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Status, threats and the conservation of endemic species in the Yarlung Zangbo river basin

Wen Xiong#, Zhigang Wu#, Hui Wang, Jianjian Cai & Peter A. Bowler
#These authors contributed equally to this study and share first authorship

Keywords: climate change, highland, biodiversity conservation, endangered species, endemic fishes

Abstract

The Yarlung Zangbo river extends through the southern area of the Tibet Plateau at the highest elevation of any large river in the world. It supports many unique and endemic species, but global warming, proposed and existing hydropower developments, and the invasion of non-native species are significant threats to its native aquatic biodiversity. Some endemic species, including fishes (*Glyptosternum maculatum, Schizothorax oconnori, Schizothorax macropogon, Schizophygopsis younghusbandi, Ptychobarbus dipogon* and *Oxygymnocypris stewartii*), water birds (*Grus nigricollis* and *Haliaeetus albicilla*) and mammals (*Lutra lutra*), have experienced great ecological and physical challenges. To ensure a sustainable development pathway, some specific conservation measures should be undertaken, including the establishment of natural reserves in sensitive areas, and more research and ecological monitoring. This study is a significant reference and example for managers developing strategies to conserve aquatic biodiversity in large, high-altitude river basins within mountainous settings.

Introduction

Rivers are important habitats that support a rich freshwater biodiversity. However, in recent decades lotic aquatic biodiversity has experienced substantive losses and is at increasing risk due to fragmentation of rivers, non-native species and over-exploitation, among other factors (Clavero et al. 2010; Reid et al. 2019). This is especially true in China, where freshwater habitat loss has been particularly acute during the last forty years (Xiong et al. 2018; 2019). The Qinghai-Tibet Plateau is the largest and most recently formed massif on the planet, and it supports many endemic species (Zhang et al. 2002). The Yarlung Zangbo is the highest-elevation large river in the world, and provides special habitats for many endemic fish species (He et al. 2020). In this study, we provide a preliminary review of the status and threats to the river's biodiversity and provide recommendations for its conservation.

Study area

The Yarlung Zangbo (28°00'–31°16'N, 82°00'–97°07'E, Figure 1) is among the headwaters of the Brahmaputra Basin. The main stem is around 2,230 km long, encompasses an area of about 2.4×10^5 km^2, and has a mean altitude of over 4,000 m (ranging from 132 m to 7,258 m). The river originates at the Angsi Glacier on the northern side of the middle Himalayas in Tibet. Located in the southeast of the Qinghai-Tibet Plateau, the Yarlung Zangbo has five main tributaries (the Duoxiong Zangbo, Nianchu, Lhasa, Nyang and Parlung Tsangpo). The river basin has a tropical, cold-plateau, mountain climate dominated by the South Asia Monsoon in the Indian Ocean Hydrosphere-Atmosphere System, with intense solar radiation and low temperatures. The annual average temperature is 5.2°C; the annual average precipitation ranges between 320 mm and 500 mm, falling mainly from June to September.

Biodiversity status

From June 2019 to July 2021, we conducted geobotanical surveys at 100 sample sites in the Yarlung Zangbo river basin. At each site, we selected 1 plot (20 m × 30 m) for tree community, 5 plots (5 m × 5 m) for shrub community, and 25 plots of (2 m × 2 m) for grass community. (For precise details, see Fang et al. 2009). Fish sampling was conducted using a dip net (0.5 m in diameter, 1 m hand shank, mesh size 0.5 mm), gillnets (20 m × 5 m, mesh size 0.5 cm), and electrofishing (CWB-2000P, 12v, 250HZ). (For detailed methods for fish sampling, see Xiong Zhu et al. 2017). We conducted visual encounter surveys and acoustic surveys for mammals, amphibians, reptiles and birds. (For details of both types of survey, see Wang, Li et al. 2021).

According to previous studies, there are 232 vascular plants belonging to 80 families distributed within the Yarlung Zangbo basin. Cyperaceae are represented by 19 species, followed by Ranunculus with 14, Gramineae with 11, and Compositae with 10. The other 76 families had fewer than 10 species each. Recently, some non-native species, such as *Cosmos bipinnata* (Asteraceae), have successfully invaded and established naturalized populations in the basin (Wang, Xie et al. 2021).

