36 000 km<sup>2</sup> in size, it remains one of the largest parks in the world and is a World Heritage Site. It is mostly *terra firme* forest, but wide stretches of swamp habitat occur in the park along the Salonga and Luilaka rivers. In the Congo, the Lac Télé/Likouala-aux-herbes Community Reserve was established in 1998 and covers 4389 km<sup>2</sup>, almost exclusively wetland habitat (Frazier 2002). It is designated as a RAMSAR Wetland of International Importance (Frazier 2002).

Although these parks exist on paper, in practice they fall far below any conservation ideal. Protected areas in the Congo basin are severely under-financed and neglected (Wilkie *et al.* 2001a). Salonga National Park was in the front line during the recent civil war (Vogel 2000). Gangs of poachers with automatic weapons controlled the rivers and hunted bonobos and elephants (Van Krunkelsven 2001). Logging and the clearing of land along access roads also remain a problem in the Salonga (UNEP World Conservation Monitoring Centre 2001). The situation in the Congo is perhaps more stable; yet bushmeat hunting and the illegal burning of

floodplains remain serious problems in the Lac Télé/Likouala-aux-herbes Reserve (Wildlife Conservation Society 2001).

### Concluding remarks

The swamps of the central Congo basin are vast and relatively pristine wetlands in the heart of the African tropical rain forest. However, the numerous references cited in this review are misleading and lie in striking contrast to the paucity of primary research from these swamps. They remain largely unexplored. Our lack of knowledge will remain a handicap for the long-term management of these swamps. Rapid population growth, underdevelopment, and regional conflict will place increasing pressure on the integrity of these swamps over the coming decades. Considering their vast extent; their rich biodiversity; their importance to local economies for supporting fisheries, hunting, and logging; and the threats they face, they deserve far-more attention from the scientific community.

From another perspective, these swamps present a great opportunity. They remain relatively undisturbed, so it is not too late to develop sound plans for their management and conservation. From this perspective, there are two opportunities. As a result of their vast size and relatively contiguous extent, they form a vast nucleus for the conservation of lowland tropical forests in central Africa. Secondly, by their very nature, they are not easily accessible to humans, and as such, they may escape the land clearance occurring in surrounding *terra firme* forests. Conservation planning efforts should build upon these strengths. The Congolese governments, in cooperation with each other and the international community, should place these strengths at the center of planning efforts for the management and conservation of lowland tropical forests in the Congo basin.

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