Ref. No.: 2018_91007_04_Subcontract

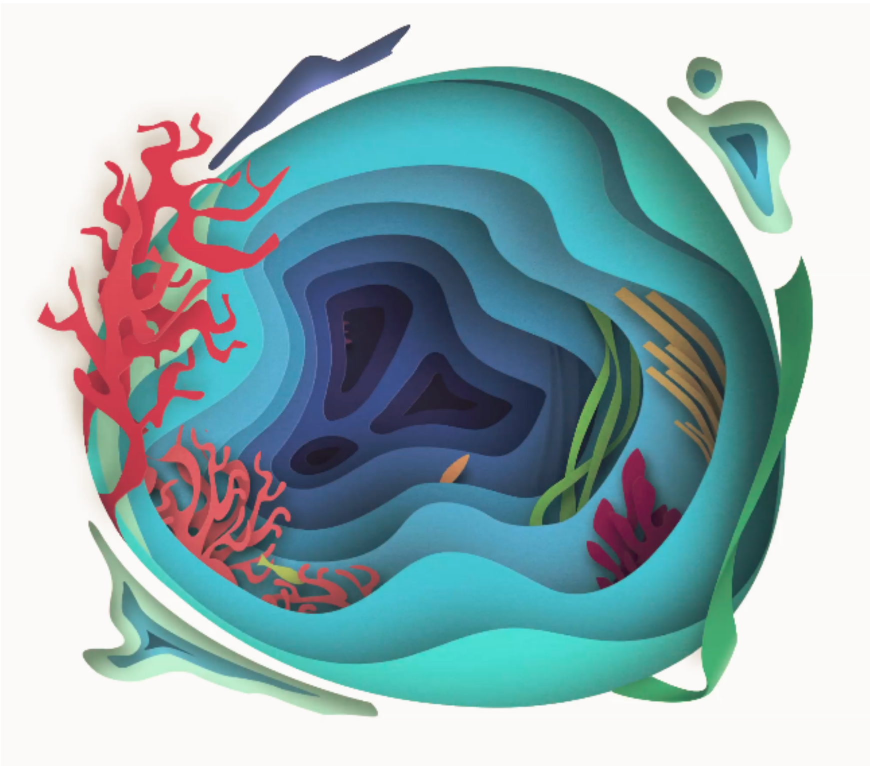
INTERIM REPORT

(Pictured by P. Zuo)

Sponsor: UNDP/GEP, UNOPS, YSLME
Reporter: Nanjing University, Yantai University
08 September 2019

Project title:

Governance and Socio-economic Assessment of Fishing Vessel Buy-back Scheme and Fish Restocking, Mariculture and Climate Change Impact Adaptation Measures in Dalian, Weihai and Dandong of PR China



Contents

1. Contract time limits

The United Nations Office for Project Services ("UNOPS") and Nanjing University have signed the contract with the time span of beginning of 21st of September 2018 and completing the Services no later than 30th of November 2019.

2. Current stage documents

2.1 Research sites

Under supervision of the Chief Technical Advisor and technical guidance of RWG-F in close collaboration with the local project team on demonstration of IMTA, restocking, climate change adaptive management, the subcontractor will conduct the following activities:

Demonstration sites: There might be little changes according to specialists. Here are some of the following demonstration sites, managers, fishermen and other stakeholders we have visited:

We have visited 6 fishery villages in Jiangsu, Shandong and Liaoning provinces (2 in each province) and 2 companies involved in fishery and aquaculture from December in 2018 to January in 2019 (table 2.1). There are 2 national fishing central ports, Xiakou village and Haitou town, in Jiangsu province. Xiakou village is a typical fishing village with long fishing tradition and have a well-organized captain-crew union in village level. We visited two typical fishing villages, Dayudao and Dongchudao village, which turning to be multi-business forms instead of traditional fishing activities, such as fishery enterprises, street venders, house renting facing crews, fishery shops, etc. 2 enterprises, Xinfa Group and Xunshan Group, belongs to one of the 2 largest companies which both developing from township factories. However, the 2 companies evolved into two different business forms with one focusing on fishing and the other on marine aquaculture. We visited Dandong city, Liaoning province, which connecting with the North Korea by Yalvjiang River. There are more than 1000 ships docking at Dandong Fishing Port. Erjiegou village lies in Liaohe River estuary focusing on traditional fishing activities.

However, some of the fishermen work as migratory workers who go out for fishing at Shandong province during fishing season and return during the Spring Festival and midsummer moratorium season.

There are clear gap among those three provinces surrounding the Yellow China Sea within both natural conditions and economic levels based on our investigation. It is easily to describe the typical gradient pressure analysis based on spatial and temporal changes along the Yellow China Sea coast from Jiangsu to Liaoning province, which reflecting the social-economic conditions with GDP and ecological pressure.

Table 2.1 The Basic information of demonstration sites

Sites	Survey	Attributes	Basic info.	Interviewee
Xiaokou village, Jiangsu	Questionnaires; Semi-structured interviews; Annual household survey	National central fishing port	≈5000 persons totally involved in fishery	≈ 138 including all stakeholders
Haitou town, Jiangsu	Semi-structured interviews	National central fishing port	≈8000 persons totally involved in fishery	Fishermen, Aquacultural pond owners
Dongchudao Village, Shandong	Questionnaires; Semi-structured interviews; Annual household survey	National historical village	≈450 persons almost none in fishery, involved in tourism and fishery processing factories	≈ 82 including all stakeholders
Dayudao Village, Shandong	Semi-structured interviews	Traditional fishing village	≈6000 persons totally involved in fishery and fishery processing factories	Fishermen
Xinfa Group, Shandong	Semi-structured interviews	Fishing and fishery processing enterprise	≈1000 ships, 4 branches for fishery processing chain	Managers, fishermen
Xunshan Group, Shandong	Semi-structured interviews	Aquacultural fishery and marine ranch	≈3000 workers, focusing on marine ranches	Managers, Aquacultural fishermen
Dandong, Liaoning	Questionnaires; Semi-structured interviews	Fishing port	≈1000 ships	≈ 122 including fishermen
Erjiegou Village, Liaoning	Semi-structured interviews	Fishing port	≈600 ships	Fishermen and Managers

Some basic information will be explained in detail of those differences in the following section.

2.2 Research methodologies

Surveys and semi-structured questionnaires: Questionnaires related to fishing vessel buy-back scheme and fish restocking (attachment 1), statistic yearbooks (Chinese Fishery Statistical Yearbook, 1985-2018), typical household daily budgets (attachment 2), demographic characteristic changes in village level references in networking news and professional journals (CNKI database, newspapers, policy collection), etc..

Methods: We selected Lianyungang (Jiangsu Province), Weihai (Shandong Province), Dandong and Panjin (Liaoning Province) as study cases, using questionnaires (with 500 in total and 346 return in validity, Dandong and Xiakou) and semi-structured interviews (56, all sites), coupled with the method of literature and other research methods. The aim is to conduct a research on the relationship of fishing vessel buy-back scheme and fish restocking, mariculture and climate change impact adaptation measures in Yellow Sea Large Marine Ecosystem (YSLME).