The Yarlung Zangbo also supports a very rich animal biodiversity, including 19 fish, 1 amphibian, 3 reptile, 41 mammal and 117 bird species. Among these, 7 species (*Grus nigricollis*, *Panthera uncia*, *Cervus albirostris*, *Aquila chrysaetos*, *Gypaetus barbatus*, *Haliaeetus albicilla* and *Aquila heliaca*) were listed as Category I protected species; 18 species (*Ursus arctos*, *Lutra lutra*, *Lynx lynx*,

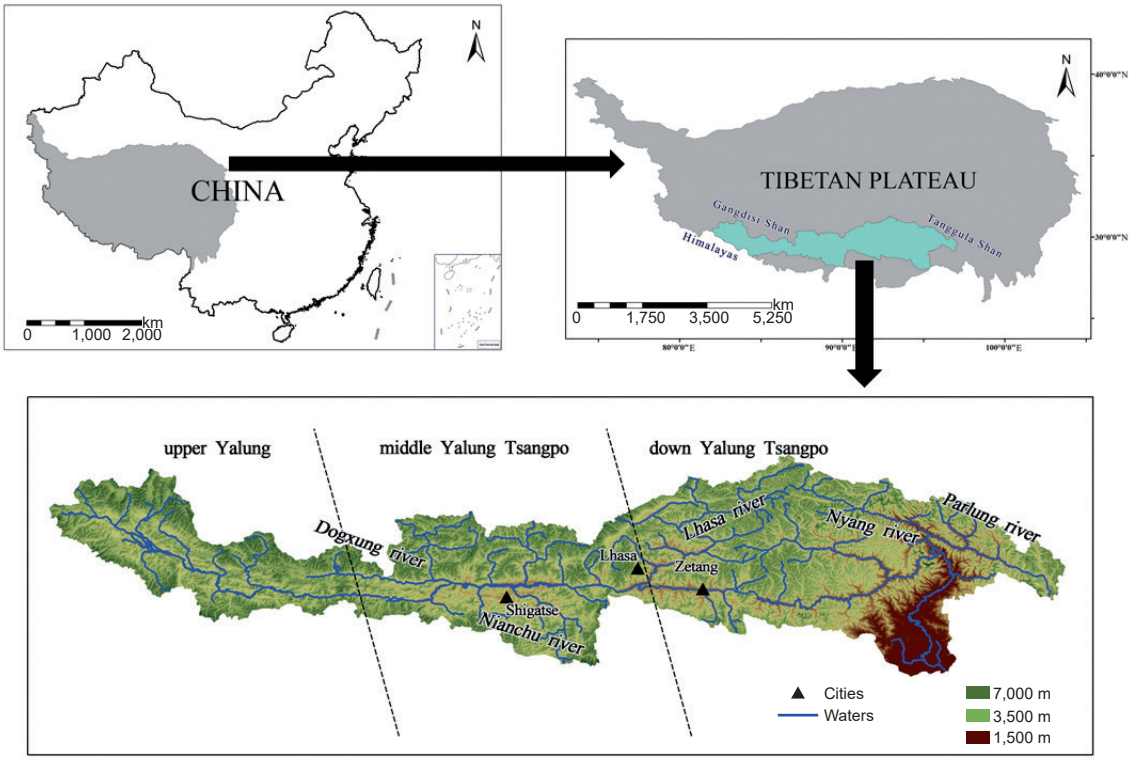

Figure 1 – The location and extent of the Yarlung Zangbo river basin.

Otocolobus manul, *Procapra picticaudata*, *Pseudois nayaur*, *Milvus korschun*, *Accipiter gentilis*, *Buteo hemilasius*, *Pandion haliaetus*, *Aegypius monachus*, *Gyps himalayensis*, *Falco cherrug*, *Falco tinnunculus*, *Falco Subbuteo*, *Crossoptilon harmani*, *Tetraogallus tibetanus* and *Grus grus*) are designated Category II protected species in China (TARFSDI 2002).

Threats

Global change

Many endemic species and ecosystems of the Tibetan Plateau are very sensitive to global warming (Lu & Liu 2010), and the highest temperatures in Tibet have increased sharply in the past twenty years (Wang et al. 2021). Climate change has intensified algal blooms. It has also altered historic natural water levels and hydrological status, the life-histories of certain animals, and species diversity and distributions (Payne et al. 2017). These changes in habitats and ecology have caused a decline in most of the native aquatic species.

Hydropower

The Yarlung Zangbo has an abundant water supply with a very high hydropower potential (Cathcart 1999). According to the fourteenth Five-year Development Plan, the Chinese government proposes hydroelectric development on the Yarlung Zangbo, which has a theoretical capacity of 80 million kilowatts. Some preliminary survey and design work has been conducted to explore hydropower sites in the basin. Hydroelectric projects inevitably alter hydrological processes and influence the local aquatic plant and animal biodiversity (Reid et al. 2019). Some endemic fish species, such as *Schizopygopsis younghusbandi younghusband*, *Schizothorax o'connori* and *Schizothorax waltoni*, would be endangered, and could even face the risk of extinction (Chen et al. 2009; Ma et al. 2012; Zhou et al. 2015).

