STATUS AND MANAGEMENT OF FISHERY RESOURCES OF THE YANGTZE RIVER

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ABSTRACT

The Yangtze River is the largest river in the Peoples Republic of China. It is 6,300 km long and drains 1.8 million km² of land. It delivers 1,000 billion m³ of freshwater into the Shanghai Bay. The basin can be divided into three parts, the upper reaches, the middle reaches and the lower reaches. The “three reaches” approach is mainly supported by fish distribution patterns and hydrological alterations. The fish fauna of the Yangtze River system comprises over 370 species (178 genera, 52 families, 17 orders), of which cyprinids (Cyprinidae) account for 51 percent, loaches (Cobitidae) 6.9 percent, bagrids (Bagridae) 6.9 percent, Homalopteridae 5.5 percent, gobies (Cobiidae) 4.4 percent and...
other families 24.9 percent. There are 126 fish species in the lower Yangtze. In the middle Yangtze, there are over 140 fish species, most of which are either semi-migratory or resident. In the upper Yangtze, there are over 180 fish species. Historically, the Yangtze River system supported large runs of anadromous fish species. The late 1960s to early 1970s had seen the highest catch of Chinese shad and sturgeon in China. However, the migratory fish populations of both anadromous species began to decline in the early 1980s as a result of overfishing, pollution, water projects and habitat loss. There is a general indication that the fishery resources of the Yangtze are underexploited. This is based on the size and quality of the species landed, the current production compared with that of previous periods and the main species. It is recommended that (a) the Fisheries Management Council be strengthened, substituting the present authoritarian system by participatory management by the fisheries community, (b) commercial fisheries be managed by the quota system and improved by catching underexploited species, (c) an adaptive management approach be adopted that takes into account natural environmental variations and (d) the need for planning for an integrated development of the whole Yangtze River fishery be recognized. The paper makes suggestions for fishery management in response to the existing problems.

INTRODUCTION

The Yangtze valley is the most developed freshwater fisheries area in China, with abundant fish resources and long history of fisheries. The area has been called “the cradle of freshwater fisheries production”, with production accounting for about 60 percent of the national total freshwater fish catch (Chen Liu and Duan 2002). The Yangtze fish catches have decreased or fluctuated after a historical record of 0.45 million tonnes in 1954 (Ke and Wei 1993). In the last decade, the catch has fallen below 0.10 million tons, with a notable depletion of migratory and semi-migratory fish stocks, the primary reasons being the destruction of the aquatic ecosystem and overfishing. This paper focuses on measures taken for strengthening fishery administration at various levels, for comprehensive harnessing of water resources and for research as a way of rehabilitating the Yangtze fisheries.

MATERIALS AND METHODS

Fishery resources of the Yangtze River were investigated between 1971 and 2000. Statistical data were obtained from the Fishery Bureau of Agricultural Ministry of China. Local and national monitoring stations provided environmental and hydrological data. All data were analysed by SAS software.

RESULTS AND DISCUSSION

FISH FAUNA AND ITS DISTRIBUTION

The fish fauna of the Yangtze River system comprises over 370 species (178 genera, 52 families, 17 orders), of which cyprinids (Cyprinidae) account for 51 percent, loaches (Cobitidae) 6.9 percent, bagrids (Bagridae) 6.9 percent, Homalopteridae 5.5 percent, gobiids (Cobiidae) 4.4 percent and other families 24.9 percent (Wu 1984).

The major species of economic importance are black carp (Mylopharyngodon piceus (Rich.), grass carp (Ctenopharyngodon idella (C. et V.), silver carp (Hypophthalmichthys molitrix (C.et V.), bighead carp (Aristichthys nobilis (Rich.), common carp (Cyprinus carpio (L.), crucian carp (Carassius auratus (L.), blunt snout bream (Megalobrama amblycephala Yih),
whitefish (*Hemisalanx brachyrostralis* (Fang)), silurid catfish (*Silurus asotus* (L.)), copper fish (*Coreius heterodon* (Bleeker)), Chinese shad (*Macrura reevesii* (Rich.)), anchovy (*Coilia mystus* (L.)), Chinese sturgeon (*Acipenser sinensis* Gray), paddle fish (*Psephurus gladius* (Martens)), Chinese sucker (*Myxocyprinus asiaticus* (Rich.)) and eel (*Anguilla japonica* Temm. et Schl.). The distribution of the fish species varies from section to section of the river.

