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Editorial: Fisheries ecological environment in South China Sea

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Editorial on the Research Topic
Fisheries ecological environment in South China Sea

The South China Sea is a marginal sea of the Western Pacific Ocean, encompassing around 3.5 million km^2. The sea is of abundant fishery resources and provides many important sites for the coastal aquaculture industry. Most of the countries in the coastal fringes of the South China Sea are developing or underdeveloped economies that are home to about 270 million people. Therefore, the fisheries and aquaculture industry is a crucial sector for the development of coastal countries. Millions of people derive their main income directly or indirectly from fisheries. The development of fisheries and aquaculture in the South China Sea has driven significant increases in food and nutrition and has improved livelihoods, employment, and local economic development among the coastal countries.

However, the intensive anthropogenic activities have posed dramatically negative impacts on the fisheries and environment in the South China Sea and weakened the development potential of fisheries and aquaculture around the coastal countries and the people's livelihoods in the future. To make fisheries, ecosystems, and resident livelihoods sustainable, there is a need for new ideas to face the challenges of fisheries and the South China Sea environment. This particular Research Topic of Frontiers in Environmental Science Section Fisheries Ecological Environment in the South China Sea includes thirteen original research articles, two methods articles, and two reviews.

Pressures from human activities not only decrease the diversity of community structure and environmental pollution to make the ecosystem worsen but also introduce hazards into the environment. With rapid industrial and economic development, the coastal bays around the South China Sea are also subjected to the potential risk of heavy metal pollution arising from anthropogenic activities. Wang et al. found that hazardous elements such as Cd, Cr, Hg, As, Cu had been all detected in Daya Bay. Their concentrations are affected by human activities such as sewage outlets, water

channel dredging, and shellfish farming, which has made Daya bay at moderate ecological risk or a considerable ecological risk. Special concerns should be paid to the rare Earth elements. Elements like La, Nd, Sm, Ho, Er, and Lu has been detected in the seawater environment of the South China Sea (Li et al.). These rare Earth elements have been extensively used in several industries and high-tech devices, such as petrochemical, ceramic, metallurgy, laser, and fiber optic industries. However, little is known about their function in the ecosystem.

Antibiotics are an effective approach for the prevention and treatment of various bacterial diseases in aquaculture. However, the overuse of antibiotics leads to increased antibiotic residues in the environment. Teicoplanin, a glycopeptide antibiotic, has been detected in environmental water (Jin et al.). The introduction of antibiotics into the water environment would not only increase drug resistance of microorganisms but also affect the growth of miniature aquatic organisms, such as zooplankton and phytoplankton. Shan et al. found that the number of phytoplankton increased but their biodiversity reduced when sulfamethoxazole and enrofloxacin were fed into the culture environment. These two antibiotics cause water pollution by affecting the species and quantity of phytoplankton and changing the dominant species and community structure, which would endanger the living environments of aquatic organisms and increases the dietary risk from fishery products. Therefore, to protect the fishery ecological environment should be paid more attention to antibiotics residue.

Xu et al. analyzed the data collected by four trawl surveys during 2016–2017 in Daya Bay, a typical bay on the coast of the South China Sea. The fish structure in the bay presented miniaturization and a low-weight trend, and the fish community structure was dominatingly composed of smaller size fishes. Rao et al. also found that small body sizes, short longevity, and high tolerance animals were more abundant in macrobenthic communities in the disturbed area of Daya Bay. Similar results have been found in the Rongjiang River estuary reaching the South China Sea. Li. et al. found that nearly 90% of animals in benthic communities were Mollusca and Arthropoda species in the sediment of the Rongjiang estuary. And in eutrophic regions, the survival of sensitive benthic species is restricted, and they are gradually replaced by tolerant species.

As shown above, anthropogenic activities have imposed great pressure on the ecological environment of the fisheries of the South China Sea. The degradation of fishery resources and environment may result in a wide range of social and economic consequences in the countries around the South China Sea. Sustainable fisheries contribute to the marine ecosystem functioning and the livelihoods of the millions of fishermen. Therefore, much innovative thinking has been proposed to solve the challenges of the ecological environment of the fisheries of the South China Sea.

He and Zhang proposed to revamp the fisheries law of China to combat illegal, unreported, and unregulated (IUU) fishing. They gave three main design and operation features. Firstly, an unbroken and immutable electronic information capture, transmission, and verification system linked to the nationwide fisheries legality label and its local subsidiaries, to ensure traceable and trackable seafood movement inside and outside China. Secondly, a precautionary and market-responsive approach to engaging public, private, and societal partnerships in adopting sustainable seafood production and consumption practices, and incentivizing nationwide awareness and whistleblowing of IUU catches, especially from imported sources. Finally, a collaborative inter-agency model of information sharing, regulatory coordination, and legal enforcement to embed seafood traceability in multiple relevant legal regimes and across all responsible governmental agencies in China. Through the technology-enabled traceability and market-responsive solutions, it may help to mitigate illicit capturing and transaction events and decrease the potential of overfishing. I think it is suitable for all countries around the South China Sea.

