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Ecology and Conservation of Large-Bodied Freshwater Catfish: A Global Perspective

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Abstract.—The order Siluriformes includes some of the largest freshwater fish on Earth, including 5 of the world's 10 largest obligate freshwater fish species. Large-bodied catfish occur predominantly in large lakes and rivers in North America, South America, Europe, Africa, and Asia. Throughout their range, catfish are an important component of commercial, subsistence, and recreational fisheries. They can also have an important role in the ecosystem as top predators or as indicators of overfishing. Despite their importance, relatively little attention has been given to the conservation status of large-bodied catfish. While certain species are considered endangered, other species have not been assessed, and no global study has been conducted to examine the threats they face or their conservation status. Multiple and combined threats from habitat degradation, dams, water withdrawals, pollution, and overexploitation have led to the decline of many catfish populations. In addition to these threats, large-bodied catfish face an additional set of conservation challenges, including shifting baselines, inadequate knowledge (including lack of taxonomic clarity), and a dearth of protected areas and species conservation plans for freshwater species. Despite these challenges, self-sustaining populations of large-bodied catfish still exist, most notably in free-flowing rivers like the Amazon and the lower Mekong. Efforts to protect the ecological integrity of the Amazon and Mekong and other rivers where large-bodied catfish occur will benefit thousands of species of freshwater fish and millions of people who rely on fish for their livelihoods and food security.

Introduction

Freshwater fish biodiversity has come under increasing pressure from a rapidly growing human population (Dudgeon et al. 2006; Strayer and Dudgeon 2010). Recent reviews suggest that 40% of North American freshwater fish and almost 50% of southern European freshwater fish are threatened (Kottelat and Freyhof 2007; Jelks et al. 2008). The situation for large-bodied freshwater fish may be even worse; several recent studies show that many species are classified as imperiled (Hogan et al. 2004; Allan et al. 2005; Dudgeon et al. 2006). Despite evidence that suggests large-bodied freshwater fish are disproportionately at risk of extinction (Olden et al. 2007), the conservation status of the world's largest catfish species is unclear. While certain species are considered endangered, other species have not been assessed, and no global study has been conducted to examine the threats they face or their conservation status. As large-bodied, and often long-lived, slow-to-mature, high-value migratory species, catfish are particular vulnerable to multiple threats, including overexploitation, habitat degradation, and river fragmentation. This paper serves as a brief introduction to the ecology of large-bodied catfish (order Siluriformes) and examines some of the broad issues surrounding their management and conservation.

Data Sources

Data on fish size and distribution were taken from FishBase (Froese and Pauly 2010) and numerous other sources. FishBase is a dynamic, open-access database containing biological information on most species of freshwater and marine fish, including body length data for more than 20,000 fish species. Data on conservation status are based primarily on information from the International Union for the Conservation of Nature Red List of Threatened Species (IUCN 2010) as well as other sources. The International Union for the Conservation of Nature Red List of Threatened Species (IUCN Red List) is a widely accepted source for classifying conservation

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status. The general aim of IUCN Red List criteria is to provide an explicit, objective framework for classification of species according to their extinction risk. Fish extinction risk is usually determined by examining trends in population size, extent of occurrence, quality of habitat, and level of exploitation. Even with data from the International Union for the Conservation of Nature (IUCN), information on ecology and conservation status of freshwater fish is limited. Out of approximately 13,000 freshwater fish, only 4,000–5,000 (31–38%) have been evaluated by IUCN. Similarly, out of approximately 3,000 species of freshwater catfish, 827 (28%) have been assessed, and of those, 120 are listed as threatened (D. Allen, International Union for the Conservation of Nature, personal communication). Because the IUCN Red List is constantly being updated and because Siluriformes have not been comprehensively assessed, IUCN data have been combined with information from published literature, personal experience, and unpublished data to provide a more complete picture of the global conservation status of large-bodied catfish.

