

Studies on the Situation of Pollution and Countermeasures of Control of the Oceanic Environment in Zhoushan Fishing Ground—the Largest Fishing Ground in China

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Zhoushan fishing ground is located in the eastern part of Hangzhou Bay of China close to the continental seashore of Zhejiang Province and Shanghai Municipality; and links up the Yangtze River, Qiantang River, Yongze River and Caoe River. The total length of continental coastline is 1500 km and the total sea area of the fishing ground is about 100,000 km². It is a spawning and growing place for various fishes, shrimps and crabs; and the species of fish are as many as 360 with hairtail, larger yellow croaker, little yellow croaker and cuttlefish well-known throughout the country. The annual catch of fish is about 800 thousand ton, occupying one-third of the national total. However, of the late years, the product of the fishing ground goes straight downwards, and drops by 50% at present. Besides the problem of overfishing, another important factor is the pollution of oceanic environment. Coastline is the most developed economic area in China, where the waste water discharged into the sea area of fishing ground comes up to two billion ton causing serious organic pollution and the heavy metals such Cu, Zn, Pb and Cr violating the standards in different degrees and directly affecting the structure and stability of oceanic ecosystem, changing the migration route of fishes and the emigration of spawning ground, and the continuous increase of residual toxics in the aquatic products. These problems have brought to the attention of Chinese government; and measures are under way to improve the oceanic environmental quality of the fishing ground. The present paper describes in detail the natural conditions and the pollution situation of the fishing ground, and also the contents of studies on the comprehensive programme of environmental protection, including prediction of the developing trend of seawater pollution, the characteristics of ocean current and the route of transference and conversion of petroleum, COD and heavy metals and the receiving capability of sea area for main pollutants; the impact assessment of environmental pollution on the aquatic resources and the countermeasures of oceanic environmental protection.

Zhoushan fishing ground is located in the eastern part of Hangzhou Bay of China, 123 ° 30' E and 29 ° 30'–32 ° N, close to the continental seashore of Zhejiang Province and Shanghai Municipality; and links up the Yangtze River, Qiantang River, Yongze River and Caoe River. The total length of continental coastline is 1500 km, and the total sea area of the fishing ground is about 100000 km². It is the greatest and the most famous fishing ground in China and its geographical position is shown in Fig. 1. This paper introduces briefly: 1. the natural conditions of the fishing ground sea area; 2. the situation of the pollution

of the oceanic environment; 3. the effect of environmental pollution on the production of fishing and 4. the countermeasures of controlling the pollution of sea area. The information comes mainly from "Review of Reserch Findings of Environmental Protection and Ecology of the sca Area of Zhoushan Fishing Ground."

I. Natural conditions of the sea area of Zhoushan fishing ground

Zhoushan fishing ground is located where the fresh water and the sea water meets, so the water body is rich in nutrients. Many rivers along the seacoast carry a lot of organic nutrient compounds into the sea area where the sunshine and water temperature are suitable, so the area is a spawning and glowing place for various fishes, shrimps and crabs.

It has been measured that the content of phosphorous in coastal waters is 30–40 mg / m³, that of silicon is 2000–3000 mg / m³, the number of phytoplankton cell is 10⁷ / m³, and the biomass of zooplankton is 250–300 mg / m³. The primary productivity is estimated to be about 500 billion ton and total biomass about 40 billion ton.

The species of fishes around Zhoushan fishing ground and Hangzhou Bay are as many as 360 or more, with hairtail, larger yellow croaker, little yellow croaker and cuttlefish well known as four great economic fish species throughout the country. The annual catch of fish is about 800 thousand ton, occupying one-third of the national total, in which the amount of fish of superior quality accounts for 60–70% of the national total, coming first on the list.

Besides, the sea area of Zhoushan fishing ground is also abundant in ocean resources of energy, mincs, chemical industry, navigation, seabeach and tourism. For example, the tidal energy of this sea area is about 5–7 million kilowatt, accounting for 45% of the national total. There are scores of rather good harbour anchorage, ice-free and non-silted up throughout the year, with deep and broad channel navigable to many inland river systems and also straight to foreign harbours all over the world. Mt. Putao in Zhoushan Islands is one of the famous Buddhistic mountains in China, having Buddhist rite and religious relations with Japan for more than one thousand years; and is usually called the Buddhist Kingdom of the sea of Heaven. Furthermore, the islands of various sizes like pearls spreading on the sea with picturesque landscape and unique scabeach attracting a great number of tourists both at home and abroad.