Based on marine ecosystem-based management, we will try to secure the important indicators relating to fishing vessel buy-back scheme and fish restocking, mariculture/aquaculture and climate change impact adaptation measures (figure 2.1&2.2).

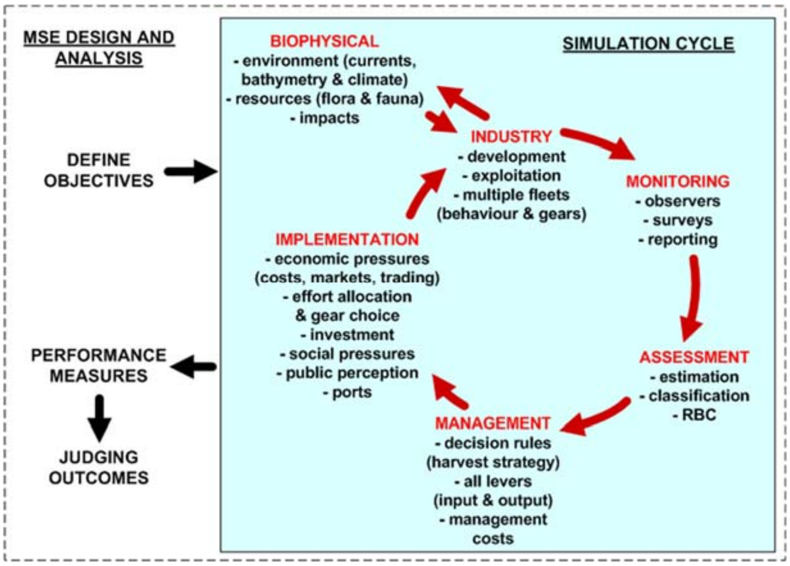


Figure 2.1 Framework of management strategy evaluation

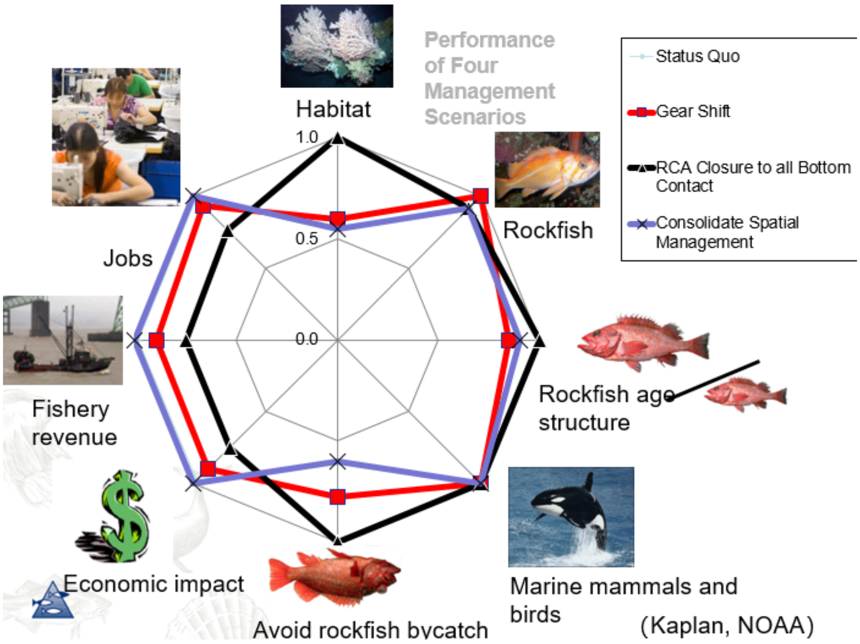


Figure 2.2 Framework of alternative management scenarios

3. Fishery development in YSLME (Chinese side)

One third of the world's marine fish stocks are overfished today, compared to only 10 percent in 1974. From *SDG 14*

3.1 Fishing background of the world

Sustainable development of fishery has significant implications on us since it supports livelihoods, food security and human health worldwide with the early times of Homo Erectus. However, the growth of global marine catch has already reached zero in 1994 based on FAO report (Figure 3.3). The world marine catch kept between 77 and 88 million tons since then. Marine ecosystem deterioration in both fishery resources and marine environment continues in recent years with even more serious tendency. The fishing catch also remained steady with about 80 million tons (FAO, 2018). There was a clear increase of marine aquaculture products since 1985 in global level. Why? The report is trying to answer the following questions:

- What should we do considering the higher demand of marine fishery resources while facing overfishing and marine ecosystem degradation?
- Which countries are supplying those marine aquaculture goods?
- What kinds of those marine organisms support or produce foods for marine aquaculture?

- How much does those feedings come from by-products of marine catches?
- What about the tendency in the surrounding area of the Yellow China Sea in China?
- What should the stakeholders do in order to improve the feasibility of restoring fish stocks?

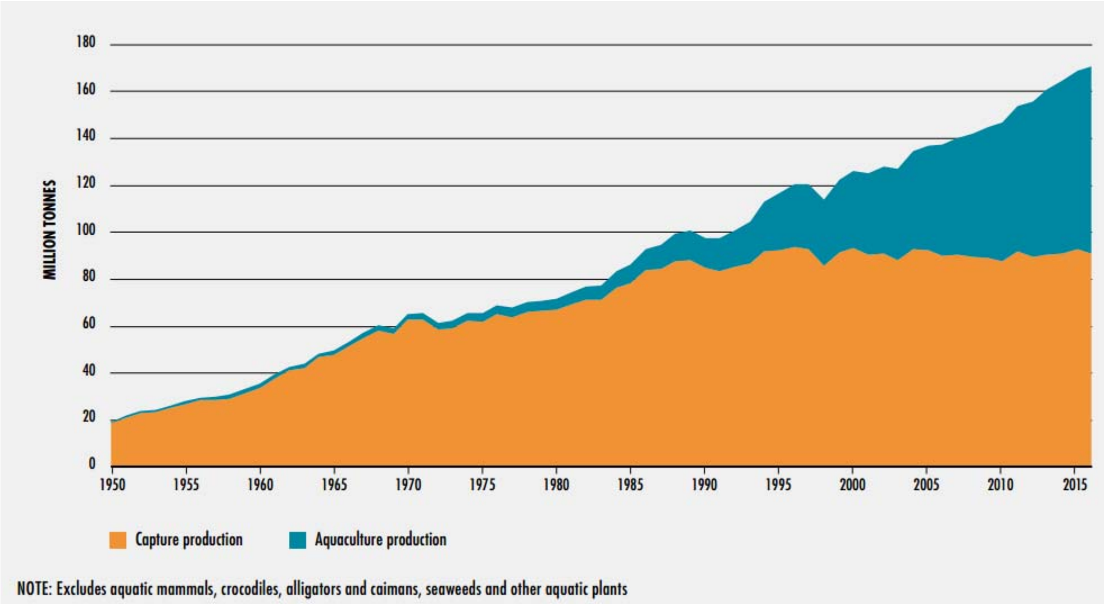


Figure 3.3 World fishery captures and Aquaculture products (FAO, 2018)

Note: We will continue on the analysis of this item in following section 4 & 5.