It should be noted that maximum sizes of freshwater fish are notoriously difficult to verify; for some species, total length and weight of very large specimens were reported nearly 100 years ago (Holcik et al. 1988). In other cases, weight is reported rather than length. It is difficult to determine if reports are accurate; fish can be misidentified, reported lengths and weights exaggerated or estimated, or sizes based on hearsay but recorded as fact. The uncertainty surrounding old and/or anecdotal records may be one reason why the Mekong giant catfish *Pangasianodon gigas* is considered by many to be the world's largest freshwater fish based on verified catch of a 293-kg specimen in 2005 (Figure 1), even though the wels *Silurus glanis* may be the longest by total length based on anecdotal data from Russia (Berg 1949; Stone 2007).

Diversity and Distribution of Large-Bodied Catfish

Catfish are among the largest of all obligate freshwater fish (Table 1). Five of Earth's 10 largest freshwater fish are catfish. The top 20 largest catfish all measure more than 1.5 m total length. These catfish occur predominantly in large lakes and rivers in North America, South America, Europe, Africa, and Asia (Table 2).

The three largest catfish in North America are the blue catfish *Ictalurus furcatus*, the flathead catfish *Pylodictis olivaris*, and the channel catfish *I. punctatus*. While all three are considered "big cats" and targeted as trophy fish by anglers, only the

FIGURE 1. The record breaking Mekong giant catfish caught in Thailand in 2005. The fish weighed 293 kg.

TABLE 1. The world's 10 largest obligate freshwater fish species. Maximum size is based on total length modified from FishBase (Froese and Pauly 2010).

Species	Common name	Order	Approximate maximum total length (cm)
Silurus glanis	Wels	Siluriformes	500
Arapaima gigas	Arapaima	Osteoglossiformes	450
S. soldatovi	Soldatov's catfish	Siluriformes	400
Brachyplatystoma filamentosum	Piraiba	Siluriformes	360
Pangasius sanitwongsei	Chao Phraya catfish	Siluriformes	300
Pangasianodon gigas	Mekong giant catfish	Siluriformes	300
Catlocarpio siamensis	Giant barb	Cypriniformes	300
Tor putitora	Mahseer	Cypriniformes	275
Acipenser fulvescens	Lake sturgeon	Acipenseriformes	274
Electrophorus electricus	Electric eel	Gymnotiformes	250

blue catfish and flathead catfish attain sizes greater than 50 kg. The three species are widespread in the United States, and their biology and management is treated in detail in many other articles in this book. One interesting detail is worth noting: while there are anecdotal reports of catches of North American catfish as large as 143 kg in the mid-1800s (Graham 1999), verified records for flathead catfish (56 kg) and blue catfish (59 kg) were both set in the past 20 years (and in the case of the blue catfish, the record was set in 2010). This may indicate that, at least in some areas, management for large size and longev-

TABLE 2. Size (total length) and continent of occurrence of the 20 largest catfish species on Earth. Data modified from FishBase (Froese and Pauly 2010).

Species	Common name	Total length (cm)	Distribution
Silurus glanis	Wels	500	Europe/Asia
S. soldatovi	Soldatov's catfish	400	Asia
Brachyplatystoma filamentosum	Piraiba	360	South America
Pangasianodon gigas	Mekong giant catfish	300	Asia
Pangasius sanitwongsei	Giant pangasius	250	Asia
Wallago attu	Wallago	240	Asia
Bagarius yarrelli	Goonch	200	Asia
Brachyplatystoma rousseauxii	Dorado	192	South America
Silonia silondia	Silond catfish	183	Asia
Wallago leerii	Tapah catfish	180	Asia
Sperata aor	Long-whiskered catfish	180	Asia
Dinotopterus cunningtoni	Singa catfish	175	Africa
Clarias gariepinus	Sharptooth catfish	170	Africa
Pseudoplatystoma corruscans	Spotted sorubim	166	South America
Ictalurus furcatus	Blue catfish	165	North America
Hemibagrus maydelli	Ponduga catfish	165	Asia
Arius gigas	Giant sea catfish	165	Africa
Pylodictis olivaris	Flathead catfish	155	North America
Sperata seenghala	Giant river catfish	150	Asia
Sorubimichthys planiceps	Firewood catfish	150	South America

ity could be having the desired effect (Graham and DeiSanti 1999; Mestl 1999). None of the large North American catfish have been evaluated by IUCN.

