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Distribution, Endemism and Conservation Status of Fishes in the Yangtze River Basin, China

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1. Introduction

The Yangtze River (Chang Jiang), with a length of 6300 km, is the longest river in Asia and the third-longest in the world. It originates from glaciers on the Geladandong Mountains of the Tibetan Plateau and follows a sinuous west to east route before emptying into the East China Sea at Shanghai. It drains one-fifth of China's land area and its river basin is home to one-third of China's population. Owing to a long geographical history, affluent water resources, an immense variety of lotic and lentic ecosystems, and the differences of physical environments in the upper, middle and lower reaches, the Yangtze River basin (a complex riverine-lacustrine network) is especially rich in fish fauna, representing high fish species richness and endemism in the Palearctic region. Being pregnant with plentiful fish resources, the basin is a cradle of inland fisheries in China. Its fishery yield accounts for about two-thirds of freshwater fishery production of the whole country (Liu & Cao, 1992). The Yangtze River Basin is therefore a globally significant area for preserving fish biodiversity and fishery resources.

However, the Yangtze River basin is also an area highly impacted by a long history of human use and environmental variation, and is further threatened by China's rapid economic development and the demands of over 400 million people living in the basin during the past few decades. Since the 1950s, loss of fish biodiversity in the Yangtze River basin have been accelerated by a series of direct and indirect effects of human activities and environmental changes, *e.g.* disappear, shrinkage and fragmentation of habitats for fish spawning, feeding and migration, overfishing, water pollution and invasion of exotic species. Documenting regional fish distribution and understanding major threats to fish biodiversity are necessary for protecting and recovering endangered fish species and natural communities. Thus, it is urgently needed to review the problems and threats facing fish resources in the Yangtze River basin, and to provide crucial information about which species are at risk and what factors threaten their existence for developing successful conservation strategies to slow the loss of fish biodiversity.

Since the 1930s, Chinese ichthyologists have investigated fish fauna and biodiversity in the Yangtze River basin, and a large amount of information has been published on taxonomic, biological and biogeographical aspects. In the present chapter, we collected and synthesized these scattered data from relevant literature including Chu (1955), Du (1962), Anonymous (1976, 1980), Yang (1987), Zeng (1990), Zhang (1991), Wu & Wu (1992), Ding (1994), Huang & Xie (1996), Chen (1998), Yue & Chen (1998), Li et al. (1998), Chu et al. (1999), Song et al. (1999), Yue (2000), Ni & Zhu (2005), Xie & Yang (2005), Zhuang et al. (2006), Ye et al. (2006; 2007), Ye (2007), Zhang & Li (2007), Wu & Zhong (2008), Zhang et al. (2008). Threatened status of fish species in the Yangtze River basin was compiled from China Species Red List (Wang & Xie, 2009) and China Red Data Book of Endangered Animals (Yue & Chen, 1998) into five threatened categories: extinct (EX), extinct in the wild (EW), critically endangered (CR), endangered (EN) and vulnerable (VU). Our main purposes were (1) to investigate large-scale distribution and endemic species composition of fishes in different reaches of the Yangtze River basin, (2) to rank the major threats to impaired or extinct fish species and quantify the relative contribution of intrinsic factors to fish endangerment, and (3) to provide recommendations for fish biodiversity conservation in the Yangtze River basin.

2. Fish distribution and endemism

2.1 Description of river reaches

The Yangtze River basin covers an area of about 1.8 million km^2 and lies across the three large topographic platforms of the Chinese mainland (Fig. 1). The riverhead is located on the Tibetan plateau, where the mean elevation is over 4500 m (Zeng, 1990). Upstream from Yichang (in Hubei Province) is the upper reach, with a narrow valley and a rocky channel of high gradient ratio. The length is more than 4300 km, and the drainage area is almost 100×10^4 km^2. The famous Three Gorges Dam is located in the upper mainstream. The range of the middle reach is from Yichang to Hukou (in Jiangxi Province), with a length of about 950 km and a drainage area of almost 68×10^4 km^2. Here, the river has a gentle gradient and takes a meandering course. It connects with shallow lakes of various sizes and numerous tributaries and forms an endemic Chinese compound ecosystem of inland water. From

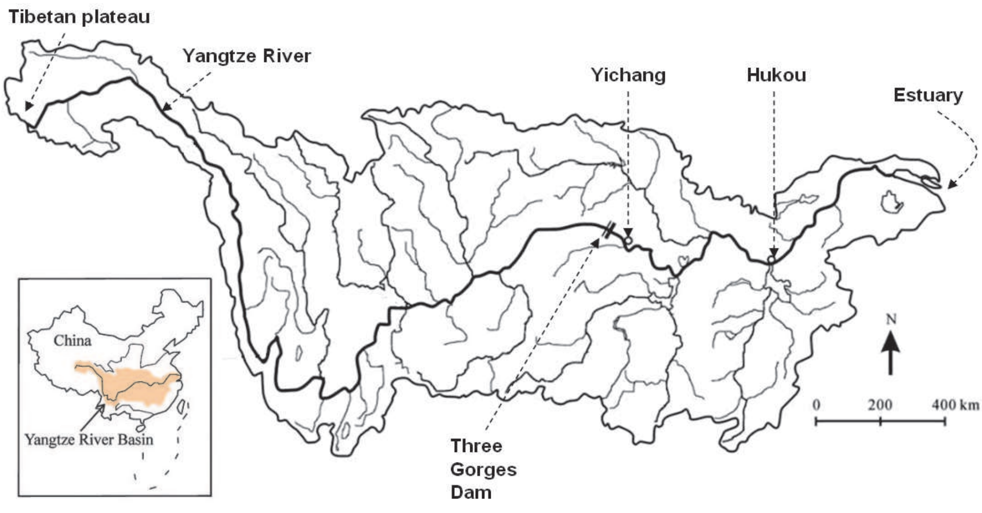

Fig. 1. Sketch map of the Yangtze River basin

Hukou downward to the mouth of the river is the lower reach, with a length of about 930 km. The drainage area is about 12×10^4 km^2. This segment of the river wanders among plains and hills, and several large interior lakes, such as Lake Caohu and Lake Taihu in association with many tributaries, drain into the reach (Chen et al., 2000). In the estuary confluent with the East China Sea, the river forms a trumpet shaped delta.

2.2 Faunal composition

Our synthesis (see Appendix 1) showed that there are 416 fish species and subspecies (16 orders and 33 families) known from the entire Yangtze River basin, which amount to about 40% of the total freshwater fishes in China (Zhu, 1995) and far exceed the number of any other river systems in China. For example, the Pearl River has 294 and the Yellow River only has 150 fish species and subspecies (Cao, 1992). Of these fishes in the Yangtze River basin, 362 species and subspecies spend all their lives in fresh water (Table 1), and 11 species of migratory fishes include eight anadromous species (*Acipenser sinensis*, *Macrura reevesi*, *Coilia ectenes*, *C. mystus*, *Myxocyprinus asiaticus*, *Hemisalanx prognathus*, *Takifugu obscurus*, *T. flavidus*) and three catadromous species (*Anguilla japonica*, *A. marmorata*, *Trachidermus fasciatus*). The rest 43 species chiefly live in the brackish water of the estuary with a wide range of salt tolerance, moving regularly between coasts and the estuary. A significant feature of the fish fauna in the Yangtze River basin is the large amount of endemic fishes (Table 1). There are 178 endemic species that occupy 42.8% of the total number of fishes in the basin.

