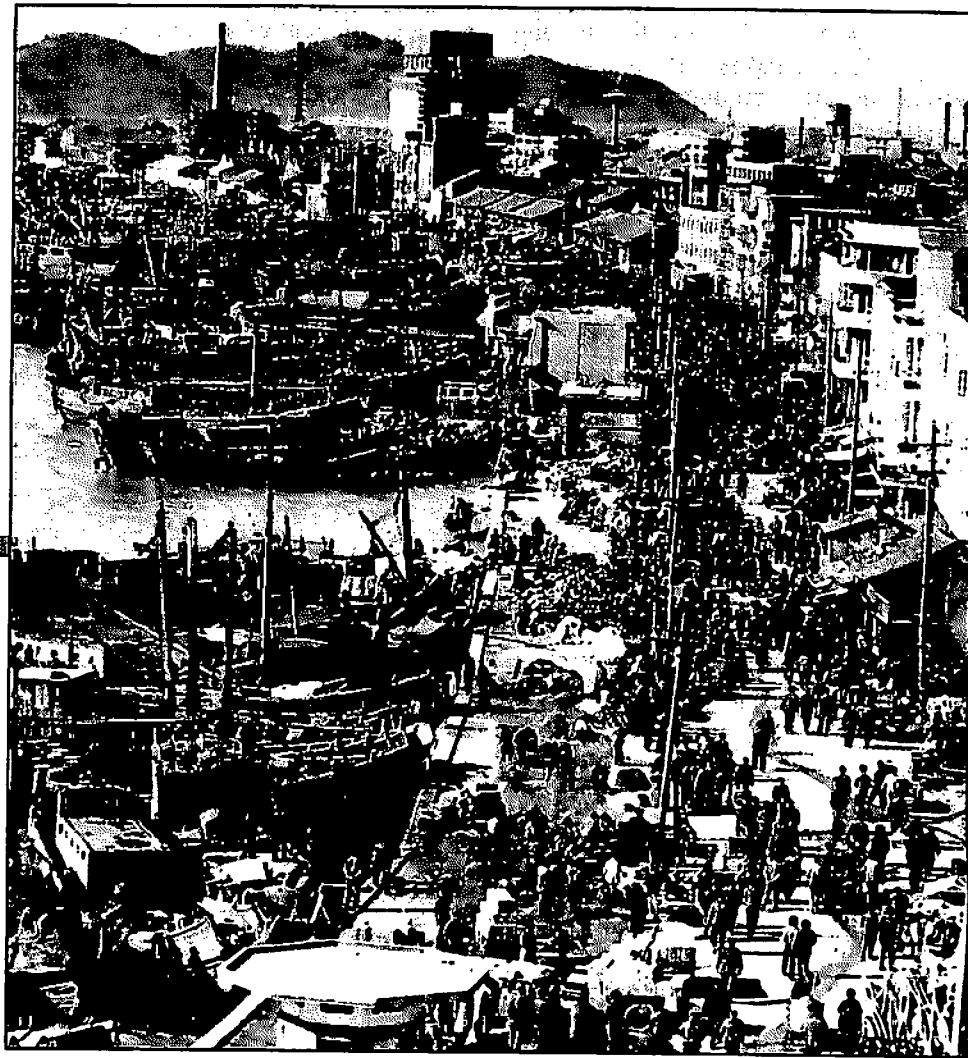


Development, Use and Management of the Zhoushan Fishing Ground, China

WANG QIANGHUA
YU CONG DA

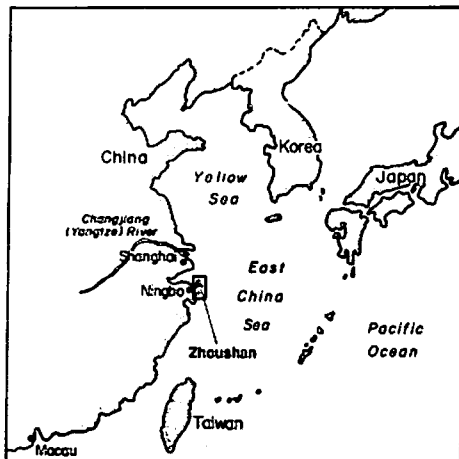


The fishing port of Shengjiamen, one of the renovated fishing ports in Zhoushan.

Introduction

The Zhoushan fishing ground is located in southeast China - 29°30'N-30°N and 121°E-124°30'E, with an area of about 106,000 km², being an international fishing area for the Chinese mainland, Hongkong, Taiwan, Macao, Japan, South Korea and North Korea.