Several large species of catfish occur in South America, notably the piraiba, the dorado, and two species of sorubim, the spotted sorubim and the firewood catfish (Figure 2). The piraiba, South America's largest catfish, reportedly attains lengths in excess of 3 m (Lundberg and Littmann 2003) and can weigh up to 200 kg (Boujard et al. 1997).

The piraiba is a large, widespread, commercially important species (Barthem and Goulding 2007). Found in the Amazon, Orinoco, and some rivers in the Guianas, the piraiba was long considered a single species, but it may actually be two or more species (Lundberg and Akama 2005; Barthem and Goulding 2007). In the Amazon, Barthem and Goulding (2007) estimate an annual piraiba yield of approximately 5,500 metric tons. In the Brazilian-Columbian-Peruvian border region, it was once the most important fisheries species by weight. Catch rates, however, have declined over the past 20 years—from almost 4,000 metric tons in 1988 to less than 500 metric tons in the early 2000s. Based on these data, the species is considered seriously overexploited in the region (Barthem and Goulding 2007). The species has not been assessed by IUCN, but if data from the Brazilian-Columbian-Peruvian border region are indicative of other areas, the species could be listed as threatened.

The dorado is a large-bodied, highly migratory catfish that was once fairly common in the Amazon. It reportedly grows to at least 192 cm (Barthem and Goulding 1997). Together with the smaller catfish, the piramutaba *Brachyplatystoma vaillantti*, the dorado is considered one of the most highly migratory fish species in the Amazon (Carolsfeld et al. 2003). It may make the longest migrations of any species of freshwater fish, a journey of more than 5,000 km (Barthem and Goulding 1997). The dorado migrates from the lower Amazon to spawn in the Amazon along the Brazilian-Columbian-Peruvian border (Barthem and Goulding 1997, 2007). Young fish are carried downstream to the Amazon estuary, which is believed to be a nursery ground (Barthem and Goulding 2007). The dorado is targeted and, some argue, overexploited (Carolsfeld et al. 2003) as part of a major international fishery. These fish are intensely harvested along their entire migration route. Young fish face heavy fishing pressure in the Amazon estuary in Brazil, and adults are targeted in the Andean foothill region of the Amazon basin. Overexploitation could become a serious problem if catch limits are not imposed (Barthem and Goulding 2007). Dams also represent a threat to this highly migratory

FIGURE 2. Piraiba and dorado.

species. If dams planned for the Rio Madeira block spawning migrations, an entire stock of the species could be wiped out (Barthem and Goulding 2007). The species has been assessed by the IUCN as Least Concern because it is relatively common and widespread. Further monitoring is important, however, given the species' highly migratory nature, concern over overexploitation, and new and growing threats posed by dams.

The wels is one of the world's largest freshwater fish and one of only two catfish species that occur in Europe (Figure 3). It is native to much of eastern Europe (as far north as southern Sweden and as far south as Greece and Turkey) as well as the North, Black, Baltic, Caspian, and Aral Sea basins (Kottelat and Freyhof 2007). Old reports of very large fish come from Hungary (200–250 kg/3 m total length [TL]), the Dnieper River (306 kg/5 m TL), the Volga River and Caspian Sea (300 kg), and the Aral Sea basin (130 kg/2 m TL) (Copp et al. 2009). The wels is a popular sport fish and has been introduced outside of its native range, most notably in the United Kingdom, Spain, Italy, and Kazakhstan. While populations of wels have declined in some parts of its native range, it is thriving at certain sites outside of its native range, so much so that there is now an active debate about the effect of wels on native biodiversity (Benejam et al. 2007; Copp et al. 2009). Populations in the Ebro River in Spain, in particular, are considered robust, although the invasion has not been studied in detail (Carol et al. 2007). The species has been categorized by the IUCN as Least Concern because it is relatively common and widespread.