Order	Yangtze River basin			World [a]	
	Freshwater species	Species using freshwater [b]	Endemic species	Freshwater species	Species using freshwater [b]
Acipenseriformes	2	3	1	14	27
Anguilliformes	0	2	0	6	26
Clupeiformes	0	3	0	79	85
Cypriniformes	280	280	150	3268	3268
Siluriformes	40	40	20	2740	2750
Osmeriformes	6	8	1	82	86
Salmoniformes	2	2	1	45	66
Mugiliformes	0	4	0	1	7
Atheriniformes	1	1	0	210	240
Beloniformes	1	2	0	98	104
Cyprinodontiformes	3	3	0	996	1008
Synbranchiformes	1	1	0	96	99
Scorpaeniformes	0	1	0	60	62
Perciformes	26	50	4	2040	2335
Pleuronectiformes	0	4	0	10	20
Tetraodontiformes	0	12	1	14	22
Total	362	416	178	9759	10205

[a] Data are cited from Nelson (2006). [b] Freshwater species plus those species frequently occurring in freshwater that may otherwise be diadromous or simply entering fresh water in substantial numbers or in a substantial portion of their range.

Table 1. Species number of fishes in the Yangtze River basin and in the world

The most species-rich order in the Yangtze River basin is Cypriniformes (Table 1), for which the proportion of species number in the basin to those in the world is 8.6%. And there are four orders (Mugiliformes, Tetraodontiformes, Pleuronectiformes, Acipenseriformes) for which the proportion of number of species using freshwater in the basin to those in the world is more than 10%. This indicates that fish biodiversity in the Yangtze River basin plays an important role in the freshwater fish species bank of the world.

Cyprinidae, Cobitidae, Gobiidae, Bagridae and Homalopteridae are the most species- or endemic species-rich families (Fig. 2 and 3). Triplophysa (Cobitidae) and Schizothorax

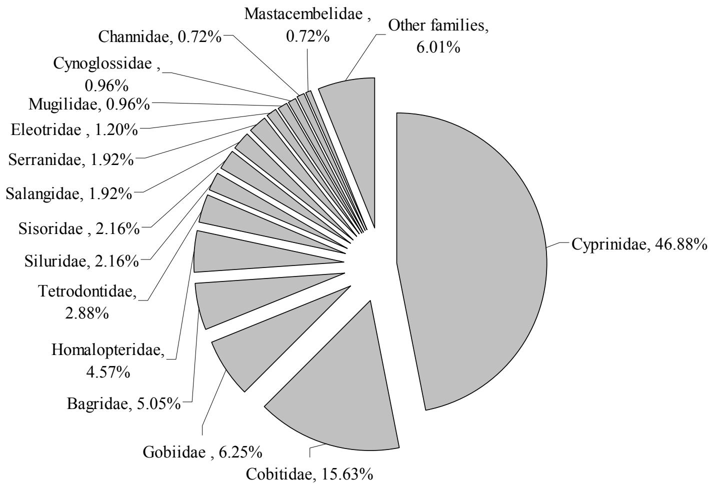

Fig. 2. Percentage of species number of the most species-rich families to the total species in the Yangtze River basin

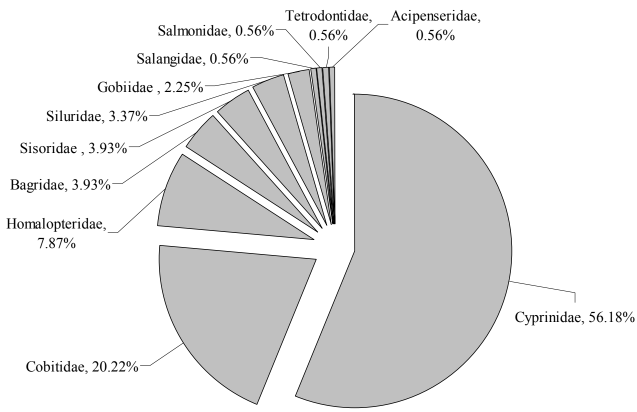

Fig. 3. Percentage of endemic species number of each family to the total endemic species in the Yangtze River basin

(Cyprinidae) are two genera with the highest species numbers in the basin, accounting for 6.5 and 4.1% of the total species, and 8.4 and 9.0% of the total endemic species, respectively (see Appendix 1). Tectonic activities, such as uplift of the Tibetan Plateau, were believed to be important and responsible for the higher diversity of the two genera (Cao et al., 1981). Tectonic activity has also been associated with the large numbers of endemic species in other river basins (Minckley et al., 1986).

2.3 Large-scale distribution

The fishes are not evenly distributed in the Yangtze River basin (Fig. 4). Among the 416 species, 206 species occupy only one of the five defined areas of the basin (riverhead, upper reach, middle reach, lower reach, and estuary). Common species that occur in two, three or four of the defined areas are all less than 25% of the total fish species number in the basin. Endemic fishes appear to have the similar distribution pattern. Only four endemic species (*Squalidus nitens*, *Saurogobio gymnocheilus*, *Parabotia bimaculata*, and *Pelteobagrus eupogon*) are common to the three reaches and estuary. Most of the 178 endemic fishes (116 species) occupy one of the define areas. In particular, 97 endemic species were found only in the upper reach (Table 2), indicating that the distribution of the endemic fishes intensively occurs there.

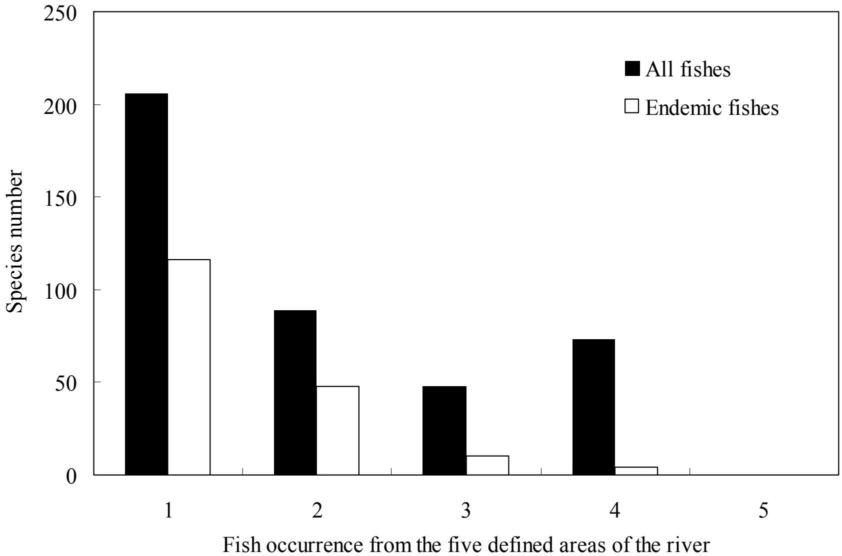

Fig. 4. Distribution range of fishes in the Yangtze River basin

In the riverhead waters, the number of fishes is very small, including five cyprinid fishes, seven species of genus Triplophysa, and two species of family Sisoridae (see Appendix 1). Here, the mean elevation is over 4500 m (Zeng, 1990) and only some specialists could live. Of these fishes, five species were found only in the riverhead (Table 1) and the other nine species were also reported in the upper reach. Nearly 60% species are endemic fishes, and one species (*Triplophysa tanggulaensis*) was recorded only in the riverhead (Table 2).