There are 126 fish species, most of them migratory, in the lower Yangtze. In the fisheries of Jiangsu Province, anchovy accounts for about 50 percent of the catch, shad and eels for 20 percent, common carp, silurid catfish, black carp, grass carp, silver carp, bighead, whitefish, etc. for 30 percent. The catch from the lower Yangtze accounts for 63 percent of the total (Table 1).

There are over 140 fish species in the middle Yangtze most of which are semi-migratory (black carp, grass carp, silver carp, bighead carp and some other) and resident species (common carp, crucian carp, etc.). The catch from the middle Yangtze accounts for 34 percent of the total (Table 1).

There are over 180 fish species in the upper Yangtze. Copper fish is the main species, accounting for about 40 percent of the catch, common carp and Chinese sturgeon (before the damming of the Yangtze River at Gezhouba) account for up to 15 percent each, *Leiocassis longirostris* accounts for 10 percent. Other major species are *Procypris rabaudi*, *Spinibarbus*, *Varicorhinus simus*, grass carp and *Elopichthys bambusa*. The catch from the upper Yangtze accounts for 3 percent of the total (Table 1).

### MAJOR FISH SPECIES

**Anchovy**

Anchovy is found mainly in Shanghai City and Jiangsu Province. In both places the production accounts for about 70-80 percent of the total catch. The annual catch fluctuates between 250 and 400 tonnes. A historical maximum of 4 000 tonnes was reached in 1973. Although the catch has been fluctuating in the last decade to some extent, it has generally been stable (Figure 1).

### Table 1: The distribution of fish species along the Yangtze River

<table>
<thead>
<tr>
<th>SECTION</th>
<th>Upper Yangtze</th>
<th>Middle Yangtze</th>
<th>Lower Yangtze</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fish species</td>
<td>126</td>
<td>140</td>
<td>180</td>
</tr>
<tr>
<td>Major fish species</td>
<td>copper fish, common carp, grass carp, <em>Leiocassis longirostris</em>, <em>Procypris rabaudi</em>, <em>Spinibarbus</em>, <em>Varicorhinus simus</em>, <em>Elopichthys bambusa</em></td>
<td>copper fish, black carp, grass carp, silver carp, bighead carp, common carp, crucian carp, Chinese sturgeon</td>
<td>anchovy, Shad, Eel, common carp, silurid catfish, black carp, grass carp, silver carp, bighead, whitefish</td>
</tr>
<tr>
<td>Catch percentage</td>
<td>3% of the total</td>
<td>34% of the total</td>
<td>63% of the total</td>
</tr>
</tbody>
</table>
Chinese shad

Chinese shad is an anadromous fish species. Before 1962 its annual catch from the Yangtze River was about 500 tonnes. After 1968 the catches decreased, with only 70 tonnes captured in 1971. In 1974, a record of 1570 tonnes were harvested, this to be followed by a dramatic decline to 12 tonnes in 1986. Chinese shad is now endangered to the point of extinction (Figure 2).

Chinese sturgeon

This is also an anadromous species. Before the Yangtze River was dammed at Gezhouba, the annual catch fluctuated between 391 and 636 individuals, averaging 517 annually (Anon. 1988; Fu 1985). After the damming, the annual mean catch from 1981 to 1987 was 378 individuals, representing 73 percent of that before damming (due to the ban on sturgeon fishing). There is
great concern that when the Three Gorges Dam is completed, the spawning grounds of Chinese sturgeon below the dam may disappear or become dysfunctional (Kynard, Wei and Ke 1995).