Despite high freshwater fish diversity, Africa is not home to any catfish species longer than 2 m TL. Several species do grow over 150 cm, including at least three catfish species in the family Clariidae: singa catfish, sharptooth catfish, and sampa *Heterobranchus longifilis*. Sharptooth catfish and sampa are both widespread species; sharptooth catfish is a popular, and nearly pan-African, food fish while sampa is the largest freshwater fish in southern Africa. Singa catfish is endemic to Lake Tanganyika where it is heavily exploited by fishermen. Sharptooth catfish and sampa have not been evaluated by IUCN while singa catfish is listed as Near Threatened.

FIGURE 3. The wels.

Several of the world's largest catfish are widespread throughout Asia; the wallago and the goonch both occur from Pakistan to Indonesia, the wels is found in western Asia, and the Soldatov's catfish occurs in the Amur basin in Russia and China. The Mekong River is home to several species of large-bodied catfish, including the endemic Mekong giant catfish, the giant pangasius, as well as goonch, wallago, the somewhat smaller river catfish *Pangasianodon hypophthalmus*, and the highly migratory "salmon" catfish *Pangasius krempfi*.

The wallago occurs in freshwaters from Pakistan to Vietnam (Figure 4). It is a large, predatory catfish, attaining lengths of up to 2.4 m (Pethiyagoda 1991). In India, the species is threatened by overharvest, habitat degradation, and pollution (Mijkherjee et al. 2002; Hossain et al. 2008). Due to these threats and declining abundance, the species is considered endangered in India (Hossain et al. 2008; Sarkar et al. 2008). In the Cambodian Mekong, fishers reported a decline in abundance of 58% since 1980 (author's unpublished data). In Tonle Sap Lake, the lower Mekong, and Kampong Cham areas, fishers reported a decline of 71% since 1980, whereas in the Kratie and Stung Treng areas, fishers reported a decline of 42% (author's unpublished data). The largest fish reported by Cambodian fishers was an 80-kg specimen from 1990. Fishers also reported fish up to 60 kg as recently as 2006 (author's unpublished data). The IUCN lists wallago as Near Threatened.

The goonch is a large, predatory catfish that is widespread in Asia (Figure 5). In India, it occurs in the Indus, Ganges, and Brahmaputra River basins (Froese and Pauly 2010). Based on available data, it appears that populations of the goonch in the Indus and Ganges drainages have declined significantly since 1980 (V. Badola, Otter Reserves, personal communication). Likewise, Sheikh et al. (1997) reported that abundance of large-sized goonch has declined dramatically in certain sections of Brahmaputra. In the early 1980s, Sheikh et al. (1997) found goonch weighing up to 300 kg, but by the early 1990s, the size of fish had decreased significantly due to increasing exploitation rates (Sheikh et al. 1997). Capture rates in the early 1990s were estimated at 10 times the capture rates of the early 1980s, resulting in an increase in catch of juvenile fish (Sheikh et al. 1997). Goonch is found mainly in rapids of the main Mekong River and its largest tributaries. It can attain sizes greater than 2 m and 100 kg in the Mekong

FIGURE 4. The wallago.

FIGURE 5. The goonch.

River, but large adults are extremely rare. During 1 month of monitoring along an approximately 100-km stretch of the Mekong River in northern Thailand (May 2006), the largest fish harvested by fishers weighed 30 kg (author's unpublished data). Goonch is threatened by overharvest, habitat degradation, and water extraction (Sheikh et al. 1997). IUCN lists goonch as Near Threatened.