The upper reach has the highest species number, and more than half species are endemic (Table 2). There are 279 species and subspecies of fishes from a wide range of taxonomic categories. Taking food of adhering algae and invertebrates, most of them adapt to rapid current and inhabit the underlayer, while others (fishes of families Homalopteridae and Sisoridae) adhere to and climb on the stones of the riverbed. The Chinese paddlefish (*Psephurus gladius*) and Chinese sucker (*Myxocyprinus asiaticus*), which are distributed mainly in the Yangtze River and could be found in all of the three reaches and their main branches, at present occur chiefly in the upper reach. There were only two migratory fishes, but the Japanese eel (*Anguilla japonica*) disappeared after the Gezhouba Dam was constructed in the upper mainstream (Xie & Chen, 1999).

Fishes in the middle and lower reaches are also abundant, but with lower proportion of endemic fishes compared with the upper reach (Table 2). More migratory fishes (*Anguilla marmorata, Macrcura reevesi, Coilia ectenes, C. mystus, Myxocyprinus asiaticus, Hemisalanx prognathus, Trachidermus fasciatus, Takifugu obscurus, T. flavidus*) occur in the middle and lower reaches. Some euryhaline marine fishes inhabit the lower reach and the estuary of the river, such as *Neosalanx andersoni*, *Liza carinatus*, *Mugil cephalus*, *Terapon jarbua*, *Repomucenus olidus*, *Cynoglossus gracilis*, *and Takifugu spp*.

	All fishes (A)	Endemic fishes (E)	E/A (%)
Riverhead	14 (5)	8 (1)	57.1
Upper reach	279 (119)	147 (97)	52.7
Middle reach	227 (36)	70 (17)	30.8
Lower reach	158 (5)	23 (1)	14.6
Estuary	142 (41)	10 (0)	7.0

Note: The number in parentheses indicates the number of fish species found only in that area.

Table 2. Species number of fishes in different areas of the Yangtze River basin

3. Threats to fish biodiversity

3.1 Structural change of fish community

Historical variations in the fish community of Yangtze River's lakes can be summarized as follows: (1) decline in species richness and number of migratory species; (2) decrease in the abundance of piscivorous species in fish catches; and (3) diminution in age-specific body length of commercial fishes (Cao et al., 1991; Xie & Chen, 1999).

Here, four examples from Lake Donghu, Lake Honghu, Lake Liangzi and Lake Poyang illustrated the changes of species richness, ecological and trophic structures of fish community during the past half century (Table 3). Apparent reduction of species richness was observed in these lakes, especially a sharp decline in Lake Donghu that is a typical urban lake and therefore received more disturbances from human being. The number and percentage of migratory fishes decreased in all the four lakes, mainly due to river-lake blockage by the building of sluice gates. The comparison of fish catches indicated that the proportion of piscivorous fishes tended to decrease dramatically, mainly due to their relatively high vulnerability to over-fishing and habitat destruction or degradation.

Another five examples on four commercial fish species were used to demonstrate the size diminution of fishes in the Yangtze River's lakes. During the past decades, the age-specific body lengths of crucian carp (*Carassius auratus auratus*), sneakhead fish (*Channa argus*), redfin culter (*Cultrichthys erythropterus*), and Chinese perch (*Siniperca chuatsi*) have shown a remarkable decline (Table 4). Extensive fishing might have removed more fast-growing individuals and thus left more stunted individuals (Cao et al., 1991).

Lake	Year	SR	Ecological group of fishes				Reference
			MS	RS	LS	PS	
Lake Donghu	before 1971	67	9 (13.4%)	9 (13.4%)	49 (73.2%)	5.22%	Huang & Xie, 1996
	1992-1994	39	5 (12.8%)	3 (7.7%)	31 (79.5%)	0.26%	Huang & Xie, 1996
Lake Honghu	1959	64	8 (12.5%)	12 (18.8%)	44 (68.7%)	10.0%	Song et al., 1999
	1992	57	4 (7.0%)	12 (21.1%)	41 (71.9%)	5.0%	Song et al., 1999
Lake Liangzi	Before 1974	72	10 (13.9%)	14 (19.4%)	48 (66.7%)	11.4%	Ye, 2007
	1997-1999	58	6 (10.3%)	4 (6.9%)	48 (82.8%)	9.4%	Xie & Yang, 2005
Lake Poyang	before 1980	117	14 (12.0%)	32 (27.4%)	71 (60.7%)	-	Zhang & Li, 2007
	1997-2000	101	7 (6.9%)	24 (23.8%)	70 (69.3%)	-	Zhang & Li, 2007

SR: Species richness; MS: Number and percentage of migratory species in fish community; RS: Number and percentage of riverine species in fish community; LS: Number and percentage of limnicolous species in fish community; PS: Percentage of piscivorous species in fish catches.

Table 3. Historical changes of fish community structure in Yangtze River's lakes

Fish species	Lake	Year	Age				Reference
			1	2	3	4	
Carassius auratus auratus	Lake Honghu	1960	61	118	184	231	Anonymous, 1976
		1988	38	63	83	99	Zhang, 1991
Channa argus	Lake Liangzi	1956	190	288	398	516	Du, 1962
		1998	198	305	366	443	Xie & Yang, 2005
Cultrichthys erythropterus	Lake Poyang	1958	115	159	218	235	Anonymous, 1976
		2006	131	148	176	191	Zhang et al., 2008
Siniperca chuatsi (Female)	Lake Poyang	1959	177	246	335	425	Anonymous, 1976
		1997	131	247	310	349	Li et al., 1998
Siniperca chuatsi (Male)	Lake Poyang	1959	173	220	324	-	Anonymous, 1976
		1997	127	228	289	328	Li et al., 1998

Table 4. Historical changes of age-specific body lengths (standard length, unit: mm) of fishes in lakes of the Yangtze River basin

3.2 Species endangerment

It was estimated that at least 20% of the world's freshwater fish species were seriously threatened or extinct, mainly as a result of habitat modification (competition for water, drainage, and pollution), species introduction, and commercial exploitation (Groombridge, 1992). In the Yangtze River basin, there are 65 threatened fish species included in the China Species Red List (Wang & Xie, 2009), belonging to 10 orders and 18 families (see Appendix 1). These fishes are classified into five threatened categories (Table 5), i.e., extinct (two species), extinct in the wild (two species), critically endangered (five species), endangered (36 species), and vulnerable (20 species). It should be noted that 69% of the threatened or extinct fishes are endemic species in the Yangtze River basin (Table 5).

As shown in Table 6, the two species extinct in the wild (*Anabarilius polylepis* and *Schizothorax parvus*) and one extinct species (*Anabarilius liui liui*) were known to be endemic only in the upper reach. Another extinct species (*Atrilinea macrolepis*) was endemic only in the middle reach. Of the five critically endangered species, Chinese paddlefish (*Psephurus gladius*) were recorded in the upper, middle, lower reaches and estuary, and *Euchiloglanis kishinouyei* were recorded in both riverhead and upper reach. The other three critically endangered species (*Megalobrama elongata*, *Schizothorax longibarbus*, and *Leiocassis longibarbus*) occurred only in the upper reach. Overall, there are much more threatened or extinct fish species distributed in the middle reach than in the other areas of the Yangtze River basin.

