Consideration on Developing the Enhancement Fishery in China

Jiahua LE[1]*, Cheng ZHANG[2]

1. College of Economics & Management of Shanghai Ocean University, Shanghai 201306, China; 2. Chinese Academy of Agricultural Sciences, Institute of Agricultural Economics and Development, Beijing 100181, China

Abstract The enhancement fishery is one of five pillar industries of aquatic products industry. Cultivation and development of enhancement fishery have certain conditions and advantages in China. From the concept of the enhancement fishery, this paper introduced four approaches for developing the enhancement fishery. It pointed out major problems in the development of enhancement fishery, including small construction scale of protection zone and unreasonable distribution, substandard releasing technology, not obvious enhancement effect, unclear development orientation, and difficult operation of implementation standard. Finally, it came up with recommendations for developing enhancement fishery, improving legal protection system, increasing input support effort, enhancing construction of scientific research institutions, strengthening supervision and management functions, establishing scientific evaluation system, and promoting comprehensive development of enhancement fishery.

Key words Enhancement fishery, Major problems, Development recommendations

1 Introduction

The *Twelfth Five-Year Plan for Fishery Development in Whole China* puts the enhancement fishery in the same place as aquaculture, fishing, aquatic product processing and circulation industry, and recreational fishery, *i. e.* one of the five pillar industries of fishery economy[1]. Developing the enhancement fishery is a strategic measure for restoring and protecting fishery resources, expanding fishery, replacement environment cost, and improving life quality. At present, cultivation and development of the new rising industry, enhancement fishery, has certain comparative advantage, excellent economic foundation and broad development space in China.

2 Concept and development path of the enhancement fishery

2.1 Concept of the enhancement fishery Since the 1990s, many countries have placed great expectation on restoration of fishery resources, supply of consumption market, and supply of high quality protein, and undertaken the fry stock enhancement fishery one after another. The enhancement fishery belongs to resource enhancement method directly increasing reproduction capacity of fishery resources with fry releasing as the core. By now, there is still no unified definition of the enhancement fishery in the world. With reference to definition of the enhancement fishery in some countries and realities of China, we can define the enhancement fishery of China is sustainable development fishery oriented towards enhancement and regeneration of fishery resources, and increasing diversity of water organisms and resource volume. Alternatively, we can define the enhancement fishery as sustainable development fishery that undertakes artificial cultivation and temporary breeding of fries of fishery resources, releases fries to natural sea areas or artificial auxiliary facilities after certain growth of fries, and develops to enhancement and regeneration of fishery resources and formation of fishing grounds, to increase water organism diversity and resource volume.

2.2 Development approaches of the enhancement fishery At the early stage of the development of enhancement fishery, "enhancement" and "fishery" are at a loss as what to do in aquatic product industry. In a narrow sense, the enhancement fishery generally refers to fry releasing and catch recovery of fishes and shellfishes; in a broad sense, the enhancement fishery is a comprehensive fishery system oriented towards sustainable development of fishery including catching rules and formation of fishing grounds[2].

From measures of countries for restoration, increase and protection of fishery resources, there are mainly 4 approaches: (i) increasing regeneration or supplement volume of fishery resources; (ii) protecting and cultivating growth of fishery fries; (iii) enlarging and supplementing fishing grounds of fishery resources and habitat of attachment organisms; (iv) protecting and improving living environment of fishery resources[3].

3 Major problems of development of the enhancement fishery in China

In the situation of constant decline of fishery living resources, increasingly strict international fishery management, and rigid increase of demands of aquatic products, the source of China's aquatic product supply will largely rely on increase in yield of the enhancement fishery. After entry to the new century, all areas constantly increase input to the enhancement and releasing and actively undertake care and protection of living aquatic resources, forming the upsurge of care and protection of living aquatic resources with management department as leading, various circles of society as support, and the masses as main part.