Black carp, grass carp, silver carp and bighead carp
The percentage of black carp, grass carp, silver carp and bighead carp in the total catch from the Yangtze River has been declining (Liu, Chen and Zhan 2002). While in 1982 these carps accounted for 84 percent of the catch in Anhui Province on the lower Yangtze, they decreased to 36.8 percent in the 1990s. In the middle reach of the river in the Yichang section of Hubei Province the carps accounted for 80-90 percent of the catch in the 1960s, but only 22 percent in 1974 and 0.52 percent to 5 percent in the recent decade.

Copper fish
The copper fish dominates the catch from the upper Yangtze. In 1974, it represented 60.8 percent of the catch in the Wanxian and Yibin sections. Before the damming the catches were stable, but afterwards there was a steep decrease. In 1982, the fish accounted for about 10 percent and in 1986 for only 4.7 percent of the total catch. During the period 1981 to 1987 catches in the Yichang section below the dam increased to 50-60 percent of the total catch.

Common carp, crucian carp and silurid catfish
These are the most widely distributed resident species. They account for 40-50 percent of the total catch from the middle and lower Yangtze and for 60.6 percent of the total from the Jialing River (the upper Yangtze). The proportion of these species in the catch remains relatively stable in spite of the decreasing total catch.

Paddlefish
Stocks of paddlefish are gradually declining and the individual size is becoming smaller. According to statistics, only about ten individuals are caught annually in the Yichang section. The average weight of most individuals is now below 30 kg. Only rarely is an individual over 50 kg captured. And the species is now rated as one of the rare fish species.

Leiocassis longirostis
This is another rare fish species. It is distributed in all sections of the river. Its flesh is tender and the taste delicious. The swim bladder, when dried, can be processed into fish maw, a well-known Chinese dish. The pen-holder-line fish maw produced in Shishou City, Hubei Province has enjoyed fame at home and abroad. Previously, several thousand kg of fish maw was processed for export, but now it cannot be found in the markets and catches of the adult fish have declined.

Chinese sucker
The Chinese sucker is also rated as rare. Formerly, in the Yangtze it represented about 13 percent of the total catch from the Mingshan section. In the last decade its stocks have been gradually depleted. Only ten old fish have been caught annually from the section from Yichang to Shishou, Hubei Province. Few individuals weigh over 10 kg and the majority are about 5 kg.

FISH CATCHES
Between 1949-2000 the Yangtze annual fish catches fluctuated between 0.10 and 0.44 million tonnes (Figure 3) and the average annual catch for this period was 0.25 million tonnes. There was an increase in catches from 1949 to 1954, reaching a historical record. From 1955 to 1960, the mean annual catch was 0.35 million tonnes, from 1961 to 1967, 0.26 million tonnes, from 1968 to 1982, 0.21 million tonnes and from 1983 to 2000, 0.13 million tonnes, showing a steady decline.

On the whole, the catch from the upper Yangtze tended to rise, but sometimes fluctuated over a small range owing to variations in the composition of fish fauna in this reach. From 1949 to 1954 the catch fluctuated between 4 756 and 6 339 tons, averaging 5 527
From 1955 to 1960, the catch fluctuated from 6,327 to 4,222 tonnes, with an average of 6,932 tonnes. From 1961 to 1967, the catch fluctuated from 5,327 to 6,260 tonnes, average 5,503 tonnes. From 1968 to 1983, the catch fluctuated from 5,184 to 14,227 tonnes, average 7,353 tonnes. From 1983 to 2000, the catch fluctuated from 4,184 to 14,886 tonnes, average 7,753 tonnes per year.

The catch from the middle and lower Yangtze River fluctuated between 0.09 and 0.44 million tonnes, with a mean annual catch of 0.24 million tonnes. The catch rose from 1949 to 1954, when the historical record was set with 0.44 million tonnes. From 1955 onwards, it was on the decrease or it fluctuated. The mean annual catch was 0.35 million tonnes for the period 1955 to 1966, 0.25 million tonnes for 1961 to 1967, 0.18 million tonnes for 1968 to 1982 and 0.11 million tonnes for 1983 to 2000.