Giant pangasius once occurred in the Chao Phraya River and its tributaries and the Mekong River from Chiang Saen to Vietnam (Figure 6). Smith (1945) reports that capture of giant pangasius up to 3 m in length was relatively common prior to 1920. By 1945, the longest fish observed measured 2.5 m, and the average size of a fish reaching the Bangkok market was 40–60 cm. Giant pangasius is now considered extirpated from the Chao Phraya River in Thailand. It still occurs in the Mekong, though populations have decreased significantly from historic levels (Hogan et al. 2009). Up until 1995, giant pangasius was a regular, though rare, catch in Chiang Khong, Thailand. In southern Laos, fishers once used harpoons to catch giant pangasius and other large species. Fishers no longer use harpoons due to the disappearance of large fish (Roberts and Baird 1995). The giant pangasius is vulnerable to overfishing because of its large size and migratory behavior. Large, spawning fish are taken from the Mekong River between Chiang Khong and Chiang Saen, Thailand. Young fish are harvested for food and aquaculture throughout the Mekong, particularly along the stretch of river from Nong Khai to the confluence of the Mekong and Mun rivers (northeast Thailand). Dams and disturbance of the fish's spawning habitat may also represent a significant, though poorly understood, threat. Based on catch trends, the IUCN listed giant pangasius as Critically Endangered in 2007.

Historically, Mekong giant catfish occurred throughout large rivers of the Mekong River basin

FIGURE 6. The giant pangasius.

in Vietnam, Cambodia, Lao People's Democratic Republic (PDR), Thailand, and possibly Burma and southwestern China (Figure 7). In Cambodia, the Mekong giant catfish moves out of the flooded habitats of Tonle Sap Lake at the end of the rainy season (October–December). During the dry season (January–May), the species inhabits deep water areas of the Mekong River. It is migratory, but the extent of migrations is unknown. Little is known about the spawning behavior of wild Mekong giant catfish. There is strong evidence that the species spawns in northern Thailand in June, but precise time and location of this spawning activity have not been confirmed. The Mekong giant catfish now appears limited to the Mekong River and its tributaries in Cambodia, Lao PDR, and Thailand. Historical reports indicate that the species was abundant in the early 1900s. However, in the 1970s, local fishers began to report disappearance of the species. Current population size is unknown, but a decline of more than 80% over the past 13 years can be estimated from past and current annual catch records (Hogan et al. 2004). Fishing is a serious threat to Mekong giant catfish (Allan et al. 2005). Loss of migratory routes through construction of dams (e.g., Pak Mun Dam in Thailand) may also have a negative effect on fish abundance in the river (Hogan et al. 2004). A 2.7-m, 293-kg Mekong giant catfish was captured by Thai fishermen in 2005 (Stone 2007). According to the Mekong Giant Catfish Fishermen's Club, this was the largest catfish caught in the northern Thai section of the Mekong since records started being kept in 1981 (author's unpublished data). Mekong giant catfish was listed as Critically Endangered by the IUCN in 2003.

Importance of Large-Bodied Catfish

Many large-bodied catfish are important fisheries species. For example, in the Mekong River basin, Mekong giant catfish, giant pangasius, and related species (catfish in the family Pangasiidae) are a dominant fish group, popular in aquaculture, and frequently the basis of local wild-capture fisheries (Roberts and Vidthayanon 1991). Annual production in Cambodia is estimated to be at least 10,000 metric tons and in Vietnam is predicted to be an incredible 1,000,0000 metric tons by 2010 (Lenormand 1996; Poulsen et al. 2008). Catfish represent 90% of all aquaculture and 20% of all inland capture fisheries in Cambodia. They account for the majority of the May to July harvest in southern Lao PDR and northeastern Thailand (Mekong River Commission 1992). They are selectively caught as juveniles on a massive scale (1–2 billion fingerlings per year) to supply artisanal aquaculture needs. Including aquaculture production from Vietnam, combined harvest from the Mekong River is likely the largest catfish fishery in the world. Though not on quite the same scale, catfish fisheries are also very important in other regions, especially North America, South America, and Africa. In North America, millions of pounds of wild ictalurid catfish were being harvested from the Mississippi as early as 1894 (Carlander 1954). More

FIGURE 7. The Mekong giant catfish.