II. Situation of oceanic environmental pollution in Zhoushan fishing ground

The neighboring seashore of Zhoushan fishing ground is dense in population with very many large and medium cities and concentrated industries, thus forming the most developed economic area in China. Shanghai the greatest city in China, Hongzhou, Ningpo and other large cities are all located in this region with a population density of 695 person per square kilometer, or 6.38 times of the national average as shown in Table 1.

The annual wastewater discharged into this sea area is 2 billion ton containing 3 million ton of COD, 18 thousand ton of Cu and 7.5 thousand ton of petroleum, causing environmental pollution of the sea area. There exists no sea area around Hongzhou Bay and Zhoushan islands with water quality of Grade I; 75% of the seawater belongs to Grade II; 25% belongs to Grade III and that of the eulittoral zone goes beyond the standards of Grade III. The detectivity of petroleum in the sea water is 100% with 95% of its value going beyond the standards of water quality for fishery; and the average of copper beyond 70%.

Table 1 The area and population of the city in
the neighboring seashore of Zhoushan

Name of City	Area (km ²)	Population (10 ⁴ person)	Density of population (person / km ²)
Nantong	9140	744.7	815
Shanghai	6186	1216.7	1967
Jiaying	3915	300.6	768
Hangzhou	16596	543.1	327
Shaoxing	7901	394.9	500
Ningpo	9365	487.7	521
Zhoushan	1249	93	748
total	54352	3780.7	695
National coastal area	410000	17616.6	427
National total			106
Ratio to national total	0.57%	3.7%	6.38 times

Table 2 Inflow water from seashore into Zhoushan
fishing ground (10⁸ ton / year)

Inflow Source	Yangtze River	Qiantang River	Caoe River	Yong River	Direct discharge	Mixed discharge	Moving source	Total
Amt. of Water	9114.0	382.7	44.3	28.6	1.7	1.9	0.8	9574.0
%	95.19	4.0	0.46	0.30	0.02	0.02	0.01	100