The Zhoushan fishing area contains the Zhoushan archipelagos (more than 1,000 islands) in which there are 96 inhabited islands and a land area of 1,258 km². The population is nearly one million including over 300,000 fishers. It is administratively called Zhoushan City, Zhejiang Province.



Location map.

Environment and Resources

This area is in the convergence of high salinity water from the Taiwan Warm Current, low salinity water from the coast and cool water from the Yellow Sea. It maintains high temperatures (above 15°C) and high salinity (about 34 ppt). The salinity of the coastal water is lower than

30 ppt all year, and its temperature is 28-29°C in summer. Blown by the northwest wind in winter, the cool water of the Yellow Sea stretches into the fishing ground in the form of a tongue. The mixing of cool and warm water supplies excellent conditions for various fish.

The rich outflow of the Changjiang (Yangtze) River makes the nearby coastal waters the most productive in China. Water depth in the fishing ground is generally less than 40 m and of a soft muddy bottom.

Islands spread all over the fishing ground divide the ocean into many areas with different current, different water color, different salinity, different depth, different bottom type and different temperature. Because of this, many kinds of fish, shrimp and shellfish, according to their demands, find suitable habitats.

The islands also provide shelter and sites for aquaculture.

There are more than 300 species of fish, over 60 species of shrimp, more than 10 species of crab and more than 50 species of algae in the Zhoushan fishing ground. Among these resources, the "four kinds of fish" - little yellow croaker in spring, large yellow croaker and inkfish in summer and hairtail in winter are famous ones. Since 1980, the large and little yellow croakers have declined, and the numbers of black scraper, mackerel, butterfish and shrimp have increased.

History of Fishing Development

From artifacts discovered in the area, fishing began 4,000-10,000 years ago.

Commercial fishing began in the Tang Dynasty (A.D. 618-907), one of the important developing periods of Chinese feudal society. With the development of navigation and shipbuilding, the Zhoushan fishing ground expanded gradually from beach to coastal sea. In the beginning of this century, there were 15,000 fishing vessels, more than 40,000 fishers and 90,000 t of yearly catch in the Zhoushan fishing ground which was called the "Chinese fish storehouse". Just at that time, Japanese vessels entered the ground to fish. Fishing conditions worsened over the years due to conflicts, until by

1949 when few fishers were left and the annual catch decreased to 10,000 t.

After the establishment of the People's Republic of China (1949), the government paid great attention to developing marine fisheries, founding special departments (fisheries bureaus in cities and counties) and a contingent of specialized fishers. By 1989, there were more than 260 fishing companies and fishing units, over 90,000 special fishers, over 10,000 fishing vessels and 500,000 t annual catch.

Motorization

In the early 1950s, local fishing boats were all nonpowered. They were small with average capacity of 3.9 t and were

helped bring about motorization of the fleet. In the winter of 1954, the government and research departments began to test powered boats which succeeded in 1956 and displayed increased speed, capacity and safety. Fishers could operate year-round and increased their productivity by a factor of 2-3. The new boats increased economic benefits by 50% over that of nonpowered boats.

Because of their high cost and the effect of Chinese small-farming economy thought for thousands of years, the initial spread was not so fast. However, in spring 1959, when more than 2,000 fishing vessels and 20,000 fishers were gathered on Jiangsu Lusi fishing ground to catch little yellow croakers, a sudden typhoon caused the sinking of more than 200 nonpowered



Motorized boats increased fish catch.

crude and unsafe. Accidents at sea were reported frequently. From 1950 to 1955, more than 300 fishing boats sank and over 600 fishers died.

After 1952, fisheries production increased rapidly because of the abundant resources and development of fishers' cooperatives. By 1954, the yearly catch reached 90,000 t. Just at that time, China was carrying out the first five-year plan of national economy. Speedy development of the steel and machinery industries

fishing boats; over 1,100 fishers died. The powered boats went home safely. After that bitter lesson, fishers were determined to make their vessels powered quickly. The government granted more than ten million low-interest loans and up to the 1970s, 200-300 powered vessels per year were being constructed. By 1989, the percentage of powered vessels was 96.7% and the average loading capacity had increased from 3.9 t in 1952 to 29 t in 1989.

Changing catch composition (%) in the Zhoushan fishing ground.