recently, aquaculture production has surpassed production from capture fisheries, but recreational fishing for trophy-sized catfish remains popular (Holley et al. 2009). In South America, dorado, piramutaba, and slobbering catfish *Brachyplatystoma platynemum* are targeted as part of a major international fishery. Barthem and Goulding (2007) estimate total Amazon River basin annual yield of *Brachyplatystoma* spp. at 30,000–40,000 metric tons. In some areas, such as the Teotonio rapids on the upper Madeira River and the upstream areas like Leticia, Columbia, catches of large-bodied represent up to 90% of the seasonal catch (Barthem and Goulding 2007). In Africa, the large-bodied catfish such as sharptooth catfish are important food fish. In Nigeria, where per capita consumption of fish is more than 7 kg/year and catfish make up about 50% of total in-country production, sharptooth catfish is the most widely cultured species (Ponzoni and Nguyen 2008).

Giant fish species, like large-bodied catfish, can have an important role in the ecosystem as top predators, as "umbrella" species, or as indicators of overfishing. Large, migratory animals are often considered umbrella species because the protection of such species and their habitat also benefits many other species. In the Amazon, for example, Barthem and Goulding (1997) write about a "profound and far reaching predatory network" where large catfish are "beyond any doubt" the most abundant, wide-ranging predators. In fact, they dedicate an entire book to what they call the "catfish connection" (Barthem and Goulding 1997). Widespread and highly migratory catfish are thought to use an area of 2,500,000 km2 and make the longest migrations of any freshwater fish species in the world (Barthem and Goulding 1997). These highly migratory catfish create an ecological link between the Amazon floodplain and the main river. Thus, management for an intact catfish connection would also benefit other species over a huge area. Likewise, in the Mekong River basin, large-bodied Pangasiid catfish like the Mekong giant catfish, giant pangasius, and related species are well known for long-distance migrations, moving extensively between Vietnam, Cambodia, Lao PDR, and Thailand (Hogan et al. 2007). Pangasiid catfish are particularly vulnerable to threats from habitat degradation and overexploitation because of their migratory behavior, high economic value, requirements for specific water quality and flow, and complex life history dependent on the seasonal floods (Mekong River Commission 1992; Roberts 1993; Hill and Hill 1994). As such, protection of particularly vulnerable species like pangasiid catfish can also provide protection for many other aquatic species (Hogan et al. 2004). Pangasiid catfish also appear to be an indicator of overfishing; as fishing pressure has increased in the Mekong River basin, abundance of large-sized fish has declined (Baran and Myschowoda 2008). The largest species are among the most highly threatened (Table 3).

In some cases, animals like large-bodied catfish also serve as charismatic flagship species, galvanizing public and political support for cooperative action to restore populations and protect habitat (Rabinowitz 1995; Dillon and Wikramanayake 1997; Caro and O'Doherty 1999). In border areas, such animals can stimulate transnational cooperation, which has led to policy formation and establishment of international regulatory agencies (Dillon and Wikramanayake 1997; Lorenz et al. 2001). Successful flagship species are usually large, often endangered, and sometimes migratory (Dietz et al. 1994; Dinerstein et al. 1997; Caro and O'Doherty 1999). Wide-ranging species can also make effective flagships because they are known to a large number of people in many countries (Butler 2000). For example, the Mekong giant catfish is well known throughout the Mekong River basin (Kottelat and Whitten 1996; Hogan 1998). Thus, the species can be used to introduce transnational issues to local communities through outreach and education (Butler 2000). Promoting community-level involvement in transnational cooperation reinforces international efforts at the local level (Agrawal 2000; Boer 2000).