**Reasons for the decline in fisheries**

**Destruction of the aquatic ecosystem**

**Blockage of passage for semi-migratory species by isolation of lakes from rivers**

The famous fish ecologist G. V. Nikolsky believed that the origin and diversity of fish fauna in the Yangtze River is due to its floodplains. The development of the fish fauna is closely related to the periodic floods. While most fish species spawn in running water, laying drifting eggs, the fry enters floodplain lakes to feed and grow there. The adults retreat from the lakes to the river for wintering and/or spawning. Most riverine fish species have a dark back and white belly, which is an adaptation for living in open waters.

Over the last 30 years, more than 7,000 drainage sluices were constructed in the Yangtze valley. With the exception of the lakes Dongting and Poyang, which are still connected with the Yangtze, all other lakes are isolated from the river, preventing the fish to migrate from lakes into the river. This has prevented fish fry and elvers from entering lakes to feed and grow, as well as preventing the return of broodstock to the river or the sea for spawning. The result has been a decline in recruitment of many fish species.

**Blockage of spawning migrations by dams**

Since the foundation of the People’s Republic of China, over 50,000 reservoirs, including the Gezhouba Hydroelectric Project and Three Gorges Dam have been constructed. Today, the main channel of the Yangtze River and many of its tributaries are dammed and migration of migratory and semi-migratory fish species is blocked. Destruction of spawning habitats has led to a reduced recruitment and substantial decrease in catches. The construction of the Wanan Dam on the upper Ganjiang River in 1986 destroyed
the spawning habitats of the anadromous Chinese shad and almost led to its disappearance. The completion of the Gezhouba Hydroelectric Project in 1981 blocked spawning migrations of Chinese sturgeon and copper fish. As a result, the rate of recruitment of Chinese sturgeon decreased by 80 percent.

**Destruction of spawning grounds by land reclamation from lakes**

In the past 40 years, when the priority was given to grain production, large areas of land were reclaimed from lakes by building dykes. For example, 80,000 hectares were reclaimed from Lake Poyang (Qian, Huan and Wang 2002), resulting in a reduction of fish spawning grounds by 50 percent and 160,000 hectares of land were reclaimed from Lake Dongting (Liao, He and Huang 2002), resulting in a loss of 36 percent. Land reclamation not only destroyed the spawning grounds of some resident fish species, but also affected the recruitment rate, both of which resulted in a decline in fish catches.

**Impact of water pollution on migration, feeding, growth and survival of fish**

With the rapid development of industry in the Yangtze valley, the amount of industrial wastewater and urban sewage discharged into the river has been increasing. Now in certain sections of the river the water is highly polluted. In the year 2000 in 21 cities along the river there were over 2000 spot pollution sources, discharging 14.2 billion tonnes of waste (Chen, Sun and Qu 2002). The discharge of wastewater and sewage into the river resulted in the pollution of water and fish food organisms, destruction of spawning grounds, depletion of broodstock, decreasing fish production and in a high fish mortality in certain sections of the Yangtze River.

**Overfishing**

There are over 160 kinds of fishing gears used in the Yangtze River (Duan, Chen and Liu 2002), of which the most harmful are small mesh fyke nets, fyke nets made of ramie cloth, fish mazes, drop nets, damming nets and trap nets. According to the statistical data, in Banhu village in Lake Poyang, 85 tonnes of fish (including 0.3 million young common carp, black carp, grass carp, bighead and silver carp) were caught with small mesh fyke nets. In Luhu village, Yuanjiang County, the juveniles of the major economic fish species accounted for 61.5 percent of the catch using small mesh fyke nets made of ramie cloth. In Shongmensan village on Lake Poyang, over 600 kg of shad juveniles of less than 1 g were caught by this gear annually, accounting for 17.15 percent of the total catch in 1973. In one day, 4,800 kg of fingerlings of over 10 cm were caught by three mazes in Dongting village, Yueyang County, Hunan Province. Before the damming of the Yangtze River at Gezhouba, over 1000 sturgeon were caught by fyke nets in Jiayu section in 15 days, one thousand or so by trap nets in Xupu section, Jiangsu Province, in two months and several thousand by stake nets in the waters around the Chougming Island (Wei 1997). The damage caused to juvenile fish by harmful fishing gears and methods is considerable. One reason for the fishing of juveniles in those days was the lack of control by the responsible administration.