In China, the enhancement and releasing activities of fishery resources started from the late 1980s and the middle of the 1990s. In the period of the Eleventh Five-Year Plan, China invested a to-

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* Corresponding author. E-mail: jhle@shou.edu.cn

tal of about 2.1 billion yuan, released 109 billion various fries, and has made certain achievement in restoring fishery population resources, improving water ecological environment, protecting biological diversity and endangered species, increasing fishery benefit and fishermen's income, and enhancing people's resource and environment protection awareness[3]. However, compared with other fishery sectors, the enhancement fishery is faced with following major problems.

3.1 Small protection zone and unreasonable distribution China has vast water area, complex and diverse ecological environment, and numerous living resources, while the protection of living resources has different emphasis point. In the whole country, there are 21 national level ocean protection zones with area about 275 000 hm^2, numerous provincial (city) ocean protection zones and more than 200 protection zones of living aquatic resources in Yellow River, Yangtze River and the Pearl River basins (including 16 national level, 64 provincial level, and more than 130 city and county level) with the total area above 100 000 km^2[5].

Compared with other fishery countries, especially Japan, the United States and Norway, China is faced with problems of late start, small scale and unreasonable distribution in construction of protection zones. Compared with the United States, China's quantity of protection zones is 2.5 times the United States, but the area is only 70.5% of the United States; in research and management, the United States has National Oceanic and Atmospheric Administration and Fish and Wildlife Service, and ithas formulated *Marine Protection, Research and Sanctuaries Act*. As to the industrial distribution, Japan built the enhancement fishery center in the whole country and prefectures since the 1950s. With years of adjustment and improvement, 47 centers (stations, sites and institutes) are still functioning. By contrast, there are only 4 enhancement experimental stations subordinate to Chinese Academy of Fishery Sciences (CAFS). In addition, all these 4 stations are situated in Huanghai Sea and Bohai Sea. There is no corresponding institution of enhancement fishery in East China Sea, South China Sea, and provinces and cities along the coast. This is inconsistent with the position of the enhancement fishery as the 5th industry.

3.2 Irregular releasing technology and insignificant enhancement effect In the process of development of enhancement fishery, it lacks comprehensive and in-depth research on biodiversity and ecosystem of sea area and water area. As a result, it is not clear about regional fishery resource volume, there is certain blindness in development, and it lacks effective evaluation on influences of regional ecosystem functions.

In the construction of artificial reefs, it lacks fundamental research about population structure, existing resource reserve, quantity of reef input, and sea area and water area ecosystem. Firsthand data are not complete and grasp of actual situation is not comprehensive. In the releasing of fishery resources, it lacks necessary demonstration and scientific guidance on ecological adaptation of releasing varieties, environmental conditions of water area, and time of releasing fries. In construction of standardization, there are problems of numerous and diverse enhancement releasing varieties, impure germplasm resources, and not outstanding key points, slow construction of standardized technology construction. In releasing specifications and tagging technologies, only Chinese shrimp (*Penaeus chinensis*), Pseudosciaena crocea, and Portunus trituberculatus have established corresponding technological specifications. Besides, fry quality inspection and quarantine work starts slowly, and the scope of inspection and quarantine is narrow.

In the protection and management of enhancement area, it implements related management only relying on fishery administration. Since domestic fishing intensity is high, irregular and unlawful operation occurs now and then. Fries are caught before they grow to adult, which will influence the effect of enhancement releasing. The effort is weak in social propaganda of enhancement fishery, and the awareness of whole people participation is weak. In particular, both enthusiasm and initiative of fishermen and fishery economic cooperatives participating in management are difficult to bring into full play. In consequence, it leads to high administrative cost and insignificant actual effect of enhancement fishery. In the institutional construction, compared with developed countries, China makes slow progress in legislation. China has not issued regulations about catching size of releasing fries, shrimps and shellfishes, and related evaluation mechanism is not established. What's worse, fund for enhancement fishery is not completely incorporated into annual financial budget, leading to unstable personnel, insufficient funds, releasing without management, and influencing overall effect of the enhancement fishery.

