

# On China's Lake Fisheries Development

**WU WANFU**  
**YANG NINGSHENG**  
**JIN LE**  
*Chinese Academy of Fishery*  
*Sciences*  
*150 Qingta Cun*  
*Yongding Lu Nan*  
*Beijing 100039, China*

The lake fisheries have played a key role in China's traditional freshwater fisheries for several thousand years. Up to the founding of the new China, freshwater fish production, mainly from lakes, accounted for more than 80% of China's total freshwater fisheries production. However, since the 1960s, the lake fisheries have gradually declined.

Meanwhile, intensive fish culture in small water bodies has flourished. In 1957, production from pond fish culture was 463,000 t, making up 39% of the total freshwater fisheries production. By 1989, it reached  $3.1 \times 10^6$  t, about 64% of the total freshwater fisheries production.

In recent years, a new trend is brewing in China's freshwater fisheries: the lake fisheries are growing again. In 1984, aquaculture production from the lakes was only 104,000 t. In 1989, it was 245,000 t, an average increase of 18.7% per year. The increase rate is equal to that of China's pond fish culture, suggesting great potential.

Nowadays, various models for China's lake culture fisheries are constantly emerging. As the models are tested and

transformed from small areas to large areas, they will be sure to bring about a profound change in China's fisheries.

## Geographic Distribution of China's Lake Fisheries

China is rich in natural lakes. There are more than 2,800 lakes with an area of over 1 km<sup>2</sup>. They total 805 x 10<sup>6</sup> km<sup>2</sup>, accounting for 30% of China's inland water area. Geographically, China is

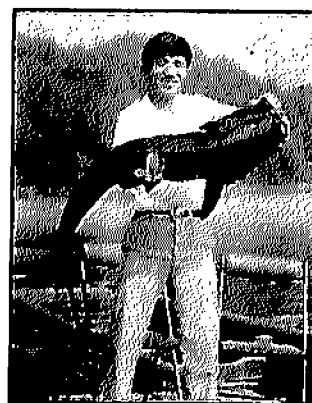
divided into five lake group areas, i.e., Qinghai and Tibet Plateau lakes, Mongolia and Xinjiang Plateau lakes, the northeastern plain lakes, the eastern plain lakes, and Yunnan and Guizhou Plateau lakes.

Not all the natural lakes are fit for fish production. At present, the lake fisheries are mainly focused on the eastern plain

lakes, including the areas along the Huang-Huai-Hai River basin and the middle and lower reaches of Yantze River with lake areas of 22,000 km<sup>2</sup> (33.24 million mu) which are about 27.5% of China's natural lakes. These lakes were formed either from the sinking of the earth's crust or from the evolution of rivers and lagoons. Generally speaking, they are shallow eutrophic lakes with low elevation, even bottom, plentiful rainfall, mild temperature and stable water level, advantageous for the growth of aquatic animals and vegetation. There are 6,000 km<sup>2</sup> of shallower lakes in the northeastern plains and 1,200 km<sup>2</sup> in the Yunnan and Guizhou Plateau. These two regions account for 9% of the total natural lake areas in China. The lakes in the Qinghai and Tibet Plateau and Mongolia and Xinjiang Plateau cover 51,000 km<sup>2</sup>, about 63.5% of the total natural lakes in China. These two lake regions have a freezing season of about four to seven months and the water

China's lake fisheries, 1978 to 1988											
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Culture areas (x 10 <sup>4</sup> mu)*	795	727	793	738	864	835	885	934	986	968	954
Output (x 10 <sup>3</sup> t)	72	75	74	68	77	91	105	144	179	208	229
Unit output (kg/mu)	9.1	10.3	9.3	9.2	8.9	10.9	13.0	15.5	18.0	21.0	24.0

\* 1 mu = 670 m<sup>2</sup>



*Harvests from Zin Ann Giang Reservoir, Hangzhou, China. (Photos by Dr. Chua Thia-Eng, ICLARM).*

contains a high quantity of salt. They are generally unsuitable for fish production.