	All species (A)	Endemic species (E)	E/A (%)
Extinct (EX)	2	2	100
Extinct in the wild (EW)	2	2	100
Critically endangered (CR)	5	4	80
Endangered (EN)	36	27	75
Vulnerable (VU)	20	10	50
Total evaluated	65	45	69

Table 5. Species number of fishes in different threatened categories

	Threatened categories					Total evaluated
	Extinct	Extinct in the wild	Critically endangered	Endangered	Vulnerable	
Riverhead	0	0	1	2	1	4
Upper reach	1	2	5	28	13	48
Middle reach	1	0	1	9	10	20
Lower reach	0	0	1	8	8	9
Estuary	0	0	1	8	3	12

Table 6. Threatened status of fishes in different areas of the Yangtze River basin

3.3 Major threats

From the China Species Red List (Wang & Xie, 2009) and China Red Data Book of Endangered Animals (Yue & Chen, 1998), we extracted the recognized causes (major threats and intrinsic factors) of endangerment or extinction of the 65 species in the Yangtze River basin. We did not try to distinguish between ongoing and historical threats, because such information is often lacking, and the distinction itself is problematic in the case of habitat destruction. We tabulated the number of species threatened by four broad categories of threats: habitat loss/degradation, unreasonable harvesting, water pollution, and biological invasion. We then used the resulting database to determine the frequency of the threat categories and intrinsic factors (i.e. recruitment/reproduction, juvenile mortality, population density, growth rate, and dispersal range) for the threatened fish species. We further subdivided primary threat factors into finer categories, and determined the frequency of each of these causes of endangerment.

Fig. 5 presents a summary of the percentages of fish species in the Yangtze River basin imperilled by the major threats. Unreasonable harvesting is the most pervasive threat to the fishes in the Yangtze River basin, contributing to the endangerment of 86.2% of the listed species, followed by habitat loss/degradation (43.1%), water pollution (30.8%), and biological invasion (27.7%). In particular, overfishing (83.1%) was identifies as the most severe threat. The great frequency of overfishing stems mainly from China's large and poor population, along with widespread trade in fishery products. The use of devastating fishing methods, such as ever-finer meshed nets, poisons, explosives, and electric shocking, is also a contributing factor. Within the threats to habitat loss/degradation, damming and other hydraulic construction appeared to be the most significant threat. The construction of dams at cascades in the river and its tributaries has blocked the passage of migratory fish species, changed hydrological conditions, made their habitats fragmented, and brought about severe impacts on fish habitats and spawning environments. Water pollution influences fish resources not only through direct effects on fish survival, but also through negative impacts on various kinds of food organisms for fishes such as plankton and benthos, resulting in decreases in the abundance of natural fish stocks.

Invasion of non-indigenous species is also a serious threat to biodiversity in the basin. Fish compositions in some plateau lakes of the upper Yangtze River, such as Lake Dianchi and Lake Lugu, have been seriously affected by exotic species introductions (Xie et al., 2001). Exotic species compete with native fishes for food and other resources, leading to greatly reduced numbers of local species, and even the local extinction of some species (Chen et al., 1998). The number of native species of Lake Dianchi has declined from 25 in the 1940s, to 15 in 1978, and 8 in 1982. A recent fish fauna investigation conducted in the lake found only five native species, and the number of endemic species and subspecies had declined from nine in the 1950s to two (Xie & Chen, 1999; Xie et al., 2001).

Among the intrinsic factors we analyzed, limited dispersal and restricted range appear to have the highest contributions to the effects of the threats upon fishes in the river basin (Fig. 6). The other intrinsic factors lag behind these two primary factors in terms of their frequency for the imperilled and extinct fish species (Fig. 6). In comparison, the three factors (slow growth rate, population fluctuation, and high juvenile mortality) could be minor causes of endangerment in the Yangtze River basin.

The endemic fish distribution in the upper reach is represented by complicated assemblages, which are highly correlated to the topographic and geomorphic characteristics of the upper Yangtze River basin (He et al., 2011). Generally, these endemic species are well adapted to specific habitats with relatively small population size. For example, the fishes of Triplophysa and Schizothorax usually live in the tributaries and mountain streams with torrential flows and gravel riverbeds, whose origin, evolution and distribution are related to the uplift of the Tibetan Plateau (Cao et al., 1981). They are usually sensitive to environmental changes or disturbances, and more prone to extinction under the threats of overfishing and habitat loss, mainly due to their limited dispersal and restricted range.

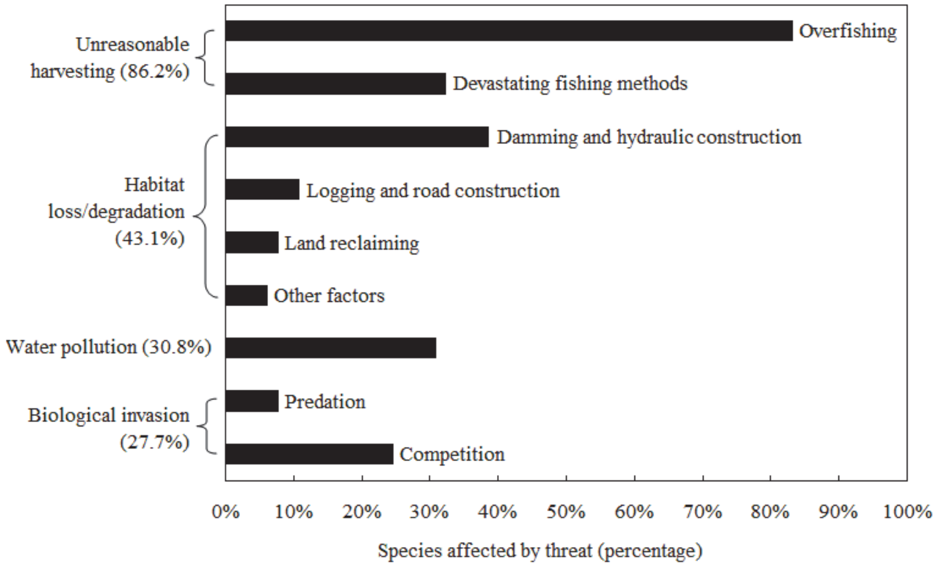

Fig. 5. Rank of the major threats to fish endangerment in the Yangtze River basin

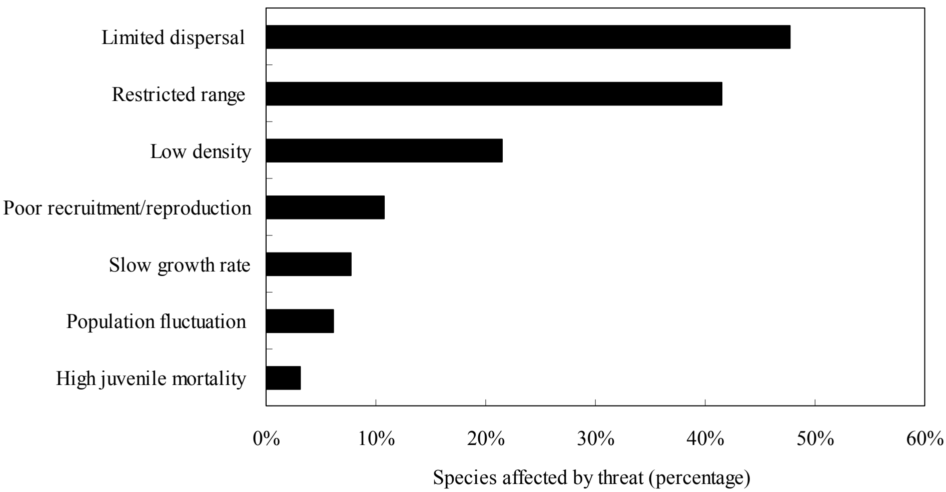

Fig. 6. Rank of the intrinsic factors for fish endangerment in the Yangtze River basin

