Notes of Study on Development Strategy of Chinese Fishery to 2030

Yingqi Zhou and Xinjun Chen

Abstract The paper presents the views from the project "Study on the developmental strategy of Chinese fishery science and technology in medium and long-term". The first priority of fisheries in China is to produce sufficient aqua-products to meet the demand, which is estimated to be more than 20 million tons over current levels by 2030. The difficulties are the restrictions from resources and the environment, and poor management in marketing and administration. The strategies for fishery science and technology are classified as "Safeguard strategy, Promotion strategy, Developing and Widening strategy and Innovation strategy". The key points suggested by the strategy for raising the level of fishery science and technology and competitive power of fishery products are: formulation of policy should be based on fish consumption purposes; integration of technology through "Digital fisheries" and "Engineering fisheries"; efficiency improvement of species, feed coefficient and processing; strengthening education and training levels of fishery labor; organizational reform by promoting four types of "Complement and Combination (C&C)" systems; introduction of technology from other industries; establishing a practical action plan and goals on aquatic product security and quality management; and setting up information sharing platforms and data bases, and related service systems.

Key words: Chinese fishery, strategy, demand, resources, sustainability

Yingqi Zhou
Fishery Study Center, Shanghai Fisheries University, 334 Jungong Road, Shanghai 200090, China

Xinjun Chen
Marine Science and Technology College, Shanghai Fisheries University, 334 Jungong Road, Shanghai 200090, China

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Introduction

The authors were in charge of the national project "Study on the developmental strategy of Chinese fishery science and technology in medium and long-term", which involves the forecast of demand for fish, as well as the need for fishery science and technology for 2020 and 2030 (Zhou et al., 2006). Therefore, the development targets of Chinese fishery, the characteristics of fishery science and technology and their goals have been studied. In this paper the main ideas and views on macroscopic strategy study will be described.

Background

China is a great fishery nation with a total yield of 51 million tons in 2005, which accounts for 1/3 of the total yield of the world, and is ranked number one in the world for the last 15 years. Chinese fishery structure took the leading position due to the introduction of aquaculture. Chinese aquaculture output amounts to 33.93 million tons and accounts for 2/3 of the world aquaculture output, in which 40.8% is from marine aquaculture. In addition, the Chinese fishery trade accounts for 6.8% of the world fish exports, which is ranked number 1 or 2, and is ranked number 10 for fish imports (Zhang and Rortveit, 2004). Thus it can be expected that the Chinese fishing industry will continue to play an important role in the global fisheries.

In China, the increase in economic growth rate of fishery is 9% which is higher than the GDP increment rate, and the average annual growth rate of total output is 4.1%. In 2005, the output value from marine fishery accounted for 35% of the total value created by marine industries in China. It is noted that the fishery population is 20.7 million people and the labor force is approximately 13.16 million, which is only about 2% of the agricultural population. However, the fishery provides 1/3 of the animal protein consumed by the Chinese people. Fisheries will continue to play an important role in the daily life of the Chinese people.

Priority in Chinese Fishery and Challenges

Strategy study on fisheries is different from research on natural science and technology, since a strategy study should focus on the future of fisheries including foresight, prediction of trends and goals and warnings and cautions, the mechanism and driving forces for development, for instance, the demand and supply of fish in 2030 and the limitations or risks involved. Since the study is at a national level, the following factors should be taken into consideration, viz. sustainable development, the national general strategic goals, and feasibility. It should investigate and understand the priority or importance of the factors "sufficient food supply, economic benefits

and efficiency, protection of environment and resources" in the fisheries concerning national macroscopic strategy targets.

The First Priority – Demand for Fish in 2020 and 2030

The administration structure of government might indicate or reveal the main goal of a country, for instance, in China the Bureau of Fisheries comes under the Ministry of Agriculture, which is similar to the practice of most nations, i.e., food, agriculture, and fisheries, and even forests are managed by one ministry. This reveals that to provide sufficient aqua-products as food for the Chinese people is the first priority, at least in the past. This is different from the situation in USA and Australia. The fisheries sector in the USA is under the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce while in Australia it is under the Department of Primary Industries (DPI); which reveals that the economic efficiency of resources utilization is the first priority. After China adopted a market economy system, the economic benefits and efficiency of fisheries become the second goal. Due to organizational reform of the administrative structure of government in recent years, the bureau of fisheries and the marine bureau at the provincial level have been merged together in one bureau in China. This reform might be advantageous from the viewpoint of conservation of environment and harmonious ecology. However, our investigation shows that in the near future, China will continue to set the production of sufficient fish to meet the demand of Chinese as the first priority.