3.3 Unclear development orientation and difficult operation of implementing standards At present, both national and provincial level enhancement institutions and city and county level aquatic technical sectors are similar in functions, repetitive in content, unclear in labor division, and indefinite in development orientation in fry production and allocation, temporary fry cultivation facilities of fishes, shrimps and shellfishes. In fry cultivation, implementing entities are indeterminate. Both the state and provincial and city level institutions undertake and produce fries, so it not only wastes enormous scientific research resources, but also wastes limited funds. In the bidding of enhancement releasing and follow-up investigation of releasing fries, it lacks implementation standard and the operability is low.

Limited by personnel, related policies, regional fishery resources, natural conditions and historical factors, fishery sci-tech infrastructure is relatively backward. As a result, it lacks scientific guidance in enhancement releasing activities. In particular, it lacks scientific guidance of enhancement releasing varieties and releasing quantity, and there is large blindness; ecological risk of enhancement releasing lacks evaluation, such as disease and disaster risk, genetic risk, and environmental risk; effect of enhancement releasing lacks evaluation, such as changes of fish resources, and changes of genetic diversity, *etc*.

The above problems seriously influence healthy development

of China's enhancement fishery and restrict sustainable development of the enhancement fishery. Thus, it is required to practically solve these problems, to realize rapid, healthy and coordinated development of China's enhancement fishery, make it become real fishery sector, and make it become new growth point of China's fishery economy.

4 Recommendations

The enhancement fishery is an industrial cluster with diversified structure. It involves wide field and has high industrial effect. Especially, it has inseparable dependence relationship with fishery related industries. Such dependence can be converted to interrelated and beneficial relationship in the industrial interaction and will become an important booster for development of the low-carbon fishery. For the future of China's fishery, accelerating the cultivation of new strategic industry is not only favorable for making full preparation for sci-tech revolution of new fishery, but also favorable for enhancing sustainable development ability. In addition, it plays a great role in promoting regeneration of fishery living resources, adjusting fishery industrial structure, solving the labor problem in fishery area, ensuring constantly increasing fishermen's income, and spurring economic growth of fishery. Specifically, we came up with following recommendations for development of the enhancement fishery.

4.1 Strengthening planning to lead development The enhancement fishery planning is the basis of industrial development, industrial distribution and resource management, the basis of government formulating industrial development policies and promoting productivity development, and also the top priority for changing fishery resource utilization mode and strengthening management of fishery resources. Therefore, making enhancement fishery development plan is favorable for ensuring biodiversity and regional ecological safety, increasing enhancement releasing and resource utilization efficiency, enhancing fishery resource management, realizing scientific, reasonable, standardized and orderly development, promoting increase in farmers' income, and ensuring sustainable development of enhancement fishery and sustainable use of fishery resources.

The development of enhancement fishery should make correct development orientation and strategy selection, and formulate practical and feasible medium and long term development plan according to living rules, habits and distribution scope of marine organism resources and situations of economic fishes and shellfishes in all regions. It is recommended to make clear tasks and measures for promoting the development of the enhancement fishery, study and come up with development path for accelerating the enhancement fishery, and propose development goals, direction and key points by types and stages, give prominence to protection of regeneration of fishery resources and satisfaction of citizens' traditional consumption demands. In addition, project should be implemented in accordance with plan, to strengthen rigid restriction of plan, avoid structural repetition of enhancement resources and waste of resources, and make effort to bring the enhancement fishery to become a growth point of fishery economy and one of major channels for supply of high quality protein.

4.2 Improving legal protection system It is impossible for the enhancement fishery to receive return in the same year, and it will have certain lagging effect. If protection measures are not adequate and continuous, the return from enhancement releasing will certainly have fluctuation, and the protection efficiency will lead to crisis of confidence of the society and fishermen in protection policies. Stability and continuity of development of the enhancement fishery must be guaranteed by legal system. Therefore, it is required to establish and improve legal protection system suitable for actual conditions of China, and to really realize there are regulations to follow and laws to comply with, to ensure the development of enhancement fishery reaches expected objective and effect.