3.2 Fishery catches from 1985 to 2017 in YSLME (Chinese side)

3.2.1 Fishery catch tendency

There are 5 provinces/cities surrounding the Yellow Sea in China, Jiangsu, Shandong, Hebei, Liaoning provinces and Tianjin city. Tianjin city is a municipality directly under the central government, and it has the smallest marine area and marine fishery occupies less in its GDP. Here we combined the fishery catches of Hebei and Tianjin together comparing with other three provinces.

Figure 3.4 showed the marine catches in 4 districts (data of Hebei and Tianji was added together due to figure appearance since both of two province/city owning lowest catches). The total fish catch reached 1.26×10^{8} t during 1985-2017 with the peak of 5.97×10^{6} t in 1998. Fish landing in Shandong Province was the highest among the 4 areas. Fish catch in Liaoning Province occupied almost the half production of that in Shandong Province, which taking up the second place. Fish landing in Jiangsu, Hebei and Tianjin kept stable with less fluctuation. However, there was a clear increasing tendency of fish landing from 1985 to 1998, flowing a slowing decrease since 2000.

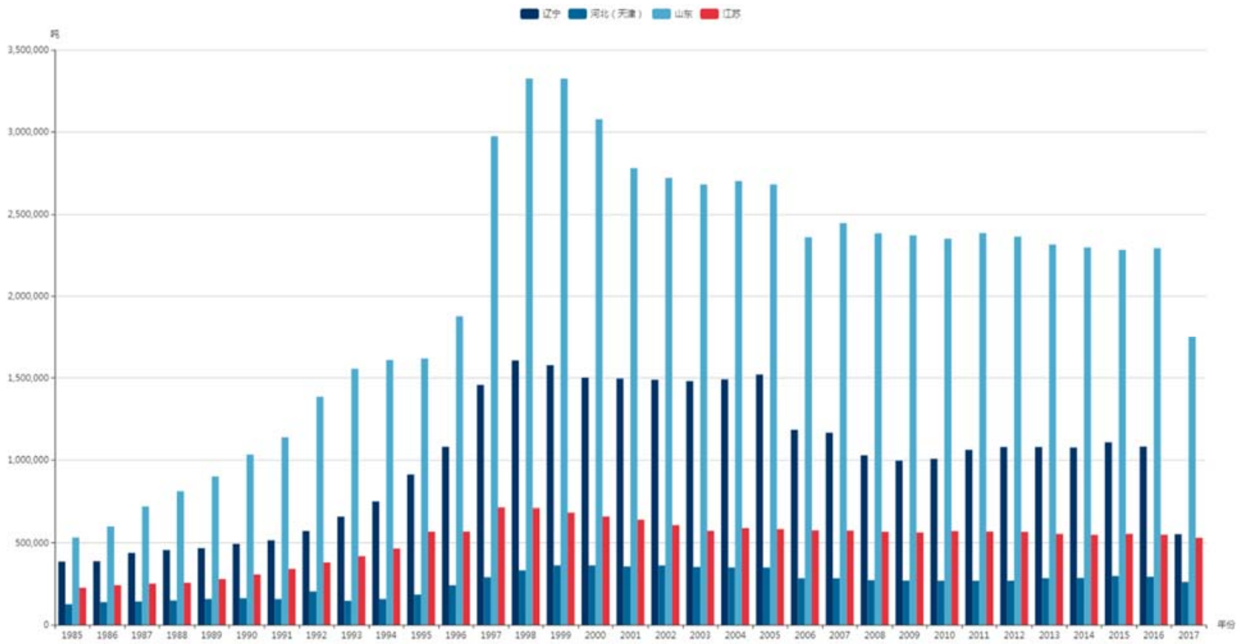


Figure 3.4 Fishing catches surrounding the Yellow Sea from 1985 to 2017

Correlation of marine fish landing changes of semi-interviewed information from fishery workers (36 persons, covering Jiangsu, Shandong and Liaoning Province):

If we compare the fishery resources changes based on localized knowledge, we can find a clear tendency between increasing fishery landing and decreasing fishery resources from 1960s to 2010s (Figure 3.5). The income of local fishery families increased from 5000-6000 in 1960s to 60000-70000 Yuan/year in 2010s, with more than 10 times growth in less than 6 decades. All interviewees admitted that their living conditions had been improved a lot comparing to that before 1980s. National open policy issued in the beginning of 1980s had great impacts to their daily life in many aspects.

However, more motivation for fishery landing also increased with more capital investments for larger ships, more advanced fishery gears and enlarged fishing areas in Yellow Sea since 1980s. There was a steady state with both fishery resources and family income during 1960s and 1970s. Some typical economic fishery species, such as large yellow croaker (*Larimichthys crocea*), showed population degradation even during 1960s and 1970s. However, local fishermen did not have that knowledge of the fishery degradation tendency. They were keeping on selling-small-ships and buying-large-ships for more fishes since 1980s. That was the higher increasing fish landing during 1990s (Fig. 3.4) and the decreasing fishery resources since 1990s. The fish landing after 2000s was also decreasing due to intensive catch in 1990s. But why the family income were still increasing?

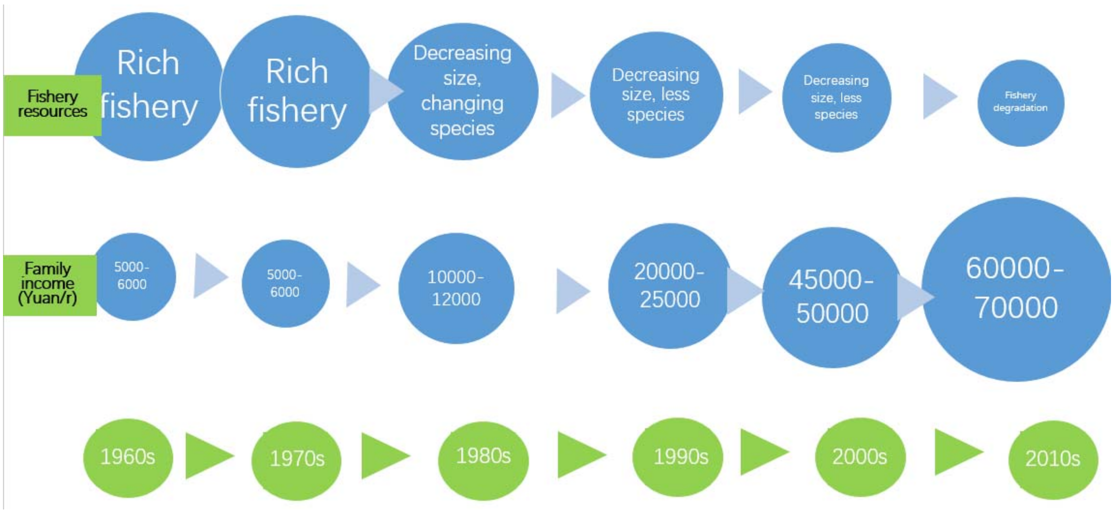


Figure 3.5 Fishery resources changes and fishery family income based on semi-interview from 1960s to 2010s

Many fishermen changed for other occupations rather than fishery since 2000s. Most of them knew that fishing as lifelong career was not sustainable, as they exactly knew fishery resources decrease with first-hand data during their usual fish catch. Village-based enterprises for fish catches, fish processing, fishing supplies, etc. appeared between the middle of 1990s and 2000s. Village-based enterprises evolved quickly with more capital investment input from government. They could hire professional crews and afforded advanced ships for open-water fishing. Women stayed in villages could work in village factories with household subsidies. What's more, marine aquaculture also appeared and developed quickly in coastal waters with technical support from scientists. Improved family income in recent years has a clear correlation with diversity occupations of local stakeholders. That's the reason why the fishery resources was decreasing but their income as still gaining since 2000s.