By sampling, interviews and modeling, and also referring to previous studies (Chang and Zhou, 1992; Zhou, 1992, 2000; Delgado et al., 2003; Zhang and Rortveit, 2004), it is estimated that the demand for Chinese fishery products will increase by 20 or 39.5 million tons in 2020 or 2030 year respectively, or that the output value would be double that of 1997. The average fish consumed per capita in 2020 could be 35.9 kg (Figure 1). The challenge is whether the goal can be achieved and how to approach it.

Challenges Faced by Chinese Fisheries

In the present strategy study, the "bottlenecks" which might occur in the fisheries sector are predicted and analyzed, and methods are indicated how to prevent or reduce the possible appearance of bottlenecks and reduce their negative influence.

The finding from our strategy study shows the challenges that Chinese fishery will face, viz. demand on fish increasing by about 40% in 2030 must rely on self-sufficiency, mainly from aquaculture, both fresh water aquaculture and sea farming. The possible supply shortage of feed, for example, even though China imports plenty of fish meal, fish feed could be the key or "bottleneck" for aquaculture; China has to properly utilize the high seas fishery resources, however, marine fish-

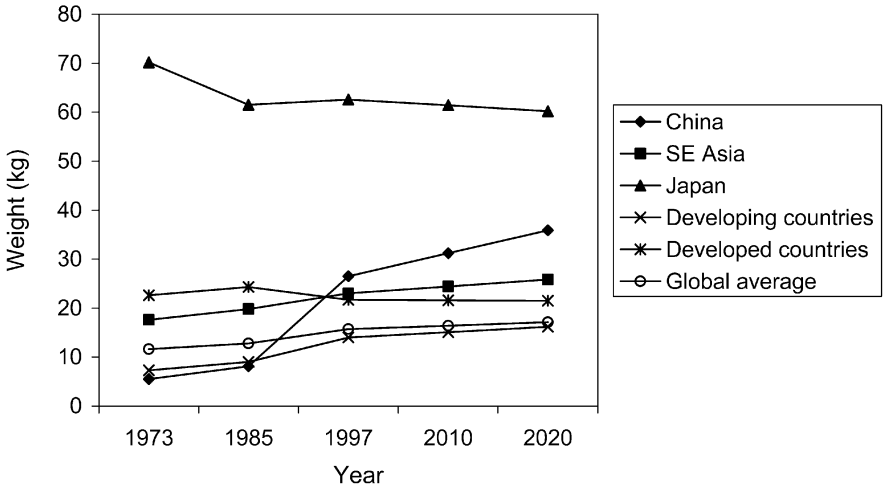

Fig. 1 Average fish consumption per capita.

ing has not much room to expand due to already declining stocks; The export of fish from China should mainly adopt the mode "import raw material and re-export after processing", hence high value added technology is required. The quality of fish will become very important as domestic and foreign consumers are requiring high quality fish.

The difficulties and restrictions involving Chinese fisheries are mainly:

- Increased industrial development has further increased the demands on resources and the environment, in fact, the current situation is that overfishing has resulted in inshore fishery resources being seriously destroyed, habitats of fishes and related aquatic environment are getting worse, and depressing biodiversity. It has been reported that the number of fishing boats are more than 480,000 in China, total fishing capacity has a surplus of 30%, and even exceed 50% in some areas (Zheng and Zhou, 2002; Zhou, 2006). "Fishing down to food web" exists anywhere according to Pauly et al. (1997). Low value species as bycatch constitutes 60%-70% of the catch. Trophic levels of species in the catch are dropping, while shrimp and small fishes becomes the main target fish. Because of environmental pollution, the output from fishing lost 500,000 tons every year in China, which is approximately RMB 3 billion Yuan.
- The development of fishery industry was restricted only by fish resources in the past; however, it has become restricted by both the resources and the market. Furthermore, because systematization of the fishery industry is poor, lack of competitive power in market economy, their survivability in risk and capability to apply new advanced technology are lower. Because of wrong guidance in the market by consuming trends, aqua-products have changed very quickly in the Chinese market, greatly increased the social opportunity costs, and as the species of market fish have changed too fast, it is not possible to carry out long term research,

Table 1 Fisheries in China.

