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# Recommendations for Development of Stock Enhancement Fishery in China

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**Abstract** In 2011, China put the stock 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. Developing the stock enhancement fishery is a strategic measure for restoring and protecting fishery resources, expanding fishery, replacement environment cost, and promoting sustainable development of fishery. At present, cultivation and development of the new rising industry, the stock enhancement fishery, has certain comparative edge, excellent economic foundation and broad development space in China.

**Key words** Stock enhancement fishery, Sustainable development of fishery, Plan guidance, Improvement of laws and regulations

## 1 Concept and development path of the stock enhancement fishery

**1.1 Concept** The stock 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 stock enhancement fishery in the world. With reference to definition of the stock enhancement fishery in some countries and realities of China, we can define the stock 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 stock 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.

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

ment organisms; (iv) protecting and improving living environment of fishery resources<sup>[3]</sup>.

## 2 Main problems

In the situation of constant decline in fishery living resources, increasingly strict international fishery management, and rigid increase in demands of aquatic products, the source of China's aquatic product supply will largely rely on increase in yield of the stock enhancement fishery. After entry to the new century, all areas constantly increase input to the stock 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 stock enhancement activities of fishery resources started from the late 1980s and the middle of the 1990s. In 2006–2015, China invested a total of about 6 billion yuan, released 300 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. However, compared with other fishery sectors, there are some problems such as small construction scale, unreasonable distribution, unclear positioning, non-standardized technology, and management not in place and ineffective in the stock enhancement fishery.

### 2.1 Small construction scale and unreasonable distribution

With vast sea (water) area, China has complex and diversified ecological environment, including Yellow Sea, Bohai Sea, the East China Sea, South China Sea and Kuroshio ecosystems, the biological resources and types are numerous. The biological resource protection has different emphasis points. In China, there are 23 national level aquatic nature reserves and 492 national level aquatic germplasm resource protection areas with more than 100000 square kilometers. 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. In the construction of marine protection area, compared with the United States, the number of China's protection zones is 150% more than 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 has formulated Marine Protection, Research and Sanctuaries Act. As to the industrial distribution, Japan built the stock 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 under the jurisdiction of Chinese Academy of Fishery Sciences (CAFS). In addition, all these 4 stations are situated in the Yellow Sea and Bohai Sea. There is no corresponding institution of stock enhancement fishery in East China Sea, South China Sea, and provinces and cities along the coast. This is inconsistent with the position of the stock enhancement fishery as the 5th industry.

## 2.2 Technologies not standardized and effect not significant

In the process of development of stock 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*), *Pseudosquilla scrocea*, 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, leading to serious invasion of alien species. Both national and local governments invest large funds in developing the stock enhancement fishery. However, due to random releasing permit, fry quality, and procurement metering, the releasing effect calculation is increasing and the marine environment pollution is serious, and the survival rate of releasing fries is relatively low. Due to impact of funds and technologies, the types and number of enhanced releasing are difficult to guarantee, and the scale is small and the function is limited.

**2.3 Indefinite positioning and difficult management** Through

taking measures of fry cultivation and releasing and establishing artificial fishing reef and marine ranching, the stock enhancement fishery realizes stable production of offshore fishery, increases market supply of fishes, shrimps, and shells, realizes protection of fishery resources and living environment, and sustainable development of fishery. 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 stock enhancement releasing and follow-up investigation of releasing fries, it lacks implementation standard and the operability is low. 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, funds for stock enhancement fishery are not completely incorporated into annual financial budget, leading to unstable personnel, insufficient funds, releasing without management, and influencing overall effect of the enhancement fishery. The above problems seriously influence healthy development of China's stock enhancement fishery and restrict sustainable development of the stock 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.