3.2.2 Average fish landing in study areas

The average marine fishery catch (1985-2017) showed as Shandong > Liaoning > Jiangsu > Hebei > Tianjin, which Shandong province occupying the highest products with 2.05×10^6 t/a, and Tianjin with only 0.03×10^6 t/a (Table 3.2). The average fish production in Liaoning reached 1.00×10^6 t/a, which took half amount of that in Shandong Province. However, the marine areas of Shandong Province is almost 7.79 times larger than that in Liaoning Province. The fish production in Liaoning Province seemed to be half of that in

Shandong province from 1985 to 2017. How could the fishermen in Liaoning province fishes so much with less marine areas than that in Shandong?

Table 3.2 Social-economic status, marine catches and ships in surrounding provinces in the Yellow China Sea (1985-2017)

Provinces	Average marine catches (×10^6 t/a)	Ship power (×10^4 kw/a)	Length of coastal line (km)	Marine areas (km^2)	population (×10^8)*	GDP (×10^{12} Yuan)*
Jiangsu	0.51	53.93	954	7500	8051	9.26
Shandong	2.05	115.49	2531	1170000	10047	7.65
Hebei	0.22	27.67	487	7000	7556	3.61
Tianjin	0.03	4.94	154	3000	1560	1.88
Liaoning	1.00	78.67	2017	150200	4357	2.53

*Note: Population and GDP data was based on 2018.

Figure 3.6 showed the average fishing catcher in the five districts surrounding the Yellow Sea. Shandong and Liaoning were the two largest fishery provinces, then following Jiangsu Province although it also has long coastal line and large marine areas. The fishermen's eager for high fishery production was not so much higher than those in Liaoning and Shandong. Their consciousness for fishery resources protection was much higher than that in other two provinces. Local fishermen were preparing different fishing nets for concrete fishery. They seemed more agreeable to various fishery regulations.

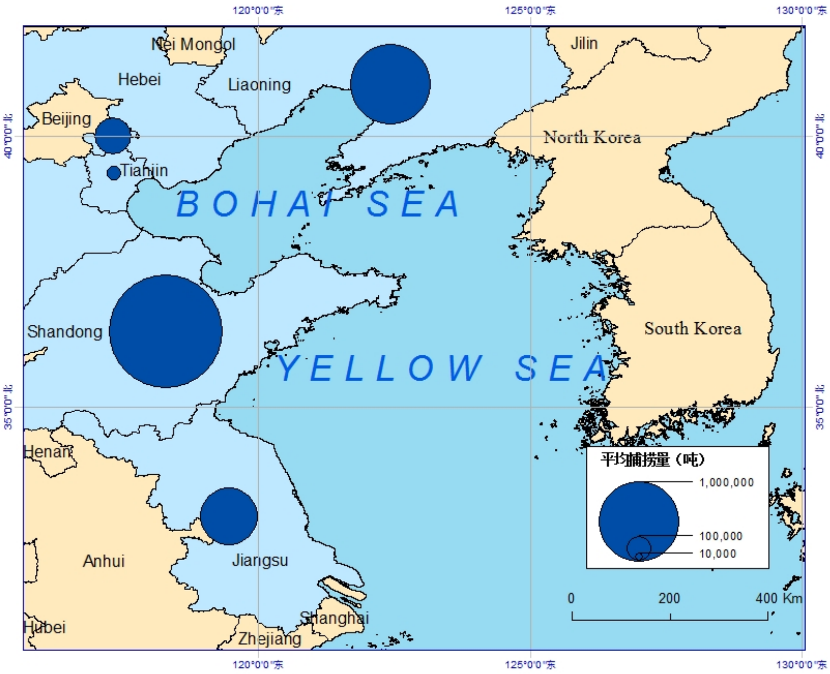


Figure 3.6 Average fishing catches surrounding the Yellow Sea (1985-2017)

An interesting interview finding: Fishing immigration from Liaoning to Shandong Province driven by fishing resources degradation

We met some fishermen in Weihai, Shandong Province. They were from Liaoning Province and went to Shandong for marine fishing. Most of them drove their boats across Bohai from Liaoning to Shandong Province after the Chinse Spring Festival (Figure 3.7). They rent rooms from local Shandong villages, going for fishing every two or three days, forming an alien community by living together in deck area. Their catch could only be sold to the village enterprises or appointed dealers who owned the decks where they could park their ships. Their shops were usually a little smaller and poorer which could only go fishing in near marine waters. They would go back to Liaoning Province during the banned fishing season (May 1^{st} to Sep. 1st) or find some other jobs in guest places. They would go fishing again from Sep. 1^{st} to the next Chinese Spring Festival in guest places. We called these fishermen fishing in guest places as fishery immigration.

We could not imagine how many fishery immigration from Liaoning Province were there every year fishing in Shandong Province. However, a non-ignoring information is that the fishery immigration told us they moved to Shandong for fishing since the beginning of 2000s with less or non-fishing resources in their own marine waters (Liaoning Province, Bohai Sea). Most of them were engaged in 3 or 4 day-catching with very small fishing mesh for small shrimps with less than 1 cm in size, such as *Acetes chinensis* (Yanzi Xia or Meng Xia, in Chinese). Those small shrimps were directly sent to local factories for fish feed, shrimp skin or shrimp paste. The fishermen told us they came to Shandong for small-size shrimp fishing just because of less of those fishery resources in Bohai Sea (Figure 3.8). Their fishing depth reached about 50-100 meters with less than 5 mm fishing mesh (Figure 3.9). The less-than-5-mm fishing nets were common in Shandong and Liaoning Provinces. We found some bottom species, such as *Lophius litulon*, were caught as a by-product selling in local markets or sundried by fishermen themselves (Figure 3.8). Such kind of fishing activities might provide a knowledge of less large/middle/economic marine species in marine water column left, thus they changed for bottom species. What's more, the worst information was that they fishing frequency was 3-4 days for a return with about 7000 kg of fishing catch of those bottom species, even working secretly and illegally in banned fishing season.