Species	1957	1966	1979	1988
Large and little yellow croaker	36	27	8	1
Hairtail	30	34	38	30
Shrimp	10	7	4	20
Mackerel and scad	-	-	4	4
Black scraper	-	-	2	9
Others	24	32	44	36

Evolution of the Chinese fishing fleet in the Zhoushan fishing ground.

Year	Total fishing vessels			Powered fishing vessels				Total power (wK)
	Number	Total tonnage	Average tonnage	Vessel		Tonnage		
				Number	%	Ton	%	
1936	15,022	45,060	3	-	-	-	-	-
1957	11,232	65,355	518	155	1.3	4,352	6.6	4,599
1959	10,136	71,950	7.1	648	6.3	17,644	24.5	24,433
1966	8,867	95,499	10.8	1,987	22.4	66,992	70	90,229
1978	8,415	192,952	22.9	3,975	47.2	174,405	90	250,920
1982	9,062	245,085	27	6,085	67.1	232,234	94.7	386,350
1989	10,640	309,057	29	10,296	96.7	308,657	99.8	580,430

Increasing harvest by Chinese vessels in the Zhoushan fishing ground over time.

Year	Catch (10 ³)	Year	Catch (10 ³)
1920	60	1966	311
1936	92	1972	349
1952	82	1972	398
1957	173	1986	471
1959	202	1989	485

Technology

Fishing equipment was gradually modernized. At the end of 1989, there were 3,252 fish-finders, 7,246 radios and 816 positioning devices. In netting material, cotton and gunny were replaced by nylon and plastics.

In the early 1950s, there were only 28 fishing ports of varying size that were often dangerous due to reefs and currents and without installations for water, electricity or oil. Since 1953, the government has made an investment of tens of millions of yuan, renovated all fishing ports and set up more than 100

fisheries harbors and over 800 wave-resisting banks totalling 15,000 m long and berthing facilities for over 20,000 fishing vessels. Over 130 navigation marks and lighthouses and five modern meteorological stations have been set up.

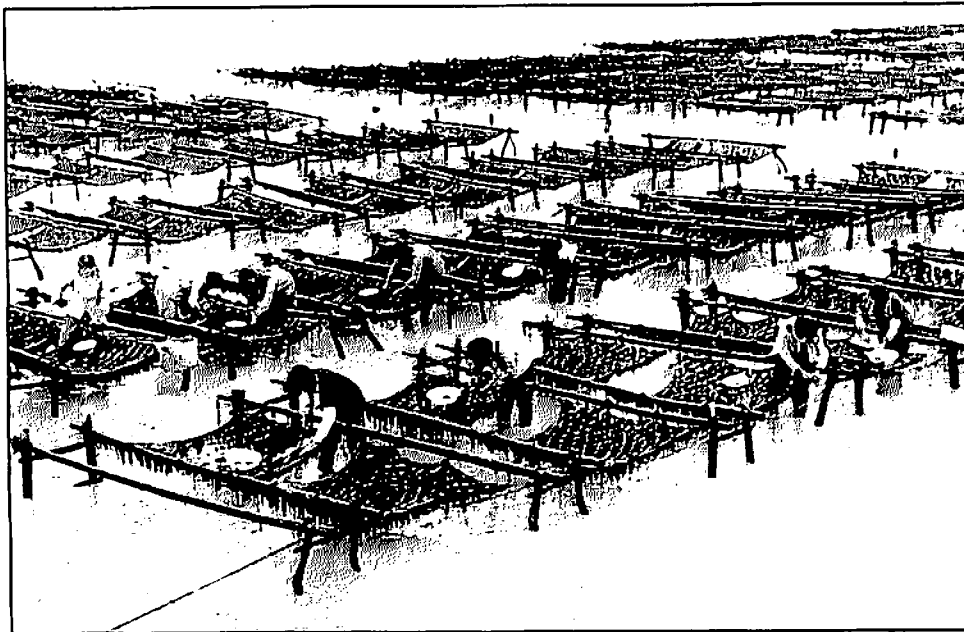
However, by the 1970s, there were still no cooling devices on the boats and few cold storage plants on land. Processing was still "knife and salt". Every year, tens of thousands of tonnes of fish and

shrimp were wasted as fertilizer and forage, or poured into sea.