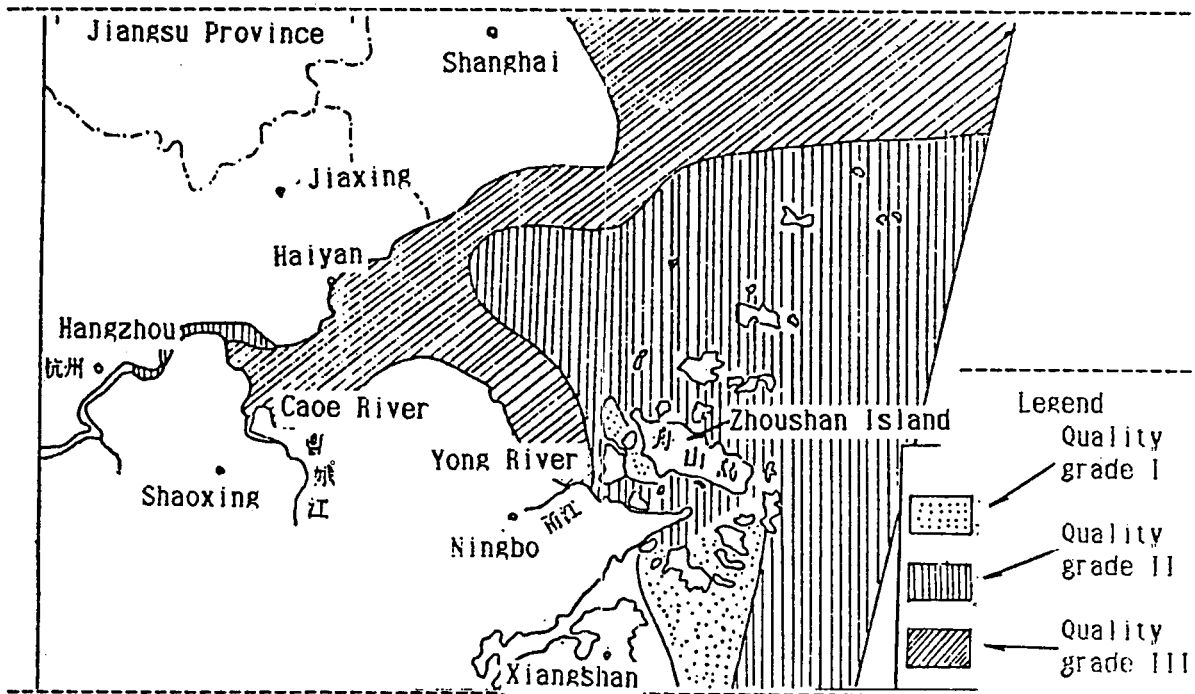


Fig. 1 Classification of the water quality of coastal sea area of Zhoushan fishing ground

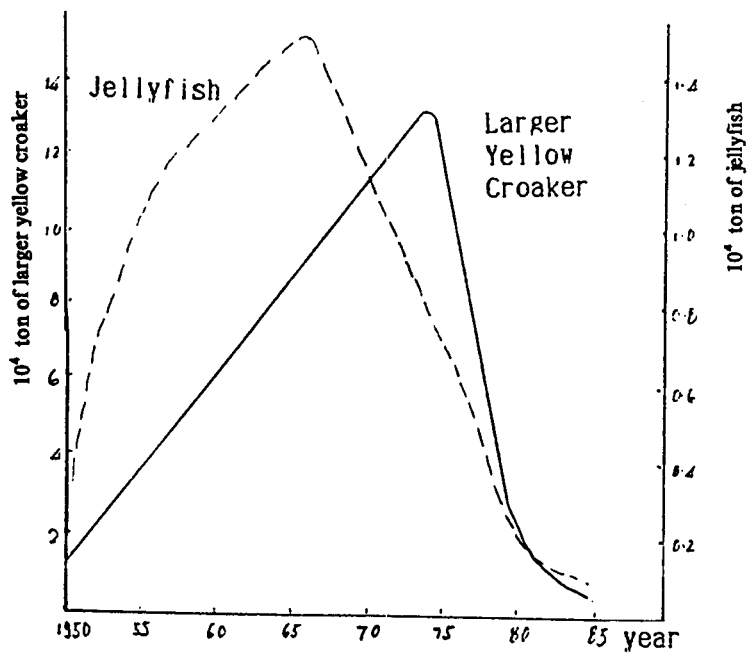


Fig. 2 Trend of decrease of marine products

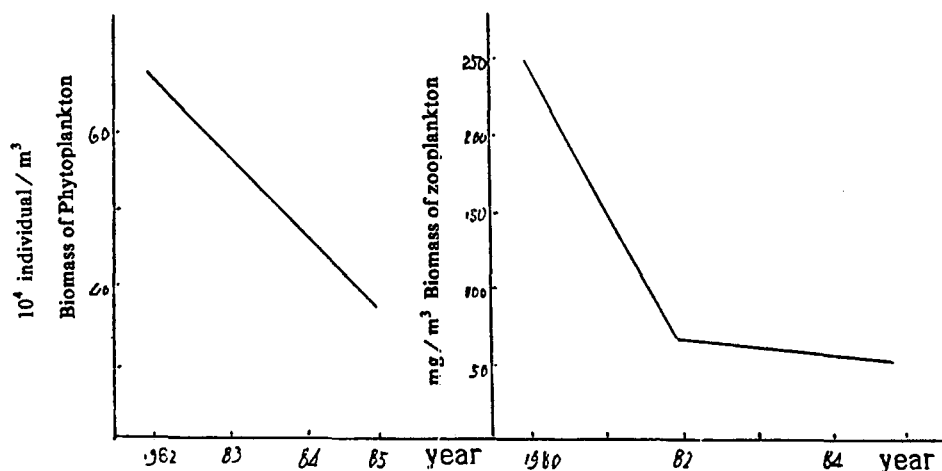


Fig. 3 Trend of variation of the biomass of Phytoplankton and zooplankton

The organic pollution is serious day by day. The inflow amount of polluted water is listed in Table 2; Fig.1 shows the situation of sea water quality. Amount of COD discharged into the fishing ground accounts for 49% of the national total, Cu 91.4%, Cr⁶⁺ 64.5% and petroleum 11%. Thus, the sea area of Zhoushan fishing ground has become the main pollutant receptor in China.