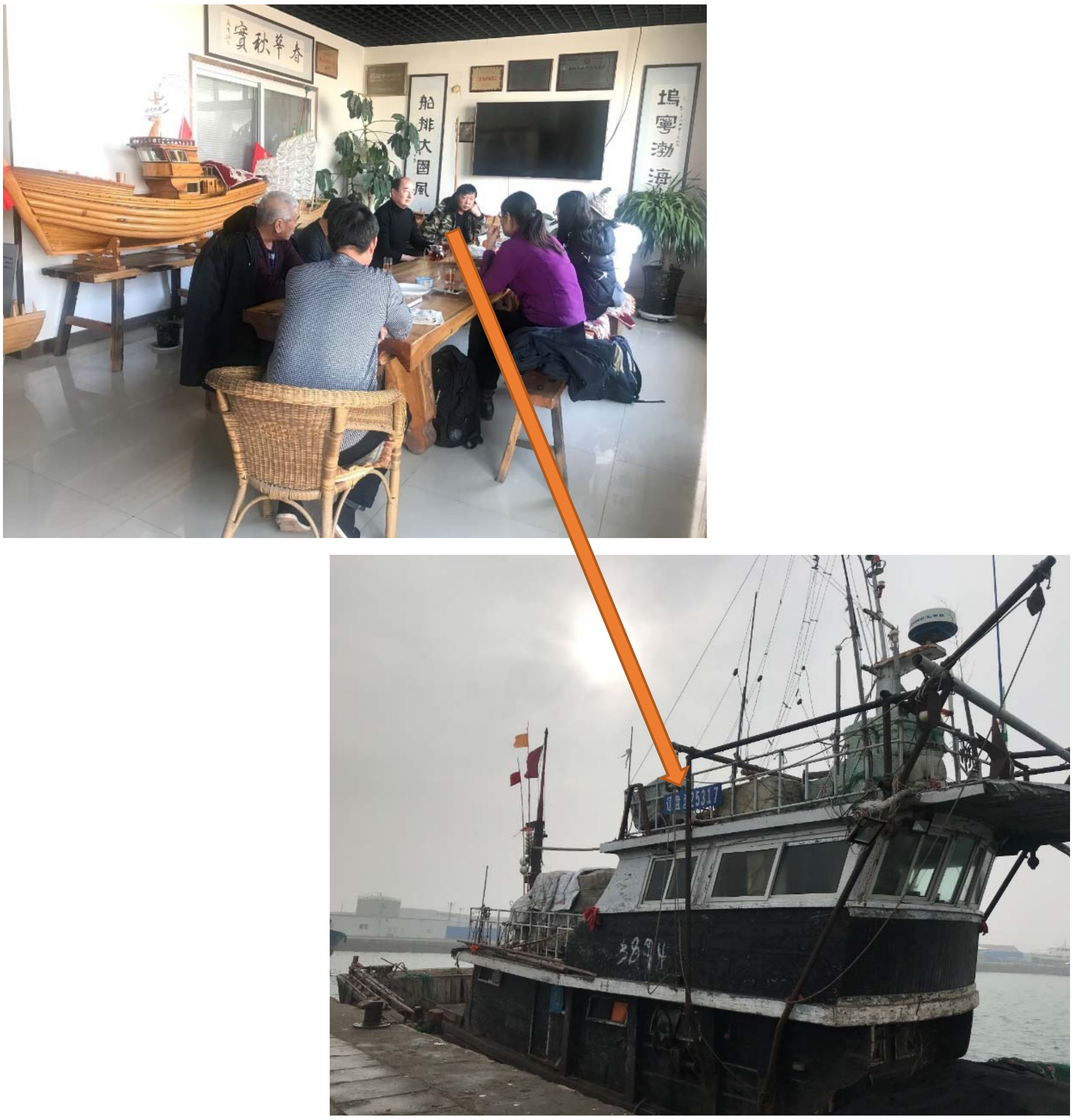


Figure 3.7 Fish landing caught by fishery immigration in Weihai, Shandong Province

Left-up: Semi-interviewing at Erjiegou, Panjin, Liaoning Province. The guy in camouflage is a fishery immigration. He used to go fishing in Panjin, Liaoning Province, following moved to Weihai, Shandong Province for higher production and income. He just returned to his family in Panjin for Chinese Spring Festival. **Right-bottom:** Boats with license plate issued by Liaoning Province but docking at Dongchudao village harbor. There were 54 rooms provided for fishery immigrants renting in Dongchudao village according to our survey.

Figure 3.8 Fish landing caught by fishery immigration in Weihai, Shandong Province

Left-up: Mengzi Shrimp (*Acetes chinensis*) with less than 5 mm in length, living about 50-100 m in depth; **Left-middle and bottom:** Ankang Fish, (*Lophius litulon*) living about 50-

100 m in depth, by-catch products; **Right-up:** The sieve used for shrimp filtering with mesh of less than 5 mm. The shrimp passed the sieve would be sent to factories for fish feed or fish paste production.

Figure 3.9 Fish nets used by fishery immigration in Weihai, Shandong Province

3.2.3 Average number of fishing vessels in study areas

The average marine fishing vessels (1985-2017) showed as Shandong > Liaoning > Jiangsu > Hebei > Tianjin, which Shandong province occupying the largest number with 1.15×10^6, and Tianjin with only 4.94×10^4 (Figure 3.10). The average fishing vessels in Liaoning reached 7.87×10^5, which took the second place among the 5 districts around the Yellow (Bohai) Sea.

Number of fishing vessels changes showed that the ship number in the 5 provinces reached the highest in 2002, 2003 and 2008 with the amount of 3.406×10^6, 3.407×10^6 and 3.409×10^6. The national Double Reduction Policy (fishery reduction and ships reduction) issued in 2002. However, there was no reduction of vessels in the following two years. Psychological desire might answer the abnormal phenomena as a compensation for owning more against banning, or they would no chance or less opportunity to own a licensed-vessel any more. There was also a fuel subsidy policy issued in 2005 facing for poor income of fishermen as less fishing resources left in seashore ecosystem. The subsidy policy benefits those fishermen who owned larger ships and higher ship power. Thus it aroused a tendency of selling older, small ships to buy newer, bigger ships with equipped efficient fishing gears. That's why the number of vessels reached the highest in 2008 since a new vessel needs 1-2 years lag from booking to licensing in government. It seemed the number of ships were decreasing since 2008. However, the fishing capability of the fishermen increased evidently with updated fishing gears. Fishing period lasted longer than before with specialized logistics ships supplying food, water and other necessary goods, also the supply ships would bought fishery catch when supplying goods. Both the fishing intensity and ability improved a lot with larger vessels since 2008, which might activating marine resources degradation.