After 1980, marketing became important. The price of aquatic products was changed according to its quality. Thus, by the end of 1989, there were 144 cold storage plants in the area, which could store 75,000 t of fish, and had daily freezing capacity of 4,451 t with the capacity of making daily 3,000 t of ice, increased by seven

times over 1980. The introduction of some advanced processing machines made remarkable social and economic benefits. For example, the black scraper, a common but ugly fish, was rejected by consumers. By removing head, skin and internal organs, a more acceptable product was obtained. Later, dried and spiced products appeared which are now in great demand in Japan. Finally, use was made of the waste bones ("spareribs"), liver (oil) and skin (glue), etc. The Zhoushan Fishery Company earned an extra 10 million yuan per year on these black scraper products.

Now, there are more than 100 fisheries processing enterprises that produce canned fish, fish sausage, fish powder, etc. They mastered the technology of long distance transportation of live fish, shrimp and crab. They export these fresh and live products to Japan and Hong Kong.



Seaweed culture in Zhoushan.

Education

In the 1930s, 78% of fishers were illiterate. Since the 1950s, basic and special education in fishing areas has been rapidly developed. Primary schools and junior middle schools have been founded in every fishing village. Senior middle schools have been founded in cities and county towns. The percentage of children going to school has risen from 20% in 1947 to over 90% now. After 1958, the Zhejiang (Zhoushan) Fisheries College and Zhoushan Fisheries School were set up. They have educated over 10,000 persons with various kinds of specialties (navigation, engineer, telegraph operator) and over 1,000 senior specialists engaged in marine fishing and processing.

Simultaneously, the government paid attention to fisheries scientific research and popularization. In March 1953, the Marine Fisheries Research Institute of Zhejiang Province was set up. After 1977, the Fisheries Research Institute of Zhoushan City, Fishery Machinery Research Institute and fisheries technology popularization stations in Daishan, Shengsi, Putuo and Dinghai counties were founded in succession, having over 60 scientists in middle or senior levels.

For decades, researchers have played a great role in the modernization of fishing

techniques, the development of fisheries production, the guidance of fishers in fishing scientifically, resource management and so on. As the forecasting method was scientifically improved, the accuracy rate of forecast reached 90% and more, which has raised the benefits of fishing, being welcomed by the government and fishers. Artificial culture of shrimp in Zhoushan is very advanced. In 1984, the Fisheries Research Institute of Zhoushan City set a national record at that time, with a harvest of 9,986 kg/ha in a pool of 0.5 ha.

Living conditions of fishers have also improved. By 1989, average income per fisher was 1,142 yuan, nearly equal to that of a city worker.

Lessons in Fisheries Management

The fishery expanded without regard for sustainability with mottos like "strive for ample catch in the off season" and "fish more busily in the peak periods". Vessel tonnage, mainly trawlers, multiplied by a factor of five between 1952 and 1980, reaching 220,000 t. Foreign vessels also increased in numbers. The annual catch of large yellow croakers declined from 150,000 t to just 10,000 t. Catch composition changed markedly.

In the early 1980s, after consultations

between government, scientists and fishers, various regulations were implemented in the Zhoushan fishing ground: fishing labor was controlled, catch limits and licence limitations were imposed; all fishing was banned in February and March, and bottom trawling banned in autumn; mesh size was limited and minimum weights prescribed for various species.

Management bodies were set up throughout the area with patrol vessels. So far, they have seized over 10,000 domestic and foreign vessels. These bodies also publicize the benefits of management and promote different fishing methods targeted to other species to reduce effort on the major groups.

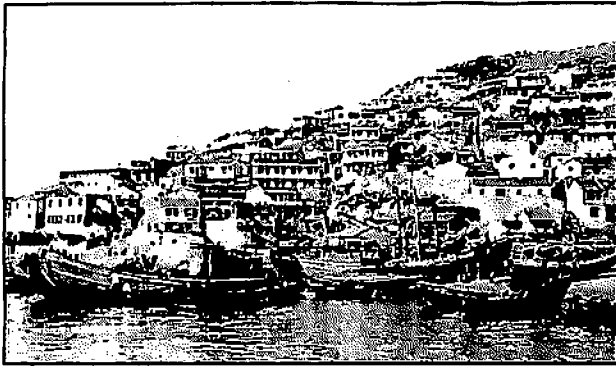
Deep sea fishing is also being developed. The Zhoushan area has been able to attract foreign capital, introducing 29 stern trawlers totalling over 70,000 t, and set up a joint venture with Japan. Deep sea catches increased from about 10,000 t in 1979 to 80,000 t in 1989. However, it is believed that the annual potential catch of mackerels, scads and sardines could be 500-550,000 t. At present, there is insufficient knowledge of boats, gears and techniques needed to develop the offshore resources efficiently.