Species that use distinct environments during different stages of their life histories (e.g. migratory fish) are at risk from elimination of crucial habitats or erection of structures that impede movement. For example, the Chinese paddlefish (*Psephurus gladius*) declined drastically in the Yangtze River after the Gezhouba Dam blocked access to its upstream spawning habitats, and the fish likely faces extinction (Wei et al., 1997). Furthermore, they are especially vulnerable to overfishing and other environmental hazards because the long maturation time limits rates of population recovery. On the other hand, fragmentation of resident populations also results from barriers, and may ultimately lead to species loss. During the late 1950s-1970s, sluice gates were constructed in almost all lakes of the middle and lower reaches except for Lake Dongting and Lake Poyang for water conservancy projects. The sluice gates blocked interchanges of fishes in the river–lakes ecosystem. Severance of fish exchange has brought about the decline in natural fish stocks in the river and its lakes, especially the decline in species richness and abundance of migratory fishes (Xie & Chen, 1999).

4. Conservation status and strategies

Restoration of the Yangtze River to its original state is impractical given the constraints prevailing in the region, but some degree of rehabilitation will be possible if relevant legislation and scientific information are promptly applied. Even though China lacks a truly comprehensive law on nature conservation, it did enact the China Wildlife Protection Law in 1989 to protect rare and endangered species. Although the law has yet to be completely enforced, China has established a legislative framework for biodiversity conservation and a number of action plans have been initiated (Xu et al., 1999). A fishery law dating from 1986 and revised in 2000 proscribes fishing of rare and precious aquatic animals. Within the last two decades, an interprovincial authority, the Administrative Commission of the Yangtze River Fisheries Resources, was established to control illegal fishing activities involving the use of electricity, explosives, and poisons, and to protect fish stocks in the Yangtze River. In February 2003, an annual fishing moratorium of three to six months was introduced to protect 8100 km of the river, including 4090 km of the mainstream and more than 4000 km of its tributaries. This measure builds on the well established and widespread practice of stocking Chinese rivers and lateral lakes with cultured fries of major carp species to maintain or enhance fishery yields (Fu et al., 2003). Such stocking cannot be regarded as a measure that contributes greatly to biodiversity conservation, because it has implications for the genetic variability of indigenous carp species. However, it may reduce harvesting pressure on endangered species that could benefit from the fishing moratorium.

Problems with protection of endemic fishes and implementation of wildlife protection legislation in the Yangtze River basin exist because the natural resources laws and regulations, especially for fisheries, have been formulated from the standpoint of economic value, which emphasizes utilization rather than protection. Thus the conservation of endangered species is mainly the responsibility of the Ministry of Agriculture, which has the historical remit of increasing or expanding the capture quotas of economically important species. Moreover, a separate authority, the Ministry of Water Resources, has an overlapping responsibility with the Ministry of Agriculture, but it is directed toward maintaining water supplies for human consumption and agriculture, whereas protection of water quality is under the jurisdiction of the State Environmental Protection Administration. The conflict between economic development and conservation plus the overlapping and sometimes contradictory responsibilities of government authorities have impeded actions that are needed to preserve biodiversity (Xu et al. 1999). Some progress has been made recently: in 2000, a 400-km section of the upper reach of the Yangtze River was designated as a reserve for rare fishes, but portions of it will be affected by rising water levels behind the Three Gorges Dam and by the dams planned for the Jinsha River tributary. Potential reserve sites for rare fishes elsewhere along the Yangtze River have been identified (Park et al., 2003), but they await official designation.

Since the Yangtze River basin is undergoing a very rapid deterioration as a consequence of human-induced changes, conservation strategies must be improved and expanded. The conservation of the fishes in the upper reach should be considered as a priority. Current knowledge of speciation theories indicates the importance of local processes in generating high endemicity of inland water fauna (Martens, 1997). The high endemicity of fish species in the upper reach indicates that the more immediate conservation need is to retain as many of the natural ecological processes and functions of the river as possible. A conservation recommendation, according to which the habitats rich in endemic species should be identified as the nature reserves, has been put forward (Liu & Cao, 1992). In view of the different endemic fish assemblages (with multiple habitats and different fish compositions) in the upper Yangtze River, different reserves aimed at different conservation objectives should be set up in order to preserve fish biodiversity (He et al., 2011). At present, there are three fish reserves, of which, one is for the protection of rare and unique species in the upper reach at the national level, and two are for the protection of Chinese sturgeon at the provincial level. The National Nature Reserve for Rare and Peculiar Fish Species in the upper Yangtze River is the only national protected zone across many provinces in China. Its management and protection tasks are very arduous. The effective realization of nature reserve functions can be pushed forward only through their tracing, monitoring and appraisal.

In the middle and lower reaches of the Yangtze River basin, the conservation strategies for fishes must take into account the complex life cycles and ontogenetic shifts in habitat requirements of migratory fishes. Restoring the stocks of the migratory fishes should be a priority in these reaches, because the severance between the Yangtze River and its connecting lakes is the most critical factor responsible for the decline of the abundance of the migratory fishes. In addition, fragmentation of the resident population resulting from the severance may ultimately lead to species loss. Ideally, restoration of natural fish stocks in the middle and lower reaches would include restoration of the free flow, so fishes can move freely between the Yangtze River and its lakes. Minimally, construction of a fish passage structure is necessary. Conventional fish ladders designed for salmonids may not be successful because most fishes do not jump. In the basin, there are more than 40 lake-river migratory fishes (species that migrate from lakes to breed in rivers; Liang et al., 1981). Most of them have been affected by severance (Xie & Chen, 1999). Compared to severed lakes, the river-connecting lakes are rich in river-lake migratory fishes (Liang et al., 1981; Liu & Wang, 2010). At present, considering the importance of river-connecting lakes for sustaining populations of the river–lake migratory fishes, river-connecting lakes, such as Lake Dongting and Lake Poyang, are also of high priority for conversation.

Conservation must be proactive. Our ability to ameliorate or mitigate the effects of human activities is predicated upon an adequate understanding of river ecology. But information on the prevailing situation with respect to habitat integrity and fish biodiversity in the Yangtze River basin is inadequate. Some published catalogs of fish faunal composition are based on dated literature or old museum collections instead of recent surveys. Information on fish conservation status is thus unreliable, and extinctions may not be evident until long after they have occurred. The basic task of compiling species inventories is one priority for biodiversity conservation, but it should be accompanied by assessments of population size and long-term viability (Dudgeon, 2000). These tasks will require monitoring strategies, such as those developed by Humphrey et al. (1995) in tropical Australia, and formulation of indices of river health that can be applied to individual habitats. Furthermore, explicit information on life histories of endangered species is highly necessary for successful conservation of the fishes.

Data sharing and collaboration between academic institutions and governmental agencies are particularly essential for the effectiveness of fish conservation. All research efforts are in vain if the resulting knowledge is not translated into social and/or political action. This may be the greatest challenge facing conservation ecologists. Ecological stations and networks should be established linking inland water biological laboratories from the universities and the institutions along the Yangtze River, in conjunction with museums, particularly regarding long-term ecological research. This will ensure that currently available information is used effectively. It is also necessary to establish and standardize databases of inland water organisms and associated environmental information.