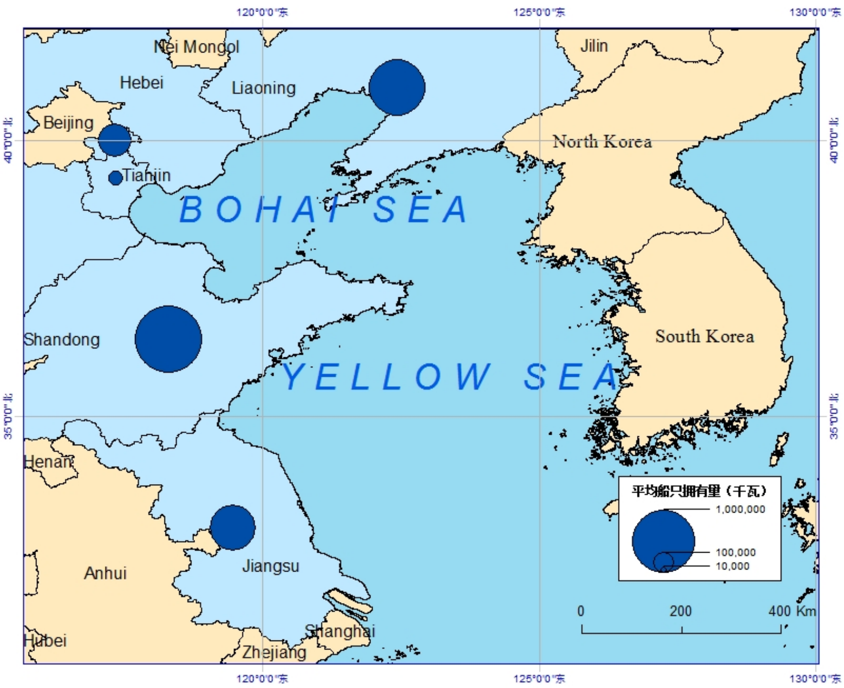


Figure 3.10 Average fishing vessels surrounding the Yellow Sea (1985-2017)

3.2.4 Correlation analysis of marine catches and social-economic factors

Correlation analysis showed that average marine catches had higher correlation with the ship power (R^2 = 0.9394) and marine areas (R^2 = 0.8736) of the 5 surrounding provinces (Figure 3.11 & 3.12). Higher ship power means more efficient fishing capability. Therefore, if fish catch already reached or overreached the maximum sustainable yields of marine economic species, large fish vessels with high ship power need to look for benefits to fill the gap of improving daily operating expenses. They had to turn to fish more intensively, even with no discrimination of targeted species and more by-products landing for aquacultural food. It turned to be a disaster for those large marine ecosystems with intensive human activities. The Yellow Sea Large Marine Ecosystem is not an exception at all.

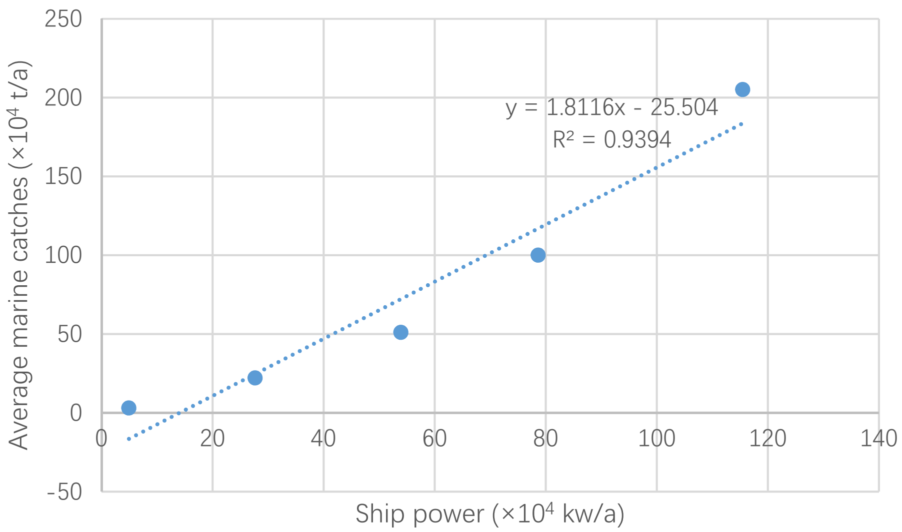


Figure 3.11 Correlation of average marine catches and ship power

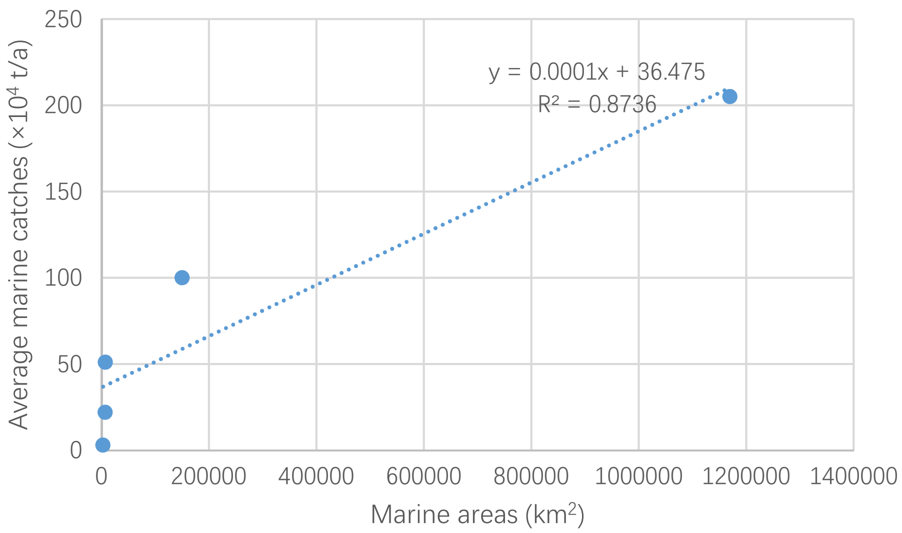


Figure 3.12 Correlation of average marine catches and marine areas

The confidence interval of average marine catches and marine areas reached 0.8736 in the 5 provinces. Definitely, it means more marine areas, more fish landing.