Solutions to fishery resource proliferation and environment restoration were also proposed. In order to fishery resource proliferation, the summer fishing moratorium system began in the South China Sea in 1999. Now the system has become the most important and influential fishery resource conservation system in China (Zhu, 2009), and made a great contribution to alleviating the enormous pressure on marine fishery resources caused by the excessive fishing intensity and protecting China's offshore fishery resources, especially the spawning fish and juvenile fish. However, the system still has much more space to be improved. Wang et al. investigated the life history of the estuarine fish from the western Pearl River estuary. They found that the spawning period of the fish is from March to September, which was longer than the summer fishing moratorium of Pearl River. Therefore, if this species is to be better protected and managed, the moratorium period needs to be extended. Zhang et al. found that the three-and-a-half-month fishing moratorium has led to an income reduction for fishermen and illegal fishing boat poaching increase. Therefore, the summer fishing moratorium system should be improved by adjusting the subsidies for fishermen and moratorium duration to find a balanced system between fishermen, people, and the system so that it can be sustainable.

Fish stock enhancement is another effective tool in fishery resource proliferation, which could enhance the wild population, increase food fish supplies, and improve the fishermen's livelihood (Booth and Cox, 2003; Leber, 2011; Kitada et al., 2019). Marine fish release is one important method of fish stock enhancement. However, the success of fish release is affected by many factors such as release timing, habitat environment, fish species, and fish health condition (Camp et al., 2013). Zhang et al. proposed an optimizing release strategy of black sea bream in the northern South China Sea. Firstly, the period from June to October was recommended for black sea bream releasing. Secondly, multiple release sites and

release batches could reduce the drastic increase in mortality rate due to over-high stocking density. This improvement in fish release would increase the survival rate of fish as well as the fish stock enhancement.

Another important measure for fish stock enhancement is protecting the fish population. The continental shelf of the northern South China Sea is a key habitat for nearly 1,500 fish species (Sun and Chen, 2013). This region is an important spawning and nursing ground for numerous fishes (Zhang et al., 1985). Therefore, the protection of spawning zones is also very important for fisheries ecology and fishery resource proliferation. Xu et al. found the population of *E. cardinalis* concentrated in the northern Beibu Gulf to spawn from November to February. In early spring, parent fish mainly occur in the northeast of the gulf after spawning and juveniles concentrate in the shallow nearshore of this area in late spring. Hou et al. identified the eggs and spawning zones of Hairtail fish in the Northern South China Sea. They found that the spawning grounds of the fish shifted with hydrological conditions. In spring, eggs of *T. japonicus* and *T. nanhaiensis* occurred at central and southern Beibu Gulf water mass and South China Sea surface water mass, while in late summer-autumn, their eggs mainly occurred in the waters of South China Sea surface water mass. The results could help us to adjust the timing and spawning zone of the fish and enhance the protection.

The restoration of the environment could have a great positive effect on the benefit to fishery resource proliferation and the ecology system of the South China Sea. Ren et al. investigated the fish assemblages in subtidal seagrass meadows surrounding the West Sand, South China Sea. A total of 843 individuals from 25 fish species belonging to 22 genera, 11 families, and ten orders were recorded in seagrass meadows. And the fish abundance was highly correlated with the seagrass coverage. It indicated that seagrass meadows could greatly enhance the biological diversity and biomass in the sea environment. Moreover, 80.36% and 46.13% of total individuals collected by beach seine and underwater visual census methods were earlier-stage juveniles, less than half the sizes of their total length at maturity, respectively. It indicated that the seagrass meadows at West Sand were very important fish nursery grounds and have played a very important ecological service.

Wu et al. investigated the composition of fish intestinal microbiota from waters along the Pearl River Estuary and tried to reveal water microbiota influences fish intestinal microbiota in different estuary habitats. The microbial exchange showed an increasing tendency from the upstream to downstream points. It indicated the potential of fish adaption to the environment increased. It provides a new view to restore the fish population in the estuary zone.

Meng et al. studied the interaction effects of environmental factors on beneficial algae and harmful algae. It was found that temperature, light, nutrients, and pH significantly influenced the competition inhibition parameters of Chlorella vulgaris and Anabaena sp. strain PCC 1042. Therefore, the growth of Chlorella vulgaris and Anabaena sp. strain PCC can be controlled by changing the environmental factors so as to mediate the water quality.

Sun et al. have studied the changes in microbial ecology driven by the culture environment. The study demonstrated that aquaculture considerably altered physicochemical factors, induced changes in bacterial community composition, and increase the metabolic capabilities of the bacterial Communities in pond water. It provides a scientific basis for the management of aquaculture environments and could be helpful to the water quality management of aquaculture areas.

As mentioned above, the scientists in the c have dedicated to fishery resource proliferation and ecological environment protection. However, these are far from enough, because it is a very complicated project to restore the ecological environment of the fisheries of the South China Sea. It needs long-term endeavors from many scientists from different research fields. Therefore, the aim we proposed such a Research Topic is to raise concerns about the ecological environment of the South China Sea and work together to protect the sea we live on.

Author contributions

CK wrote the manuscript of the Editorial, the other guest editors of the Research Topic reviewed and revised the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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