5. Conclusion

The large amount and high endemicity of fish species have resulted in the importance of the Yangtze River basin in the freshwater fish species bank of the world. Fish biodiversity and freshwater ecosystems are seriously jeopardized by human activities in the basin. The decline of diversity and the loss of some fishes will have potential impacts on the global fish biodiversity, so more hotspots of fish biodiversity in the Yangtze River basin should be identified as nature reserves. There is an urgent need for integrated action and legislation to ensure that the endangered species are legally protected within their range. A mixture of strategies will be essential to preserve fish biodiversity in the long term. It must include reserves that protect key, biodiversity-rich water-bodies (e.g. tributaries in the upper reach and river-connecting lakes in the middle reach) and their catchments, as well as species- or habitat-centred plans that reconcile the protection of biodiversity and societal use of water resources. In parallel, conservation ecologists must more effectively communicate the importance and value of fish biodiversity to stakeholders and policy makers, so as to make certain that all available information on fish biodiversity is applied effectively to ensure its conservation.

6. Acknowledgment

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Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
I. Acipenseriformes						
Acipenseridae						
*1. Acipenser dabryanus**	EN		+	+		
2. A. sinensis	EN		+	+	+	+
Polyodontidae						
3. Psephurus gladius	CR		+	+	+	+
II. Anguilliformes						
Anguillidae						
4. Anguilla japonica			+	+	+	+
5. A. marmorata	EN				+	+
III. Clupeiformes						
Clupeidae						
6. Macrura reevesi	EN			+	+	+
Engraulidae						
7. Coilia ectenes				+	+	+
8. C. mystus					+	+
IV. Cypriniformes						
Catostomidae						
9. Myxocyprinus asiaticus	VU		+	+	+	+
Cyprinidae						
10. Zacco platypus			+	+	+	+
*11. Z. chengtui**	VU		+			
12. Opsariichthys bidens			+	+	+	+
13. Aphyocypris chinensis			+	+	+	+
*14. Gobiocypris rarus**	EN		+			
15. Phoxinus oxycephalus			+	+	+	
16. Atrilinea roulei	VU				+	
*17. A. macrolepis**	EX			+		
18. Mylopharyngodon piceus			+	+	+	+
19. Ctenopharyngodon idellus			+	+	+	+
20. Squaliobarbus curriculus			+	+	+	+
21. Luciobrama macrocephalus	EN		+	+	+	+
22. Ochetobius elongatus			+	+	+	+
23. Elopichthys bambusa			+	+	+	+
*24. Anabarilius liui liui**	EX		+			
*25. A. l. chenghaiensis**			+			
*26. A. brevianalis**			+			
*27. A. songmingensis**			+			
*28. A. qionghaiensis**	EN		+			
*29. A. xundianensis**			+			
*30. A. polylepis**	EW		+			
*31. A. alburnops**	EN		+			
32. Sinibrama wui			+	+	+	
33. S. macrops			+	+	+	
*34. S. taeniatus**			+			
*35. Ancherythroculter wangi**			+			
*36. A. kurematsui**			+			
*37. A. nigrocauda**			+			

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
38. Pseudoleubuca sinensis			+	+	+	+
39. P. engraulis			+	+	+	+
40. Toxabramis swinhonis			+	+	+	+
41. Hemiculter leucisculus			+	+	+	+
*42. H. tchangi**			+			
43. H. bleekeri			+	+	+	+
*44. Hemiculterella sauvagei**			+	+		
45. H. Wui				+		
*46. Pseudohemiculter kweichowensis**			+			
47. Cultrichthys erythropterus			+	+	+	+
48. Culter alburnus			+	+	+	+
49. C. mongolicus mongolicus			+	+	+	+
*50. C. m. elongatus**			+			
*51. C. m. qionghaiensis**			+			
52. C. Dabryi			+	+	+	+
53. C. Oxycephalus			+	+	+	+
*54. C. oxycephaloides**			+	+	+	
55. Parabramis pekinensis			+	+	+	+
56. Megalobrama skolkovii			+	+	+	+
*57. M. pellegrini**			+	+		
*58. M. amblycephala**				+	+	+
*59. M. elongata**	CR		+			
60. Xenocypris argentea			+	+	+	+
61. X. davidi			+	+	+	+
*62. X. yunnanensis**	VU		+			
*63. X. fangi**	EN		+			
64. X. microlepis			+	+	+	
65. Distoechodon tumirostris			+	+	+	
*66. D. hupeinensis**	EN			+		
67. Pseudobrama simony			+	+	+	+
68. Hypophthalmichthys molitrix			+	+	+	+
69. Aristichys nobilis			+	+	+	+
70. Hemibarbus labeo			+	+	+	
71. H. maculates			+	+	+	+
72. H. longirostris				+	+	
*73. Paracanthobrama guichenoti**				+	+	+
74. Belligobio nummifer			+			
*75. B. pengxianensis**	EN		+			
76. Pseudorasbora parva			+	+	+	+
77. P. elongata	VU			+	+	
78. Sarcocheilichthys sinensis			+	+	+	+
79. S. parvus				+	+	
80. S. kiangsiensis				+	+	
81. S. nigripinnis			+	+	+	+
*82. S. davidi**			+			
*83. Gnathopogon herzensteini**			+	+		
*84. G. imberbis**			+	+		
*85. G. nicholsi**				+	+	

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
86. G. taeniellus					+	
87. Squalidus argentatus			+	+	+	+
*88. S. nitens**			+	+	+	+
89. S. wolterstorffi			+	+	+	
90. Coreius heterodon			+	+	+	+
*91. C. guichenoti**			+	+		
92. Rhinogobio typus			+	+	+	
*93. R. hunanensis**				+		
*94. R. cylindricus**			+	+		
*95. R. ventralis**			+	+		
96. Platysmacheilus exiguus				+		
*97. P. longibarbatus**	VU			+		
*98. P. nudiventris**			+	+		
99. Abbottina rivularis			+	+	+	+
*100. A. obtusirostris**			+			
101. Microphysogobio fukiensis			+	+	+	
*102. M. microstomus**					+	
103. M. kiatingensis			+	+	+	
*104. M. tungtingensis**				+	+	
105. Huigobio chenhsinensis				+	+	
106. Pseudogobio vaillanti			+	+	+	
107. Saurogobio dumerili			+	+	+	
108. S. dabryi			+	+	+	+
*109. S. gracilicaudatus**				+		
110. S. xiangjiangensis				+		
*111. S. gymnocheilus**			+	+	+	+
*112. Gobiobotia (Progobiobotia) abbreviatea**			+			
113. G. (Gobiobotia) tungi				+	+	
114. G. (G.) meridionalis				+		
*115. G. (G.) filifer**			+	+		+
116. G. (G.) brevirostris				+		
*117. G. (G.) jiangxiensis**						
*118. Xenophysogobio boulengeri**			+	+		
*119. X. nudicorpa**			+			
120. Rhodeus ocellatus			+	+	+	+
121. R. lighti			+	+	+	+
122. R. fangi				+	+	+
*123. Acheilognathus gracilis**			+	+	+	
124. A. macropterus			+	+	+	+
*125. A. omeiensis**			+			
126. A. barbatus			+	+	+	+
127. A. barbatulus			+	+	+	+
*128. A. elongatus**	EN		+			
129. A. polylepis				+	+	
130. A. tonkinensis			+	+	+	+
131. A. tabira				+	+	
*132. A. hypselonotus**			+	+	+	
133. A. chankaensis			+	+	+	+