## 3 Recommendations

The stock 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 addi-

tion, 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. Developing the stock enhancement fishery is not only the result of the practice in the past, but also starting point of practice, as well as the direction of future practice. The overall idea for development of China's stock enhancement fishery should take the Scientific Outlook on Development, follow the principle of "scientific planning, reasonable distribution, giving prominence to key points, and overall development", take reasonable utilization and benefits of fishery resources as the center, take the management of marine ecological environment and resources, bring into play the advantages, provide powerful support for sustainable development of fishery and constant increase in fishermen's income, and start the new situation of development of stock enhancement fishery. The development path of the fishery resources should take the enhancement fishery resources as main body, stick to the mechanism of "department linkage, policy integration, fund gathering, and resource consolidation", promote construction of stock enhancement fishery industrial system, and make clear construction entity, construction type, and construction scale, to realize benign cycle of effective resource protection and reasonable utilization.

**3.1 Strengthening planning to lead development** The stock 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 the stock 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 stock 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 stock 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 stock enhancement resources and waste of resources, and make effort to bring the stock enhancement fishery

to become a growth point of fishery economy and one of major channels for supply of high quality protein.

**3.2 Improving legal protection system** The stock enhancement fishery is a new fishery and complex project. It involves many fields. Pull one hair, it moves the whole body. The non-excludability and consumption competitiveness of marine fishery resources lead to excessive use of fishery resources and bring about problem of "tragedy of the commons". At the same time, the production of stock enhancement fishery management has great difference compared with aquaculture fishery. If protection measures are not adequate and continuous, the return from stock enhancement releasing will certainly have fluctuation, and the protection efficiency will lead to crisis of confidence of the society and fishermen in protection policies. It is impossible for the stock enhancement fishery to receive return in the same year, and it will have certain lagging effect. Stability and continuity of development of the stock enhancement fishery must be guaranteed by legal system. However, there is no definite provision in existing fishery laws and regulations. The existing aquatic resource protection and management system mainly relies on government functions. The management cost is high. Fishermen have realized the importance of resource protection, but due to characteristics of fishery resources, the implementation of fishery laws and regulations is not ideal. Therefore, it is recommended to establish and improve legal protection system suitable for actual conditions of China, to really realize that there are regulations to follow and laws to comply with, to ensure the development of enhancement fishery reaches expected objective and effect.

**3.3 Increasing financial support** The stock 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 stock enhancement fishery as major fund source, and properly increase the support for fundamental research and application research. At present, China's fishery science and technology is relatively weak. An important reason is little R&D fund, staff instability, and weak sustainability and research ability. 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 stock 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 stock enhancement fishery.

**3.4 Strengthening construction of scientific research institutions** The stock 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 stock enhancement fishery. It is recommended to integrate scientific research and technical extension organizations to set up national stock enhancement fishery research center, make clear functions of the stock enhancement fishery center, strengthen application development and fundamental research, and undertake operation of the stock 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 stock 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 stock enhancement fishery.

### 3.5 Strengthening supervision and management functions

The stock 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 stock 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 stock 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 stock enhancement fishery supervision management method, take full advantage of fishery compensation fund to undertake the stock 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 the stock enhancement fishery project consultation and demonstration, social hearing and disclosure system, widely listen to opinions of all parties, and con-

sciously accept social supervision, and improve feasibility, scientific nature and transparency. In addition, it should strengthen inspection of the stock enhancement fishery project and promptly know industrial progress, fund use and effect evaluation.

**3.6 Establishing scientific evaluation system** Research and practice show that economic means is more effective in management of stock enhancement than other policies. Public welfare nature of the stock 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 stock 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 the quantitative analysis is the mark of scientific decision making. Whether it is policy decision or policy choice, it needs quantitative analysis because the purpose of quantitative analysis is to make the policy decision more accurate qualitative determination. Besides, it is recommended to attach great importance to the evaluation of economic, social and ecological benefits, especially the latter two, and give adequate attention to methods and systems. It is recommended to make scientific and systematic analysis of regional population protection, seed selection and breeding, seed quality improvement, input and output efficiency through independent and different aquaculture industry. It is helpful for healthy and prosperous development of the stock enhancement fishery.

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