Along the eastern plain lakes, quite a lot of people rely mainly on fishing. In past decades, lake fish production went down and fish quality worsened due to overfishing, reduced water areas due to enclosing lakes for agriculture, and blocking fish migration channels in water conservation projects between lakes and rivers. For example, Dongtinghu Lake, the largest lake in China, originally had a water area of  $7 \times 10^6$  mu (1 mu = 670 m<sup>2</sup>) but now there are only  $4 \times 10^6$  mu left because 248,000 mu were enclosed for agriculture and the rest silted up. The average annual production of the lake in the 1950s was 33,000 t but it dropped to 24,000 t by the 1980s, a decline of

mu were put into fish culture, producing a total output of 229,000 t (average production 24 kg/mu). Compared with 1978, the culture areas have expanded 20% and the production increased by a factor of 2.18 (i.e., unit production has increased by a factor of 1.63).

#### From Closed to Open Ecology

During the early period of lake fishing, people were engaged in catching aquatic animals and plants along the banks of lakes with simple nets and tools. The ecosystem in this period remained balanced naturally, and the system was an entirely closed one with very limited productivity.

With the appearance and wide use of

longer relies only on their natural resources production. On the contrary, it is practically entirely based on artificial inputs.

#### Model of a Lake Fishery: An Open Ecosystem

The modern lake fisheries ingeniously take advantage of the three-dimensional spaces of lakes to fully develop the resources. Currently, the fisheries concentrate on the following three aspects:

#### *Bringing the water body into full play*

In developed areas and areas with sufficient labor force, the lake fishery is

The fisheries of some lakes in China.

Lake	Location	Areas (km <sup>2</sup> )	Water type	Main measures adopted	Annual output		Statistical year
					Total output (t)	Output (kg/mu)	
Qinghaihu Lake	Qinghai	4,200	Saltwater	Fishing protection	4,372	0.64	1986
Dongtinghu Lake	Hunan	2,691	Freshwater	Aquaculture, stocking and protection	24,500	6.07	Average in 1980s
Taihu Lake	Jiangsu	2,338	Freshwater	Fishing forbidden and stocking	16,021	4.57	1988
Hongzhehu Lake	Jiangsu	1,851	Freshwater	Aquaculture, stocking	37,200	13.40	1988
Nansihu Lake	Shandong	1,225	Freshwater	Crab fry stocking	15,000	8.16	Average in 1980s
Bositenghu Lake	Xingjiang	960	Saltwater	Fishing forbidden and varieties introduced	2,660	1.85	1987
Honghu Lake	Hubei	402	Freshwater	Enclosure aquaculture	9,870	16.40	1987
Gehu Lake	Jiangsu	133	Freshwater	Enclosure aquaculture, fishing forbidden	7,000	35.10	1988
Kelukehu Lake	Xingjiang	42	Freshwater	Protection, stocking	200	3.17	1986
Dazhong Lake	Jiangsu	28	Freshwater	Aquaculture	1,350	32.14	1987
Jinjihu Lake	Jiangsu	7	Freshwater	Aquaculture	1,534	143.10	1985

37%. In Boyanghu lake, the second largest lake in China, fishing effort doubled while production dropped 38% in the past two decades.

The government has made efforts to strengthen the management of the lake fisheries, especially in the larger lakes, and fisheries administration committees have been established to carry out management work. Policies, such as setting up fish reproduction protection zones, controlling fishing boats and nets, introducing better varieties and stocking, have been made to improve the lakes' resources.

In recent years, aquaculture has grown rapidly in the lakes thanks to the transfer of technologies from pond culture. Under the present technological conditions,  $28 \times 10^6$  mu of lake area in China can be used for fish culture. By 1988,  $9.5 \times 10^6$

fishing boats, fishermen began fishing in deepwater areas and China's lake fisheries gradually grew. However, production was still based on natural reproduction with no effort made to enhance the resources. It was still a semi-closed system, which resulted in the recycling of substances and energies within the system at a very low level, thus yielding only limited production. The system could neither meet the demand of the market nor resist environmental perturbations. Consequently, the lake fishery began to collapse in the late 1970s.

In the 1980s, the rise of aquaculture changed this semi-closed cycle into an entirely open high-input and high-output system. By adopting a series of intensive culture technologies including feeding, stocking, disease control and regular management, fish culture in the lakes no

shore-based, using various technologies. For example, the Dazonghu Lake with an area of 42,000 mu, in the suburbs of Yancheng City, Jiangsu Province, has been developed using five approaches:

- *Protecting aquatic resources reproduction in open water areas while stocking fish fry and crabs.* As a result, fishing production reached 200 t in 1987, 20% more than before.
- *Intensive culture with purse nets in deepwater areas.* In 1987, this technique was spread over 300 mu with a unit production of 1,000 kg/mu, which was far more than the previous total fishing yield of the lake.
- *Enclosure fish culture in the lake's shallows.* The lake has shallow areas of 10,000 mu, of which 4,000 mu were used for enclosure fish culture in 1987 with a production of 250 kg/mu.