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
*134. A. nanchongensis**						
135. Paracheilognathus himantegus				+	+	+
136. P. imberbis			+	+	+	+
137. Spinibarbus hollandi			+	+	+	
*138. S. sinensis**			+	+		
139. Barbodes laticeps			+			
*140. B. polylepis**			+			
*141. Percocyprinus pingi pingi**	VU		+			
142. Sinocyclocheilus multipunctatus			+			
*143. S. grahami grahami**	EN		+			
144. Acrossocheilus labiatus				+		
145. A. fascitus				+	+	
*146. A. jishouensis**				+		
*147. A. monticola**			+	+		
148. A. elongatus				+		
149. A. yunnanensis			+	+		
150. Onychostoma macrolepis			+	+		
151. O. sima			+	+		
152. O. barbata			+	+		
153. O. lini	VU			+		
*154. O. rara**	EN		+	+		
*155. O. angustistomata**			+			
156. O. barbata			+	+		
*157. O. daduensis**			+			
*158. O. brevis**			+			
159. Tor brevifilis			+	+		
*160. Sinilabeo rendahli**			+	+		
*161. S. tungting**				+	+	
*162. S. longibarbatus**			+			
*163. Rectoris luxiensis**			+	+	+	
*164. R. mutabilis**			+			
165. Semilabeo notabilis	VU		+			
*166. Pseudogyrincheilus procheilus**			+	+		
167. Garra pingi pingi			+	+		
*168. Sinocrossocheilus guizhouensis**	VU		+			
169. Discogobio yunnanensis			+	+		
170. D. brachyphysallidos			+			
*171. Schizothorax (Schizothorax) chongi**			+			
*172. S. (S.) wangchiachii**		+	+			
*173. S. (S.) dolichonema**	EN	+	+			
*174. S. (S.) sinensis**			+	+		
*175. S. (S.) grahami**	VU		+			
*176. S. (S.) cryptolepis**			+			
*177. S. (S.) heterochilus**			+			
*178. S. (S.) prenanti**			+	+		
*179. Schizothorax (Racoma) kozlovi**			+			
*180. S. (R.) yunnanensis weiningensis**			+			
181. S. (R.) griseus	EN		+			

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
*182. S. (R.) parvus**	EW		+			
*183. S. (R.) ninglangensis**	EN		+			
*184. S. (R.) microstomus**	EN		+			
*185. S. (R.) labrosa**	EN		+			
*186. S. (R.) longibarbus**	CR		+			
*187. S. (R.) davidi**			+	+		
188. Ptychobarbus kaznakovi	VU	+	+			
*189. P.chungtienensis gezaensis**			+			
*190. P. c. chungtienensis**	EN		+			
191. Gymnodiptychus pachycheilus	EN		+			
*192. G. potanini potanini**			+			
*193. G. p. firmispinatus**			+			
*194. Schizopygopsis malacanthus malacanthus**		+	+			
*195. S. m. chengi**			+			
*196. S. kialingensis**			+			
*197. S. malacanthus baooxingensis**			+			
*198. Herzensteinia microcephalus**		+	+			
*199. Procypris rabaudi**	VU		+	+		
*200. Cyprinus (Mesocyprinus) micristius**	EN		+			
201. C. (Cyprinus) chilia			+			
*202. C. (C.) qionghaiensis**	EN		+			
203. C. (C.) carpio			+	+	+	+
204. Carassius auratus auratus			+	+	+	+
Homalopteridae						
205. Vanmanenia stenosoma				+	+	
206. V. pinchowensis				+		
207. V. tetraloba			+			
208. Pseudogastromyzon fangi				+		
209. Paraprotomyzon multifasciatus			+			
*210. P. niulanjiangensis**						
*211. P. lungkowensis**			+	+		
*212. Beaufortia szechuanensis**			+			
*213. B. niulanensis**						
*214. B. liui**			+			
*215. Lepturichthys fimbriata**			+	+		
*216. Hemimyzon yaotanensis**	VU		+			
*217. Jinshaia abbreviata**			+			
*218. J. sinensis**			+			
*219. Sinogastromyzon hsiashiensis**				+		
*220. S. sichuangensis**			+	+		
*221. S. szechuanensis**			+	+		
*222. Metahomaloptera omeiensis omeiensis**			+	+		
*223. M. o. hangshuiensis**				+		
Cobitidae						
*224. Triplophysa markehenensis**		+	+			
225. T. stewarti		+				
226. T. orientalis		+				
*227. T. bleekeri**			+	+		

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
228. *T. pseudoscleroptera*			+			
229. *T. robusta*			+			
230. *T. microps*		+				
231. *T. stoliczkae*			+			
232. *T. rotundiventris*		+				
233. *T. ninglangensis**			+			
234. *T. stenura*		+	+			
235. *T. polyfasciata**			+			
236. *T. angeli**			+			
237. *T. venusta**			+			
238. *T. grahami**			+			
239. *T. xichangensis**			+			
240. *T. anterodorsalis**			+			
241. *T. brevicauda*			+			
242. *T. obscura*			+			
243. *T. leptosoma*			+			
244. *T. tanggulaensis**		+				
245. *T. xiangxiensis**				+		
246. *T. xiqiensis**			+			
247. *T. daqiaoensis**			+			
248. *T. brevibarba**			+			
249. *T. crassilabris**			+			
250. *T. yaopeizhii*			+			
251. *Nemacheilus obscurus*			+			
252. *Paracobitis variegates*			+	+		
253. *P. potanini**			+	+		
254. *P. wujiangensis**			+			
255. *Oreias dabryi*			+	+		
256. *Sphaerophysa dianchiensis**			+			
257. *Yunnanilus nigromaculatus**			+			
258. *Y. pleurotaenia**			+			
259. *Y. caohaiensis**			+			
260. *Y. sichuanensis**			+			
261. *Y. longibulla**			+			
262. *Schistura dabryi*			+			
263. *S. niulanjiangensis**						
264. *S. fasciolata*			+			
265. *S. incerta*				+		
266. *S. xiangxiensis**				+		
267. *Botia superciliaris*			+	+		
268. *B. reevesae**			+			
269. *Parabotia fasciata*			+	+	+	
270. *P. bimaculata**			+	+	+	+
271. *P. maculosa*			+	+	+	
272. *P. kiangsiensis**				+		
273. *P. banarescui**				+		
274. *Leptobotia elongata**	VU		+	+	+	
275. *L. taeniops**			+	+		