Threats to Large-Bodied Catfish

Fish and freshwater habitats are facing growing threats from increased human use (Dudgeon et al. 2006). Multiple and combined threats from habitat degradation, dams, water withdrawals, pollution, and overexploitation have lead to decline of populations of freshwater biodiversity at twice the rate of terrestrial organisms (Dudgeon 2010; Strayer and Dudgeon 2010). Large-bodied catfish are vulnerable to many of these same stressors. In Asia, for example, gross pollution in the Ganges River and water withdrawals in the Indus River threaten freshwater fish like wallago and goonch (Hossain et al. 2008; Sarkar et al. 2008). Pollution, dams, and water withdrawals have also been blamed for the decline of giant pangasius in the Chao Phraya River in Thailand (Humphrey and Bain 1990; Roberts 1993; Hogan et al. 2004). In the Amazon River basin, large-bodied migratory catfish face an uncertain future due to the planned Madeira hydroelectric complex. The Madeira complex, which will consist of four dams on a main tributary of the Amazon, may block the spawning migration dorado and other species (Barthem and Goulding 2007). Construction of dams will also flood the town and rapids of Teotonio, a famous fishing spot for large, migratory catfish. Last, but certainly not least, overexploitation of large-bodied freshwater fish, including catfish, is a serious threat. Olden et al. (2007) found that commercial and subsistence fishing are important drivers of extinction risk of large-bodied freshwater fish. The Mekong giant catfish and giant pangasius are perhaps the two best documented examples of fishing-related population decline. Overall catch of both species has declined steadily over the past several decades, and populations are now thought to be at less than 10% of historic levels.

Table 3. An example of the relationship between size and conservation status of catfish in the Mekong River basin. Total lengths come from Rainboth (1996) and are based on the maximum reported size of the species in recent times.

Species	Maximum size (cm)	Conservation status	References
Mekong giant catfish	300	Critically endangered	Rainboth (1996); Hogan et al. (2004)
Chao Phraya catfish	250	Critically endangered	Rainboth (1996); Hogan et al. (2009)
Pangasianodon hypophthalmus	120	Declining/rare	Roberts (1993); Rainboth (1996)
Pangasius conchophilus	60	Common	Roberts (1993); Rainboth (1996)
Pangasius macronema	18	Common	Roberts (1993); Rainboth (1996)

Conservation Challenges

The overarching and often interacting threats to freshwater biodiversity have been well documented (Agostinho et al. 2005; Allan et al. 2005; Dudgeon 2010; Strayer and Dudgeon 2010). In addition to these threats, large-bodied catfish face an additional set of conservation challenges, that, though not unique to giant catfish, are significant nonetheless. Those conservation challenges include shifting baselines, inadequate knowledge (including lack of taxonomic clarity), and a dearth of protected areas and species conservation plans for freshwater species.

The idea of shifting baselines is not new, but it can be especially problematic for large, poorly studied fish like the Mekong giant catfish, giant pangasius, river catfishes, goonch, and goliath catfishes of the Amazon. As these species become rarer, their importance, and in certain cases even their presence, is rapidly forgotten (Humphries and Winemiller 2009). This is in large part due to lack of documentation of past abundance and a constantly aging population of fishermen. This leads to a shifting perceptions of large fish abundance; decline of fish abundance is overlooked and society does not recognize the need for, or importance of, conservation. Until recently, this was certainly the case for Mekong giant catfish and giant pangasius, two species that, in the 1990s and early 2000s, quietly drifted toward extinction (Sretthacheua 1995; Hogan 1998).

Inadequate knowledge is a particular problem in tropical freshwater ecosystems where diversity is highest (Dudgeon 2000, 2003). Many species remain to be discovered, and of those that have been discovered and described, little information exists on their ecology or population status. For example, one of the world's largest fish, the giant freshwater stingray *Himantura chaophraya*, was only described in 1990, and since that time, no studies have been done on its biology or conservation status (Monkolprasit and Roberts 1990; Stone 2007). Lack of taxonomic clarity can also be a serious obstacle to conservation because it is difficult to assess or protect a species when it is not properly identified. The goonch, for example, is thought to be widespread throughout South and Southeast Asia, but the taxonomy of the species is not well understood (IUCN 2010) and some populations of the species have declined significantly. This situation has lead to a call for goonch to be "re-assessed following resolution of its taxonomic uncertainty." IUCN (2010) believes that "the subsequent species identified may all then qualify for a threatened category." Lack of taxonomic clarity may also be an issue in South America where a new species of goliath catfish was recently described (Lundberg and Akama 2005), and taxonomy and population status of several large-bodied species is currently under discussion (Castello and Stewart 2010).