Items	2000	2005	2010
Total output (million ton)	42.79	51.02	60.00
Aquaculture	25.78	33.93	45.50
Capture	13.91	13.09	12.00
Total value (billion Yuan)	280.8	418.0	570.0
Import & export (million ton)	4.05	6.23	
Export (million ton)	1.534	2.57	4.00
Value (billion USD)	3.83	7.89	12.0
Income per fisherman (Yuan)	4725	5869	7200
Processed products (million ton)		1.195	1.700
Value (billion Yuan)		132.1	220.0
Processed ratio	30%	34.8%	
Marine fishing vessels (1000 vessels)	248	215	192
Power (Million kw)	12.0	12.2	11.43

so the producers will find it difficult to obtain sufficient technical support. After the market system was introduced into China, the economic benefits have been paid great attention. The most high value species are selected for aquaculture, mainly to provide restaurants or hotels, however, these species which are at the top of the food chain consume more energy for growth, for instance, feed with small fish and fish meal, which places high demands on natural resources.

- Chinese fishery production methods are still coarse and un-integrated. The development of fisheries excessively relies on the input production elements, inflow of funds and resources have been massively consumed. In China, only 34.8% of aquatic products is processed (Table 1), and in the case of fresh water fish it is only 5.7%, a very low percentage in the total fresh water fish yield. In Japan, Canada, America and Peru, up to 60–90% of the fish is processed. It has to be noted that a lower processing rate affects the value added and the economic performance of fisheries.
- The essential supporting system for the fishery industry is weak. For example, research and extension service work on breeding, disease prevention and control, fish and water resources conservation and management are not sufficient. Regarding the fishery resources and the environment survey, fishery research lacks fundamental study and systematic data collection, and even lacks reliable data.
- Education and training for fishery labor is not sufficient. With the reform of the state economic structure and changes to the fishery structure, there is a massive number of fishery workers who have to transfer into other sectors; however it is difficult to shift because of lower education level (Chen and Zhou, 2000). On the one hand, this kind of shift needs the support of the entire society; obviously this is societal engineering, which involves the culture, education, exchange, and enhances the adaptive ability of fishermen to modern society. Furthermore, to create new jobs for fisheries, and then also have to maintain a continuously increasing income is another major challenge. All these are part of the challenges which Chinese fisheries face.

Recommendations for Development Strategy of Fishery Science and Technology

The outline recommended for the sustainable development of fisheries is, "To construct and create an ecologically friendly fishing industry, integrated healthy aquaculture, advanced processing industry, advanced logistic and distribution industry, varied recreation fishery and sport fishing". The fishery science and technology development strategy may be divided into four kinds: (1) safeguard strategy, (2) promotion strategy, (3) developing and widening strategy, and (4) innovation strategy.

Safeguard Strategy

To produce sufficient aquatic products, the selection and cultivation of species for farming and their production pattern, quality control and ecological security are important issues.

Promotion Strategy

To overcome the restrictions and limitations from fisheries, water, human resources and marketing, the technology to explore new resources, cultivation and development of the market, and human resource training are required.

Developing and Widening Strategy

Refers to the "3F development" (Fishery, Fishery village and Fishermen) as a comprehensive package, it is not only to develop the fishery as an industry, but also involves society, human development, and harmonious ecological development.

Innovation Strategy

There are new areas related to fisheries, such as application of digital technology, genetic technology, aqua-biomass production as raw material, and marine medicine, which should be explored.

The key points suggested by the strategy study for raising the level of fishery science and technology and competitive power of fishery products are as follows:

- Formulation of policy should be based on fish consumption purposes. Fish utilization can be classified into groups, i.e. fish for daily food, fish for well-off life, fish for export, fish for leisure and recreation, and fish as industrial raw material. (a) Fish for general populace daily consumption and main source of protein, referred to as "people's fish", should have high priority and full support from the government including intensive research. The criteria recommended for selecting people's fish are: a low energy consumer or has broad feed scope such as herbivorous species and suitable for large scale processing, for instance, tilapia and shrimp are highly recommended. However, aquaculture of people's fish has a lower profit margin in general but huge demand. It is important to safeguard supply as the first goal in China, hence the government should organize and promote all available research institutions and universities conducting research on each link of the entire industrial chain from fish pond to table. Also providing funds to the project as a national key project to form industry on a large scale. (b) Along with improved people's living standard, the demand for different types of fish will be inevitable, including consumption of more costly fish on holidays. This type of demand makes it necessary to develop expensive and high quality variety table fish from aquaculture or fishing. To satisfy this requirement for the well-off life, the fish authority may provide appropriate support and guidance. (c) Fish for export only involves economic efficiency as the essential target. It is suggested that the policy, in principle, will guide enterprises based on market economy rules. The industry will seek and obtain R&D funds and loans from banks or the private sector. (d) Ornamental fish has a great potential market value where the buyers will be people having well-off life. However, the aquaculture of this type of species requires high tech support from research institutions. (e) Algae could be potential biofuel, an important renewable energy resource in the future.
- The integration of technology in the development of fisheries is anticipated through "Digital fisheries" and "Engineering fisheries". Aquaculture production in China relied mainly on the experience of past practices. Since there is a shortage of data from scientific research and experiments, it is difficult to adopt modern technology such as information and engineering technology. For guiding the R&D work, the new concepts "Digital fisheries" and "Engineering fisheries" are proposed. Digital fisheries in aquaculture can be called "precision fish farming". Systematic research, and the collection and analysis of all relevant data of aquaculture, can be used to give instructions and monitor the production process, control the energy flow and utilization of resources, adjust nutrition provided and metabolism of fish in precise mode, supported by computer technology. Digital fisheries also include the application of 3S technology (RS, GIS, GPS) in marine fishing and fish resources conservation and ecological system study, digital modeling of fish behavior and fishing gear performance and selectivity; also including documentation fishery or traceable fishery, professional system and intelligent fishery instrumentation, etc.