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
276. L. pellegrini				+		
277. L. guilinensis				+		
*278. L. microphthalma**			+			
*279. L. tchangi**				+		
*280. L. tientaiensis hansuiensis**				+		
*281. L. rubrilabris**				+	+	
282. L. orientalis				+		
283. Cobitis sinensis			+	+	+	+
284. C. taenia				+	+	
285. C. rarus				+		
*286. C. macrostigma**				+	+	
287. Misgurnus anguillicaudatus			+	+	+	+
288. Paramisgurnus dabrynus			+	+	+	+
V. Siluriformes						
Bagridae						
289. Pelteobagrus fulvidraco			+	+	+	+
*290. P. eupogon**	VU		+	+	+	+
291. P. vachelli			+	+	+	+
292. P. nitidus			+	+	+	
293. Leiocassis longirostris			+	+	+	+
294. L. crassilabris			+	+	+	
*295. L. longibarbus**	CR		+			
296. L. tenuifurcatus			+	+		
297. Pseudobagrus ussuriensis			+	+	+	+
*298. P. pratti**			+	+	+	
299. P. truncatus			+	+	+	+
300. P. ondon				+	+	
301. P. taeniatus				+	+	+
*302. P. analis**				+		
*303. P. medianalis**	EN		+			
304. P. tenuis				+	+	+
305. P. emarginatus			+	+		
*306. P. brevicaudatus**			+	+		
*307. P. omeihensis**			+			
308. P. adiposalis				+	+	
309. Mystus macropterus			+	+	+	
Siluridae						
310. Silurus asotus			+	+	+	+
311. S. meridionalis			+	+	+	
*312. S. mento**	EN		+			
Amblycipitidae						
*313. Liobagrus marginatus**			+	+		
314. L. anguillicauda				+		
*315. L. kingi**	EN		+			
*316. L. nigricauda**				+	+	
*317. L. styani**				+	+	
*318. L. marginatoides**			+	+		
Sisoridae						

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
319. Glyptothorax fukiensis fukiensis			+	+	+	
*320. G. sinense sinense**			+	+		
*321. Euchiloglanis kishinouyei**	CR	+	+			
*322. E. davidi**	EN		+			
*323. Pareuchiloglanis sinensis**	EN	+	+			
324. P. feae			+			
*325. P. sichuanensis**			+			
*326. P. robusta**			+			
*327. P. anteanalis**			+			
Clariidae						
328. Clarias fuscus			+	+	+	
VI. Osmeriformes						
Salangidae						
329. Protosalanx chinensis				+	+	+
*330. Hemisalanx brachyrostralis**				+	+	+
331. H. prognathus					+	+
332. Salanx ariakensis						+
333. Neosalanx oligodontis				+	+	+
334. N. taihuensis			+	+	+	+
335. N. andersoni						+
336. Plecoglossus altivelis	VU					
VII. Salmoniformes						
Salmonidae						
*337. Hucho bleekeri**	EN		+	+		
338. Brachymystax lenok	VU			+	+	+
VIII. Mugiliformes						
Mugilidae						
339. Liza carinatus						+
340. L. haematocheila						+
341. Mugil cephalus					+	+
342. Osteomugil ophuyseni						+
IX. Atheriniformes						
Atherinidae						
343. Allanetta bleekeri				+		+
X. Beloniformes						
Hemiramphidae			+	+		
345. Hyporhamphus intermedius			+	+	+	+
345. H. sajori						+
XI. Cypriodontiformes						
Oryziatidae						
346. Oryzias latipes			+	+	+	+
347. O. latipes sinensis	VU		+			
Poeciliidae						
348. Gambusia affinis			+	+		
XII. Synbranchiformes						
Synbranchidae						
349. Monopterus albus			+	+	+	+
XIII. Scorpaeniformes						

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
Cottidae						
350. Trachidermus fasciatus	EN				+	+
XIV. Perciformes						
Serranidae						
351. Lateolabrax maculatus						+
352. Siniperca whiteheadi				+		
353. S. chuatsi			+	+	+	+
354. S. knerii			+	+	+	
355. S. scherzeri			+	+	+	+
356. S. undulats	VU			+	+	
357. Coreosiniperca roulei	VU			+	+	
358. Coreoperca obscura				+		
Belontiidae						
359. Macropodus chinensis			+	+	+	+
360. M. opercularis			+	+	+	
Channidae						
361. Channa argus			+	+	+	+
362. C. asiatica			+	+	+	
363. C. maculata				+		
Mastacembelidae						
364. Sinobdella sinensis				+	+	
365. Mastacembelus aculeatus				+	+	+
366. M. armatus				+	+	+
Polynemidae						
367. Eleutheronema tetradactylum						+
Terapontidae						
368. Terapon jarbua						+
Callionymidae						
369. Repomucenus olidus						+
Eleotridae						
370. Hypseleotris swinhonis			+	+	+	+
371. Odontobutis obscura				+	+	+
372. Bostrichthys sinensis						+
373. Eleotris oxycephala						+
374. Prionobutis koilomatodon						+
Gobiidae						
375. Mugilogobius myxodermus			+	+	+	+
*376. M. polylepis**	EN				+	+
377. Ctenogobius giurinus			+	+	+	+
378. C. multimaculatus					+	
*379. Ctenogobius shennongensis**	EN			+		
380. Acanthogobius elongata						+
381. Chaeturichthys stigmatias						+
382. Ctenogobius brunneus			+	+	+	
*383. C. szechuanensis**	EN		+			
384. C. cliffordpopei			+	+	+	+
*385. C. chengtuensis**			+			
386. Glossogobius giuris						+

Order **Family** *Species*	Threat status	River-head	Upper reach	Middle reach	Lower reach	Estuary
387. Lophiogobius ocellicauda						+
388. Odontamblyopus rubicundus					+	+
389. Synechogobius ommaturus						+
390. Tridentiger trigonocephalus					+	+
391. T. barbatus						+
392. Cryptocentrus filifer						+
393. Luciogobius guttatus						+
394. Amblychaeturichthys hexanema						+
395. Taeniodides cirratus						+
396. Oxuderces dentatus						+
397. Trypauchen vagina						+
398. Periophthalmus cantonensis						+
399. Boleophthalmus pectinirostris						+
400. Scartelaos histiophorus						+
XV. Pleuronectiformes						
Cynoglossidae						
401. Cynoglossus (Areliscus) semilaevis						+
402. C. (A.) abbreviatus						+
403. C. (A.) gracilis					+	+
404. C. (Cynoglossoides) robustus						+
XVI. Tetrodontiformes						
Tetrodontidae						
405. Takifugu obscurus				+	+	+
*406. T. coronoidus**	EN				+	+
407. T. flavidus	EN					+
408. T. ocellatus						+
409. T. vermicularis						+
410. T. xanthopterus						+
411. T. pseudommus						+
412. T. alboplumbeus						+
413. T. bimaculatus						+
414. T. porphyreus						+
415. T. reticularis						+
416. T. niphobles						+

*: Endemic fish species; EX: Extinct; EW: Extinct in the wild; CR: Critically endangered; EN: Endangered; VU: Vulnerable; +: Present

Appendix 1. List and distribution of fishes in the Yangtze River basin

7. References

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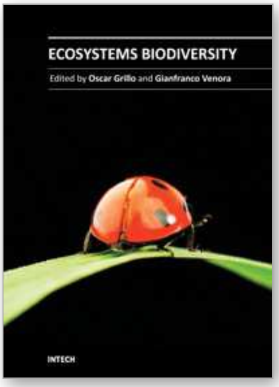

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Ecosystems can be considered as dynamic and interactive clusters made up of plants, animals and micro-organism communities. Inevitably, mankind is an integral part of each ecosystem and as such enjoys all its provided benefits. Driven by the increasing necessity to preserve the ecosystem productivity, several ecological studies have been conducted in the last few years, highlighting the current state in which our planet is, and focusing on future perspectives. This book contains comprehensive overviews and original studies focused on hazard analysis and evaluation of ecological variables affecting species diversity, richness and distribution, in order to identify the best management strategies to face and solve the conservation problems.