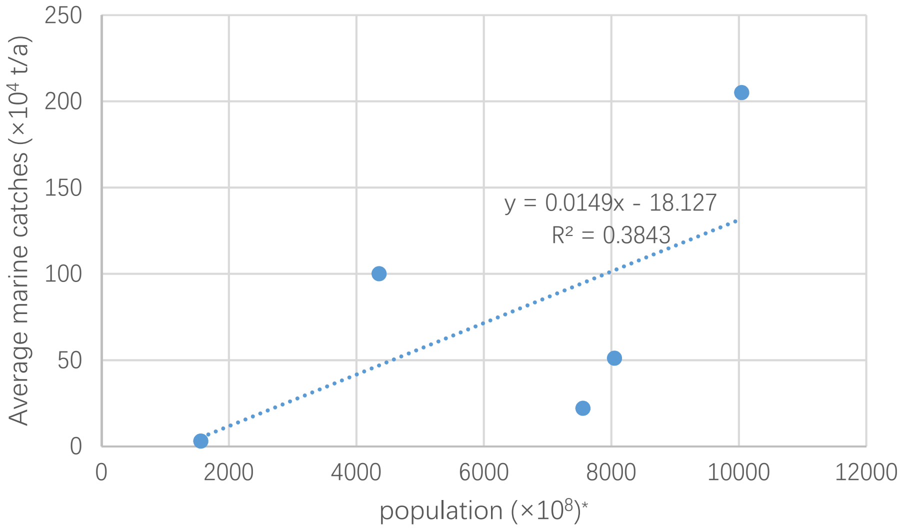


Figure 3.13 Correlation of average marine catches and population in 5 provinces

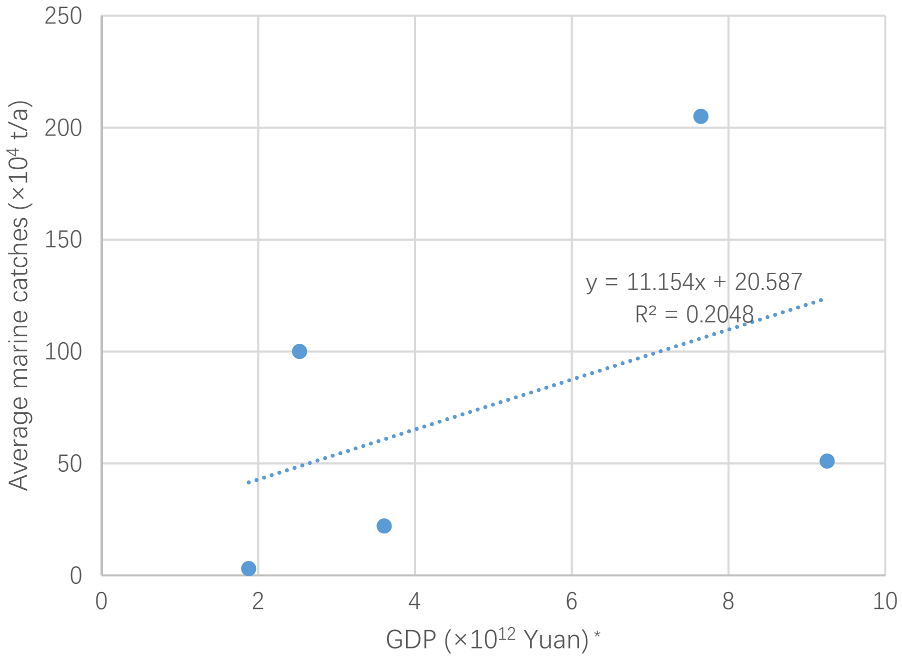


Figure 3.14 Correlation of average marine catches and GDP in 5 provinces

However, the confidence interval of average marine catches and population, GDP in the 5 provinces showed positive correlation but with lower values. The population and GDP we used is the provincial data, which might cause lower correlation. if we changed for data of population, GDP from coastal counties of each province, the confidence interval might be improved for showing more correlation.

3.3 Fishery conditions and further development trends

1) Overfishing is the main threats to marine ecosystem health in YSLME

According to our interview, anthropogenic activities, such as degraded habitats and overfishing, are the main threats to marine ecosystem health in YSLME. Of these threats, Overfishing not only reduces food production but also impairs the functioning of ecosystems and reduces biodiversity, with negative repercussions for economies and societies. Biologically sustainable levels of marine fish stocks showing clearly decreasing trend in YSLME. Some urgent measure should be taken for lessening the biodiversity loss and ecosystem degradation immediately.

Figure 3.15 fishing gears used by fishermen in different provinces

Left-up: Women in Haitou village were repairing fishing nets in winter (Nov. 2018, Jiangsu Province). **Left- bottom:** Fishing nets in Dongchudao village used for bottom shrimps with less than 5-mm meshes (Jan. 2019, Shandong Province). **Right-up two**: Fishing nets in Erjiegou village used for bottom shrimps with less than 3-4mm meshes (Jan. 2019, Liaoning Province). **Right-bottom**: Electric Fishing gears in Dandong harbor used for bottom clams, especially

Mactra chinenesis and *Cyrenodonax formosana* Dall (Jan. 2019, Liaoning Province).

Figure 3.15 showed fishing nets and fishing gears used in Jiangsu, Shandong and Liaoning province and their daily lives of local fishery families. The local fishermen Haitou village in Jiangsu showed close interaction with fishing in near-seashore fishing. Women were busy with repairing different fishing nets with different mesh sizes. They showed higher compliance with fishing regulations and no fishing for small size shrimps or bottom clams. We interviewed some families by going to their home for better understanding of their consciousness of their income connection from fishery and future plans. All of them have the knowledge of resources degradation and support the national off-season fishing ban (May 1st – Sep. 15th in Jiangsu province). Some of them even suggested that 3-5 year national fishing ban were welcome for fishery resources recovery if they could get some subsidies. They also felt depressed at the start-up fishing period when netting many juvenile fishes in YSLME.

Figure 3.16 *Mactra chinenesis* and *Cyrenodonax formosana* Dall. caught by electric gears

Fishing evolution in Liaoning Province provided us a complete sample exhibiting marine overfishing. It can be simply concluded as: Many species in 1960s & 1970s, such as *Larimichthys crocea*, *Larimichthys polyactis*, *Trichiurus lepturus*, Sepiidae, Stromateidae, Sparidae, *T. modestus*, Sphyraenidae, Scomberomorus, *Mugil cephalus*, *Muraenesox cinereus*, *Miichthys miiuy*, etc. were all caught in adult size. Economic species in 1980s turned to be less and their body size was smaller than before, following in 1990s, 2000s and 2010s. How did the fishermen cope with those changes?

They harvested fishery species with less and less size in 1980s and 1990s. They changed to catch shrimp with less than 1 cm and other bottom species living in more than 50 m deep in 2000s. When the shrimp and other bottom swimming species went out due to heavy fishing, the fishermen splited into two parts. One of them moved to Shandong province as fishery immigrants continuing to catch small bottom shrimps in the other side of Bohai Sea. Others staying in local shifted to use electric gears to dug *Mactra chinenesis* and *Cyrenodonax formosana* Dall in the sedimentary with the depth of about 30 meters every day (Figure 3.16). The daily production reached as 10 t per ship. Actually, fishermen in Shandong provinces told us those destructive fishing nets or unsustainable fishing activities were all introduced by the fishery immigrants from Liaoning Province. They do not like the fishing manners of fishery immigrants. However, they still added one sentence as" They rent our room, buy food and other goods for fishing from us. They also sell fish to us for factory processing or our market. So……". To local people in Shandong province, it seems a dilemma for them to drive the fishery immigrants using destructive producing ways since they still could provide some benefits to local community.

None discrimination of marine catches might be the one of causes for fishery resources destruction if there is a higher demand from aquaculture markets besides of climate change, environmental pollution and other human interventions. All in all, we think overfishing is directly caused by mismanagement of fisheries and could be corrected through improved policy and effective harvest strategies. To achieve sustainable development of fisheries, fish stocks must be maintained within biologically sustainable levels – at or above the abundance level that can produce maximum sustainable yield. Good governance of marine ecosystem biodiversity would certainly increase the contribution of marine fisheries to the food security, nutrition needs, economies and well-being of coastal communities.