Lack of protected areas and management plans can also be an obstacle to conservation (Barletta et al. 2010). While terrestrial and marine protected areas are relatively common, freshwater protected areas, or even conservation plans for freshwater species, are rare (Abell et al. 2007; Suski and Cooke 2007). Thus, in many cases, freshwater biodiversity does not receive the same level of protection as terrestrial and marine biodiversity, even though freshwater biodiversity is more threatened. This is particularly problematic for high value or highly migratory species, especially those that cross international borders, since these species are unlikely to be managed effectively without formal protection (Valbo-Jorgensen et al. 2008). The large migratory catfish of the Mekong and Amazon rivers are cases in point; both Pangasiidae and Pimelodidae are vulnerable to habitat degradation over a wide area, depend on critical habitats for survival, and are harvested as part of an international fishery. The situation has led to calls for species conservation plans, freshwater protected areas, basin-wide management (Hogan et al. 2004), and, in some cases, international treaties to protect these large, migratory catfish (Barthem and Goulding 2007).

Conservation Opportunities

The Amazon and the Mekong rivers are hotspots of large-bodied catfish biodiversity. Almost half of the world's largest catfish species occur in one of these two rivers, and both rivers are also home to the healthiest remaining populations of large-bodied catfish on earth. In the Amazon, piraiba and dorado are still abundant, and in the Mekong, smaller pangasiid catfish remain relatively common. For larger endangered species like the Mekong giant catfish and giant pangasius, the Mekong River is a last refuge.

Perhaps more remarkably, neither the lower Mekong nor Amazon mainstream has been dammed. This is especially important because both the goliath catfishes of the Amazon, and the giant catfish of the Mekong, are migratory. Amazon species make some of the longest distance migrations of any species of freshwater fish, thousands of kilometers from the mouth of the Amazon to the foothills of the Andes, to complete their spawning migrations. Likewise, several large-bodied catfish of the Mekong migrate more than 1,000 km to spawn, moving upstream from Vietnam and Cambodia to Lao PDR and Thailand at the beginning of the rainy season. Given these long distance movements, and also the economic importance of most large-bodied catfish, they can be considered indicators of the overall health and integrity of the rivers where they occur (Hogan et al. 2004).

Sustainable development and fishery harvest of the Amazon and Mekong basins remains possible. Both river basins are incredibly productive; the Mekong, for example, yields an estimated 2,000,000 metric tons of fish per year. Yet this productivity could be threatened by unmanaged harvest or by dams on the mainstream Mekong. Decisions made in the next 20 years will determine whether or not the connectivity and environmental flows of the rivers remain intact and fisheries remain bountiful. Barthem and Goulding (1997, 2007) have called for immediate steps to manage Amazon fisheries. Several authors have noted the importance of a free-flowing Mekong River to fish diversity and fisheries productivity (Poulsen and Jorgensen 2000; Hogan et al. 2004). Efforts to protect the ecological integrity of the Amazon and Mekong rivers will benefit thousands of species of freshwater fish and millions of people who rely on fish for their livelihoods and food security.

Conclusions

Catfish are a highly diverse, widely distributed group, including more than 3,000 species (Ferraris 2007). They are common in aquaculture, a key component of commercial fisheries, and popular with recreational anglers. Large-bodied catfish in particular are well known and the target of commercial, subsistence, and recreational anglers worldwide. Despite their importance, relatively little attention has been given to the conservation status of large-bodied catfish. Preliminary evidence (i.e., shrinking distribution, decline in catch, decline in fish size, decline in catch per unit effort, and accounts of local people) suggests an alarming trend—populations of many species of large catfish are in decline. Due to the precarious state of populations of large catfish, especially in Asia, lack of data on catfish populations, and the traditionally low visibility of catfish conservation, study and conservation of large catfish is now a priority.

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