III. Situation of fishery resource in the sea area of Zhoushan Fishing Ground

(I) Decrease of fishery product

Since 1974 the fishery product of this area has been dropping straight downwards. The catch of larger yellow croaker in 1974 was 133 thousand ton and decreased to 1.1 thousand ton in 1986 with the trend of decrease as shown in Fig. 2. Of course, the main reason of the drop of fishery product is over-fishing. The effect of environmental pollution on fishery resource still needs deliberate investigation.

(II) Decrease of the bait-bios year after year

The average biomass of phytoplankton in Hangzhou Bay was 68×10^4 individual/m³ in 1982 and decreased to 38×10^4 individual/m³ in 1985. The annual average of biomass of zooplankton was 100–250 mg/m³ in 1980 and decreased to 54 mg/m³ in 1985; and that of the benthon was 23.6 g/m³ in 1959 and decreased to 3.7 g/m³ in 1985.

(III) Gradual disappearance of the fishing ground and degradation of fish population

Since the seventies, the spawning place of river mouth fishes such as salangid, mullet, hilsa herring and the like has disappeared basically; the oyster and laver which were abundant in the past near some islands have vanished now; the butterfish, spanish mackerel, anchovy, etc. have decreased in the spawning area; and the product of jellyfish was reduced rapidly with the diameter of its cover reduced from 40–50 cm to 20 cm mostly.

IV. Studies on the controlling measures of sea water pollution in Zhoushan fishing ground

In order to protect the fishery resource of Zhoushan fishing ground, control the sea water pollution and coordinate the oceanic environmental protection and economic development, the National Environmental Protection Agency of China organizes an expert group to study the countermeasures of pollution control for the oceanic environment in Zhoushan fishing ground, the main contents of which are shown in Fig. 4.

(I) Survey, assessment and prediction of the pollution source both land source and marine source, and also the inflow throughput of pollutants of the tidal river estuary.

(II) Evaluation of the situation and developing trend of environmental quality of the sea area in Zhoushan fishing ground, with the main assessment factors of COD, petroleum, heavy metals (Cu, Zn, Pb) and suspended substances, including the quality of sea water and sea bottom materials.

(III) Analysis of the sea water flowing or current field. The interchange features of sea water, the distribution of active area and detention area, the routes of transfer of main pollutants in the Yangtze River estuary and Hongzhou Bay, and the range of effects are made clear through calculations with two or three dimensional tidal current model, Lagrange remainder current model and advective diffusion model of pollutant.

(IV) Study of the effect of oceanic resources of Zhoushan fishing ground, including the effects on the amount of bait-bios and the structure of biocommunity, the analysis of residual toxicant in organism, the toxicity test of pollutant in fish, selection of pollution biological indicator, and so forth.