In addition, more attention should be focused on the integration of engineering technology in fish cage farming, in particular, the large-scale fish cages with supporting

platforms in the open sea. Engineering fisheries means, not only application of engineering technology, but also to use systematic engineering concepts to re-organize and manage the fisheries. The results from our ecological accounting study show that land-based intensive farming is better on water, resulting in land resources saving and lower ecology cost. This is a noteworthy result (Hu and Zhou, 2005).

- Efficiency is the key of production–species, feed coefficient and processing. To meet the demand of fish in future, the products will mainly come from aquaculture, particular by sea farming. So productive species and feed coefficient become the keys to Chinese aquaculture. At present, Chinese aquaculture consumes 3 million tons of feed. If 40% of feed could improve its feed coefficient from 2.1–4.0 to 1.3–2.0, it means an additional 500,000 tons of fish can be fed. If the fish loss due to fish disease is reduced by 20%, an additional 6 million tons of fish will survive. Cultivation of well-bred species, for instance species that grow 30% faster, such as F6 salmon and F6 black beam (Pujiang No. 1), could produce considerable economic returns and fish production. The output value could be increased by means of high value added products, processing and well organized logistic management.
- Concerning the quality of human resources, while the Chinese fisheries step into modernization, the first thing is to strengthen the education and training levels of fishery labor, because, in general, fishermen are the beneficiaries and executors of sustainable development. The level of education received by fishermen received will be the key issue for sustainable fisheries. The government has to give full attention and support to this matter.
- Concerning the establishment of system and mechanism, the key lies in organizational reform. The authors suggested to promote four types of "Complement and Combination system (C&C)", also called "the three-in-one combination (3-in-1)": The first type "Enterprise-Training-Research C&C (ETR)", involves universities and scientific research institutions through this cooperation, provides the technical support for enterprise development and promotion, and is beneficial to speed up technology transfer and modernization. However, it should be noted that this type of C&C has an extremely strong utilitarian bias; it will pursue economic profit for the enterprise as the core target. It is not suitable for public welfare research. The second type of C&C is "Administration-Education-Research (AER)". This kind of 3-in-1 combination mainly carries out soft research projects by universities and research institutions, which provides policy-making guidelines and advice for the government. The third C&C is the most important in the development of fisheries, namely "Education-Research-Extension service work (ERE)". This kind of cooperation is quite common in the agricultural sector of developed countries. Education, research and extension services are the main functions of universities. Providing technical services for fishermen will guarantee the sustainable development of fisheries. The ERE system can continuously provide the knowledge and support to the persons engaging in technical extension service work, and speed up the technical transfer. At present the ERE system is not properly set up in China, in fact, the education, research and extension service are split and allocated in different sectors, which results

in the extension service being placed in a very difficult situation. The fourth one is: "Government-Institution-Enterprises (GIE)". By government instructions or guidance according to national macroscopic goals, universities transfer their scientific findings and technical achievements to enterprise directly, and rapidly, to form and create new industries to meet national or provincial goals.

- Because fisheries rely on the introduction and integration of technology from other industries, it is important to actively introduce and adopt achievements from IT, space science, bio-tech and new materials etc. and promote the integration of technology, to implement elaborate management and enhance efficiency.
- Aquatic product security and the quality are directly related to the people's welfare and health. So it is proposed to set up a practical action plan and goals on aquatic product security and quality management.
- Set up information sharing platforms and data bases, and related service systems.

Towards 2030, the important R&D works recommended in order are as follows: improve and/or optimize aquaculture production, disease prevention and control, feed development, high density aquaculture technology, fish cage farming, genetic technology, deep-sea fisheries, raises the ratio of processed fish, logistic management and distribution, intelligence fishery equipment and instrumentation, digital fisheries, engineering fisheries and resources economy and management.

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