Non-native species

China is the country most seriously threatened by non-native aquatic species and the ecological damage they can cause (Xiong et al. 2015; Xiong et al. 2017; Wang et al. 2016; Wang et al. 2021). Researchers traditionally considered that fewer non-native species could successfully invade plateau ecosystems because of their harsh environment. However, a number of highly invasive species have been observed in aquatic ecosystems in the Qinghai-Tibet Plateau (Wang et al. 2021; Xiong et al. 2021). Non-native plants, fishes and amphibians have caused significant negative ecological impacts on native biodiversity in the Yarlung Zangbo river basin as well as in many other settings in China (Liu et al. 2015; Deng et al. 2021; Xiong et al. 2021).

Recommendations

The designation of protected areas for endangered species or ecosystems is considered one of the most effective means of preserving biodiversity (Chape et al. 2005). To date, only 47 nature reserves have been established in the Tibet Autonomous Region, most of which are focused on the protection of the terrestrial flora and fauna (MEE 2019). Most regions of the Yarlung Zangbo river basin have not received adequate

Table 1 – List of protected species in the Yarlung Zangbo river basin.

No	Scientific name	Biological group	Protection class
1	*Grus nigricollis*	Bird	I
2	*Panthera uncia*	Mammal	I
3	*Cervus albirostris*	Mammal	I
4	*Aquila chrysaetos*	Bird	I
5	*Gypaetus barbatus*	Bird	I
6	*Haliaeetus albicilla*	Bird	I
7	*Aquila heliaca*	Bird	I
8	*Ursus arctos*	Mammal	II
9	*Lutra lutra*	Mammal	II
10	*Lynx lynx*	Mammal	II
11	*Otocolobus manul*	Mammal	II
12	*Procapra picticaudata*	Mammal	II
13	*Pseudois nayaur*	Mammal	II
14	*Milvus korschun*	Bird	II
15	*Accipiter gentilis*	Bird	II
16	*Buteo hemilasius*	Bird	II
17	*Pandion haliaetus*	Bird	II
18	*Aegypius monachus*	Bird	II
19	*Gyps himalayensis*	Bird	II
20	*Falco cherrug*	Bird	II
21	*Falco tinnunculus*	Bird	II
22	*Falco Subbuteo*	Bird	II
23	*Crossoptilon harmani*	Bird	II
24	*Tetraogallus tibetanus*	Bird	II
25	*Grus grus*	Bird	II

protection. A series of nature reserves should be established in key areas of the Yarlung Zangbo for the conservation and protection of endemic and endangered species, such as *Glyptosternum maculatum* (Regan 1905).

Long-term, ongoing monitoring is very important for the protection and understanding of the status of endemic species (Wang et al. 2021). However, it is very difficult to conduct environmental and ecological monitoring in the Qinghai-Tibet Plateau because of its harsh conditions. New technologies such as remote sensing, automatic recording and cameras, and environmental DNA are useful in monitoring the remote and wild areas of the Tibetan Plateau. Research is also needed to explore conservation options such as artificial propagation, supplementing existing populations, establishing backup sites, and control of disease in endangered species such as *G. maculatum*.

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Authors

Xiong Wen[1]

is a lecturer at Hubei Normal University. He has a PhD in Botany. His research focuses on biological invasion and biodiversity conservation in vulnerable habitats. E-mail: chinaxiongwen@gmail.com

Wu Zhigang[2]

is a research associate professor at the Institute of Hydrobiology, Chinese Academy of Sciences. He has a PhD in Ecology. His research focuses on plant ecology, evolution and systematics. E-mail: wuzg@ihb.ac.cn

Wang Hui[3]

is a lecturer at Huazhong Agricultural University. She has a PhD in Ecology. Her research interests relate to biological conservation in wetland ecosystems. E-mail: wanghui@mail.hzau.edu.cn

Cai Jianjian[4] – corresponding author

is a radiologist and researcher at Tongji Hospital of Tongji Medical College of Huazhong University of Science and Technology. His research focuses on animal magnetic resonance and biological research. E-mail: 369611141@qq.com

Peter A. Bowler[5]

is an emeritus Professor of Teaching in the Department of Ecology and Evolutionary Biology at the University of California, Irvine, from where he holds his PhD. His research interests are diverse, and include ecological restoration, mitigation and open space management, conservation biology, freshwater ecology and plant ecology. E-mail: pabowler@uci.edu

[1] College of Life Sciences, Hubei Normal University, Huangshi 435002, China
[2] Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China
[3] College of Horticulture & Forestry Sciences/Hubei Engineering Technology Research Center for Forestry Information, Huazhong Agricultural University, Wuhan 430070, China
[4] Department of Radiology, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan 430030, China
[5] Department of Ecology and Evolutionary Biology, University of California, Irvine, California 92697-2525, USA