The Chinese have developed efficient technology for harvesting fish stocked in lakes and reservoirs.

in the lake in 1988 reached 7,000 t (33.7 kg/mu), a threefold increase over 1985, and of which nearly 5,000 t or 68% came from aquaculture.

In small lakes, the strategy of intensive aquaculture in the whole lake is adopted. For example, in Wujiang County, Jiangsu Province, intensive aquaculture has been practised in all the County's 64 small lakes covering 19,000 mu, producing 347 kg/mu/year, 1.7 times higher than the average production (125 kg/mu) of the whole country's pond fish culture.

Compared with the traditional lake fisheries system, the modern system has the following two characteristics:

- *Bright development prospects.*

The traditional lake fishery was mainly focused on fishing on the basis of the natural ecosystem. It was confined by limited resources. Under the present situation, the lake fisheries tend to be overfished, such that advanced fishing technology cannot make production grow. On the contrary, it will quicken the decline of resources. The modern fisheries mainly concentrate on stocking and aquaculture, which have great potential with the development of technology and increase of investment.

- *Rational production structure.* It is thought as an eternal truth that more boats, more nets and more people result in more fish. As a result, development is unbalanced. The new lake fisheries utilize all parts of a lake to develop the resources comprehensively and make lake fisheries a complete system with multiple functions, high efficiency and low costs.

China's lake fisheries can be regarded as evolving into Dissipative Structures.

Dissipative Structures are systems capable of maintaining their identity only by remaining open to their environment. Thus, they take in energy and produce entropy which they dissipate in a structured manner. Dissipative Structures require to be thermodynamically far from equilibrium (see *Order out of chaos* by I. Prigogine and I. Stengers. 1984. Bantam Books, Toronto.)

By bringing in a large amount of external energy (inputs), it is expected that the lakes should create efficient, stable structures—in the form of the fisheries—to best dissipate this energy.

- *Fish culture with lotus root planting in marshy areas.* The lake has more than 2,000 mu of marshes where water is available in the rainy season. About 400 mu were used for cultivation of fish and lotus roots in 1987.

- *Constructing fry farms along the lake.*

Through the comprehensive development above, the lake's fish production has increased by a factor of five and the profits more than tenfold.

#### *Various types of aquaculture enclosures*

For those lake arms with a stable water level, fish pens are used. Generally speaking, such sites account for 10% of the lake areas. They are easy to be enclosed and managed. Moreover, they are suitable for both intensive and extensive culture with decentralized management and with low investment.

For the lake arms or inlets with significant water level changes, the method of combining dikes with pens is adopted: a dike about a meter high is built in the appropriate place and a pen is set up over it. With this device, fish escape can be avoided during the rainy season and water is retained inside the dike during the dry season.

For the lake arms with shallow water and stable water levels, intensive aquaculture is adopted by means of setting barriers at water entrances. As a result, not only are high yields harvested in this area, but also the whole lake fisheries

production benefits from the fertilized water and remnants of feed coming from the enclosed area.

For open and shallow lakes, small-scale enclosure culture with nets is applicable. For example, the Nanjing Geography and Lake Research Institute of the China Academy of Sciences made such an experiment in the eastern Taihu Lake, Jiangsu Province, in 1989, and produced 6,500 kg/mu. Generally speaking, lake culture in such enclosures would produce up to 1,200 to 1,500 kg/mu.

#### *Selective measures in resources protection, stocking and aquaculture*

In large lakes with low fisheries productivity, stocking and protection of the lake's resources during their reproduction should be adopted while making aquaculture a subsidiary. For example, in Dongtinghu Lake, Boyanghu Lake and Qinghaihu Lake, measures have been taken in recent years to control fishing effort and to stock fish fry. As a result, fish production is increasing again.

In medium-sized lakes, aquaculture is integrated with stocking. Take Gehu Lake, Jiangsu Province, as an example. It is a shallow lake of 200,000 mu where enclosure aquaculture using nets has been carried on since 1985. By 1988, there were 32,000 mu under culture. Meanwhile, a series of measures concerning protection of the resources and stocking have been taken. As a result, overall fish production