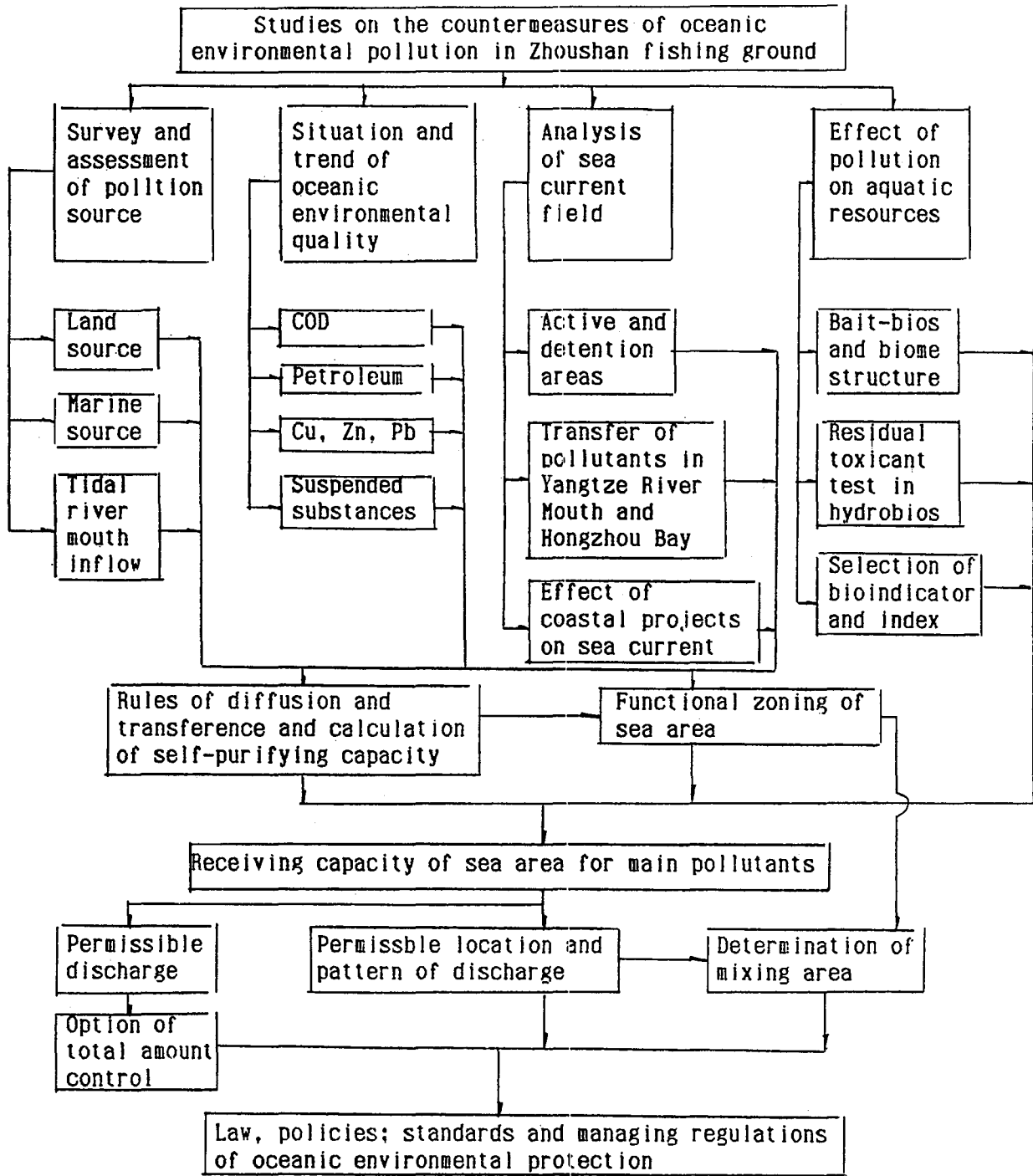


Fig. 4 Schematic diagram of the studies on Zhoushan fishing ground

(V) Estimation of the self-purifying capacity of sea water in Zhoushan fishing ground, setting up the environmental protection objective, carrying out the functional zoning of the sea area and determination of permissible pollutant discharge and its optimal allocation for the alternatives of total amount control of areal pollution; and mean while, the optimized programming of the location and pattern of discharge, the monitoring and managing system of sea water pollution and drawing up the environmental protection laws, policies and standards for the fishing ground, all based on the findings of the studies mentioned above.

This research project is planned for five years with the expert group recently organized including the Chinese Research Academy of Environmental Sciences, Shantong Oceanographic University, Zhejiang Environmental Protection Agency and Shanghai Environmental Protection Agency. And the kindly support or direction of foreign experts is heartedly welcome.

Main References

1. Pollution Management Department, NEPA, etal. "Review of Research Findings of Environmental Protection and Ecology of the Sea Area of Zhoushan Fishing Ground."
2. Outline of Study on the Integrated Planning of Environmental Protection of the Sea Area of Zhoushan Fishing Ground, 1989.