Cheng San fishing port.

Increased awareness of aquaculture began in the early 1980s, especially the "fervor of feeding shrimp". Culture areas and yield reach 2,502 ha and 8,215 t in 1989 increased by 150% from 1980 to 1989.

Enhancement of shrimp fisheries has also been successful. Since 1987, up to



A Zhoushan fishing village.

300 million juvenile shrimp have been seeded into the ocean annually. Economic benefits are obvious. For example, of 156 million stocked shrimp, 14.6% were later captured yielding 269 t worth 3.2 million yuan.

On land, various industries have been introduced into fishing villages to create new occupations, which have decreased dependence on fisheries from 91% to 76% of the workforce.

However, while the government has licenced 1,100 powered fishing boats from other provinces to fish in the fishing ground, thousands of small fishing boats have been built and used illegally within the area.

International Agreements

While China has a fisheries agreement with Japan, it has no agreements with

other nearby fishing entities - the Koreans, Hong Kong, Macao and Taiwan. More and more vessels from these places are entering the fishing area. Over 500 Taiwanese vessels alone fish there, taking over 200,000 t annually. Thus, there is contradiction between China's conservation efforts and foreign fishing activities. There is a need to limit these activities for the long-term benefit of the resources.



WANG QIANGHUA and YU CONG DA are from Fisheries Research Institute of Zhoushan City, Zhejiang Fisheries College, Zhejiang Province, China.

Workshop in Fisheries Research

C.P. MATHEWS

Two workshops cosponsored by the Asian Development Bank's Marine Science Education and Technology Project for Indonesia were recently held in Bogor. The first of these dealt with the "Application of Hydroacoustic Data Processing in Fisheries Research" and was led by Dr. A. Stepnowski of the Telecommunications Institute, Technical University of Gdansk, Poland. The second Workshop was led by Dr. C.P. Mathews, Zoology Department, University of Reading, England, and dealt with "Applied Stock Assessment and Living Marine Resource Exploration and Prospection". Both workshops were held at the Darmagar Campus of the Institut Pertanian Bogor, on 13-18 January 1992.

The first workshop was intended to acquaint Indonesian scientists with the technical possibilities now available in the field of echoacoustics, especially with the application of real time hydroacoustic data processing to the estimation of fish population size, especially for small pelagics. The subjects included echointegration techniques, and analysis of fish target strength.

A manual based on extracts from Ricker¹

and Pauly² and some extra material and exercises was prepared for and distributed to the participants of the second workshop. This manual included various versions of surplus production and dynamic pool modeling methods, as well as more general material on population dynamics, fisheries biology, and bioeconomics. Lectures covered the major approaches used in stock assessment and fisheries management today. Also, copies of a compendium of programs for population dynamics studies (Hall)³ were made available and the participants were taught how to handle these programs, using data from Indonesia and the Gulf of Thailand. Also, the Compleat ELEFAN software package was used to analyze size-frequency data on *Penaeus merguensis* from the Arafura Sea, published by Dwiponggo et al.⁴ and on the Java Sea population of *Nemipterus japonicus*. The assessments included analysis of spawning stock biomass per recruit (Mathews)⁵, which suggested that the *P. merguensis* stocks may have been subjected to recruitment overfishing in the late 1970s and the early 1980s, while the *N. japonicus* stock was not suffering from this problem.

The participants were also given the opportunity to analyze their own data and to draw their own conclusion as to how the fisheries studied might be managed.



Further Reading

- ¹Ricker, W.W. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191: 1-382.
- ²Pauly, D. 1984. Fish population dynamics in tropical waters: a manual for use with programmable calculators. ICLARM Stud. Rev. 8, 325 p.
- ³Hall, N. 1981. Population dynamics programmes. Kuwait Institute for Scientific Research, Tech. Report. Safat, Kuwait. MB-6, 222 p.
- ⁴Dwiponggo, A., T. Hariati, S. Banon, M.L. Palomares and D. Pauly. 1986. Growth, mortality and recruitment of commercially important fishes and penaeid shrimps from Indonesian waters. ICLARM Tech. Rep. 17, 91 p.
- ⁵Mathews, C.P. 1991. Spawning stock biomass-per-recruit analysis: a timely substitute for stock recruitment analysis. Fishbyte 9(1):7-11.

C.P. MATHEWS is from Zoology Department, Whiteknights University of Reading, Reading, England and was part of the Marine Science Education and Technology Project Institut Pertanian Bogor/Asian Development Bank.