**MANAGEMENT OPTIONS**

**Strengthening administration of the Yangtze fishery**

In order to enhance the Yangtze valley fishery it is necessary to establish and strengthen fishery administration agencies at various levels in the Yangtze valley, to formulate better fisheries laws and regulations and to enforce them. The activities should include rationalisation of the fishery, protection of fishery resources and improvements in management such as licensing; fishing gear and net mesh size restrictions, length limits and seasonal restrictions. Also, there should be some attention to co-management approaches in the Yangtze River fisheries.
EMPHASIS ON REHABILITATION OF AQUATIC ENVIRONMENT

Aquatic ecosystems consist of many components that interact with each other. A change in one component will influence the ecosystem including the fish assemblages. Over thirty years of experience has shown that isolation of lakes from rivers, damming of rivers, land reclamation from lakes, water pollution and overfishing damages or destroys fish habitats and ultimately results in severe depletion of fish stocks, as experienced in the Yangtze River. In order to develop fisheries for the people in the Yangtze valley, emphasis should be placed on a comprehensive rehabilitation of water resources. Hydraulic structures should be constructed for protection and enhancement of fish habitats. Wastewater should be disposed according to water quality criteria endorsed by the government. Land reclamation should be forbidden from lakes and fisheries should be managed to protect the sustainability of fishery resources.

Chinese sturgeon and Chinese sucker are already rated as rare fish species. Their stocks have been depleted and some species are endangered to a point of becoming soon extinct. It is difficult to restore such fish species merely by forbidding the fishing of broodstock. Stocking should be another way of increasing their stocks. Some endangered species have been successfully artificially propagated and their fry reared in hatcheries, from which the young fish have been regularly released in a variety of water bodies. It is suggested that if a million fingerlings of each of the rare species are released in the Yangtze annually, this would lead to a 30 000 to 50 000 tonne increase in annual production, which is equal to 1/6 of the present catch from the Yangtze.

ENFORCEMENT OF CLOSED AREAS AND SEASONS TO ENHANCE FISH REPRODUCTION

Broodstock and juveniles of shad should be protected and the protection of their spawning grounds enforced to ensure that the juvenile stocks are not destroyed (Shi and Wan 2002). The capture of elvers should be strictly controlled and their resources protected. Closed seasons should be introduced and enforced in order to protect fish breeding in the whole river in the spring.

BAN ON FRY CAPTURE FROM THE YANGTZE RIVER

Because of the isolation of lakes from the Yangtze River, catches of the four major commercial fish species have drastically decreased. Fish farmers usually collect fish fry from the river and transfer it to lakes to enhance fish yields. This may result in a certain success, but it leads to a depletion of the stocks of the four major carps in the river. Transfer of fry into lakes from the river without the possibility for the return of adults is detrimental. In order to ensure that there will be sufficient stocks in the river, the quantity of fry removed from the river should be limited.

BAN ON HARMFUL FISHING GEAR AND METHODS AND INTRODUCTION OF SIZE LIMITS

Fishing gears and methods that damage juvenile fish stocks must be banned, mesh size for various types of nets strictly controlled and minimum allowable catch sizes for individual fish species introduced.

INTENSIFICATION OF RESEARCH

The rehabilitation and management of Yangtze fisheries must be based on both policy and science. Although a considerable amount of research has been done on Yangtze fisheries in the last forty years, administrators directed most of it. Scientific research was uneven, full of ups and downs for the lack of a comprehensive programme of sufficient duration and consistency. Some projects ended prior to their completion. The instability of research (by research institutes), superficial character of research work and absence of a follow-up led to incomplete data collection.

The present status of Yangtze fishery resources and the deterioration in the aquatic environment of the
Yangtze shows that future research should focus on biology, ecology, fish culture techniques, resource enhancement, protection of natural spawning areas, protection of migratory and semi-migratory species. Future management should also put more emphasis on social aspects of fisheries.

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