4.3 Increasing financial support The enhancement fishery is a public welfare undertaking. It needs long-term and continuous input. Both the central and all levels of financial budget should set up special fund system for the enhancement fishery as major fund source, and properly increase the support for fundamental research and application research.

Central and local government should not only increase input, but also should actively introduce system and mechanism that is favorable for bringing into play functions of social force, and encourage increasing funds for research and development of enhancement fishery in many channels and approaches. It is recommended to comprehensively use financial and taxation policies, provide preferential measures in taxation and credit, formulate flexible mechanism in talent cultivation, introduction and employment, and establish incentive and subsidy system with clear objectives, direct benefit, diverse types and convenient operation, to attract social capital and fishermen to participate in developing the enhancement fishery.

4.4 Strengthening construction of scientific research institutions The enhancement fishery should set foot on resource, environment, recycle and ecology, focus on deepening sci-tech and extending system reform, increasing sci-tech innovation and achievement conversion effort, and actively encourage and attract enterprises and fishermen to participate, to promote rapid and coordinated development of the enhancement fishery. It is proposed to integrate scientific research and technical extension organizations to set up national enhancement fishery research center, make clear functions of the enhancement fishery center, strengthen application development and fundamental research, and undertake operation of the enhancement fishery. Provinces and cities along the coast and key fishery cities (prefecture cities) should integrate resources, establish corresponding independent institutions as soon as possible, and take charge of coordinating regional enhancement fishery. In addition, it is recommended to strengthen scientific research team construction, heighten the attraction to high level talents, and accelerate comprehensive development of the enhance-

ment fishery.

4.5 Strengthening supervision and management functions The enhancement fishery involves wide area and has great difficulty in management. Thus, it needs strengthening guidance, supervision and management of government, actively explore effective management mode, establish and improve policies and systems including ecological compensation mechanism, and gradually improve the management and coordination mechanism for development of the enhancement fishery. At the early stage of development, government should provide guidance and demonstration, start from scientific research, set up new and independent fry cultivation and temporary stock system, make clear the comparative benefit of input and output, and increase fry survival rate and enhancement releasing effect.

It is recommended to actively protect fishery resources and ecological environment of fishing ground, continue implementing closed fishing system in hot season, properly extend fishing ban period, regulate fishing tools and laws, formulate practical and feasible enhancement fishery supervision management method, take full advantage of fishery compensation fund to undertake the enhancement fishery, and energetically develop recreational and leisure fishery, to realize proper use and effective management of fishery resources. Besides, it is recommended to set up enhancement fishery project consultation and demonstration, social hearing and disclosure system, widely listen to opinions of all parties, and consciously accept social supervision, and improve feasibility, scientific nature and transparency. In addition, it should strengthen inspection of enhancement fishery project and promptly know industrial progress, fund use and effect evaluation.

4.6 Establishing sci-tech evaluation system Research and practice show that economic means is more effective than other policies in enhancement releasing management. Public welfare nature of the enhancement fishery determines that it is required to establish scientific, rational and effective input and output evaluation system, and further make clear and grasp economic, social and ecological benefits of the enhancement fishery.

When establishing scientific evaluation system, it needs considering different benefits, making quantitative and qualitative analysis, and adhering to scientific and quantitative orientation. Stressing qualitative analysis is a mark of scientific decision making of policies. No matter the policy decision making or policy selection, it needs qualitative analysis, because the purpose of qualitative analysis is to make more accurate qualitative analysis on policy decisions.

Besides, it is required to attach importance to evaluation of economic, social and ecological benefits, especially the latter two aspects, and pay adequate attention in methods and systems. Through scientific and systematic analysis on regional population protection, fine variety selection and cultivation, fry quality improvement, and input and output benefits different from operation and evaluation system for breeding industry, it is helpful for healthy and prosperous development of the enhancement fishery.

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of monopoly of rural information resources. Therefore, it is recommended to strengthen the effort in integration of rural information resources, to provide information resource service for realization of rural modernization and informationization.

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