2) Environmental pollution is another threat to marine ecosystem health in YSLME

The YSLME belongs to one of marine ecosystem with the highest density of human population and most intensive human activities in its surrounding coastal zones. Millions of tonnes of polluted water was discharged into the basin, and some solid wastes were buried in coastal wetlands each year. There were more aquacultural sewage flowing into the basin since 2000s with more aquacultural ponds appearing in coastal areas. Local people suggested less fish juveniles was found in nearshore shallow seawaters. Clams were also reducing in both quantity and distribution. They suggested it might be caused by aquacultural and industrial sewage with various poisonous pollutants. Also coastal wetland loss exhibiting an increasing tendency in recent 15 years caused more and more wetlands as larvae shelters were disappearing.

However, as for climate change, almost all stakeholders have no idea or information of what it will change or affect their daily lives in the future. They do not care about the possible emerging sea level rise.

4. Good aquaculture practices based on community level

Fish is one of the most traded food commodities worldwide and the main source of valuable animal protein in many regions of the world. With stagnating global capture fisheries production, growing human population, and continuing demand for food fish, the production of safe and quality aquatic food will be a great concern for global food security in the next years. In the period from 1983 to 2012, capture fisheries production increased from 71.1 to 92.6 million tonnes. Aquaculture production meanwhile expanded from 6.2 to 70.2 million tonnes at an average rate of 8.6 percent per year, which keeping the highest growth rate that other protein supplying food. Fig.1 showed some eastern Asian countries, such as China, India, provided the highest production of aquacultural goods.

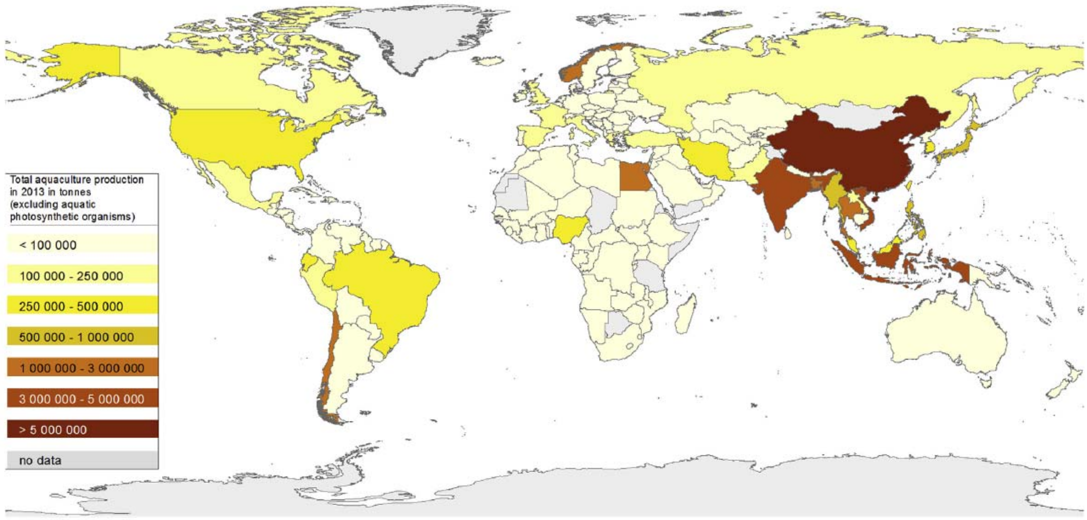


Figure 4.1 Map of global aquaculture production in 2013 (Ottinger et al., 2016)

The FAO defines aquaculture as the farming of aquatic organisms as fish, crustaceans, molluscs and aquatic photosynthetic organisms. Aquaculture farming implies individual or corporate ownership of the stock being cultivated and typically involves the enclosure of a species in a secure system. Till now, more than 600 different animal species are produced in aquaculture system comprising finfish (e.g. catfish, trout, carp, tilapia, salmon), crustaceans (shrimp, prawn, crabs), and molluscs (e.g. mussels, oysters and clams). Regarding the fast growth of aquaculture production in our country, it has posed a challenge to the sustainable usage and management of aquacultural products.

4.1 Background and development of good aquaculture practices

As we all know, aquaculture modifies the environment, habitats, flora and fauna, scenery, proximal or in vivo water bodies as well as soil (Dosdat 2009). Continual consumption of these resources by aquaculture without a thought about sustainability will lead to depletion notwithstanding the competing claims on these resources by other sectors of productive economy. The environmental-ecological impacts of aquaculture could be listed as causing land use changes, ecosystem degradation, surface and ground water pollution, water withdrawal, coastal erosion and land subsidence, disease dispersion, food chain pollution, etc. Figure 4.2 showed algae blooming (both brown, yellow and green) in shrimp ponds in Lianyugang, Jiangsu Province. It not only causes heavy economic loss to local farmers but also has environmental pollution to the environment, habitats, flora and fauna, scenery of the water basins.

In light of the increasing concern about environmental, economic, and social impact of aquaculture development, the Yellow Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, has introduced Good Agricultural Practices (GAPs) as guidelines to advocate sustainable and best aquaculture practices. Healthy aquaculture food needs a series of considerations, procedures and protocols designed to foster efficient and responsible aquaculture production and expansion, and to ensure final product quality, safety, and environmental sustainability. Unfortunately, GAPs is not a compulsory practice that must be implemented by all farmers, but rather it is adopted on a voluntary basis to qualify an aquacultural producer to follow the scientific instruction from scientists.

Marine ranching has been developed very fast in recent year is Shandong province. Most of them has the scientific support based on the Integrated Multitrophic Aquaculture (IMTA) (Fang et al., 2018). The fundamental theory of IMTA is that the organic or inorganic matter (e.g., waste feed, feces) generated from feeding culture units (e.g., fish and shrimp) provides the nutrients for other culture units (filter-feeding shellfish) within this culture system combining different tropics. This approach makes efficient use of nutrients in the system and mitigates the pressure of the local system, thus improving culture diversity and enhancing profit which finally contributes to the sustainable development of aquaculture.

Figure 4.2 Algae blooming in traditional aquacultural ponds (Aug. 2019)

4.2 Good aquaculture practices sites: Dongchudao Village

Figure 4.3 showed the location of Dongchudao village. Dongchudao is a small village located at the south cape of Sanggou Bay, with a population of

437 in 2017. It used to a fishery village participating in fish catch in surrounding waters before 1980s. Now it has developed into a multi-organized community-based enterprise focusing on eco-tourism, integrated multitrophic aquaculture, marine ranching, fishery processing, recreational fishery etc. all the factors abovementioned connected together providing an example for good aquaculture practices.

Figure 4.3 Study site: Dongchudao village

Table 4.1 showed the population changes of the village. The total population and households kept in steady level in recent 30 years with an average of about 440. However, the people moved out of the village was only 1/5 of the people immigrated to the village, which means more people are flowing into the village. It is a sign meaning higher attraction from relative persons. However, low new-birth rate, with 1-4 new baby each year, showed the village is walking into aging society slowly.

Table 4.1 Population changes in Dongchudao village from 1997 to 2017

	Total	Households	Male	Female	New-birth		Emigrants	Immigrants
					Male	Female		
1997	460	190	226	234	2	1	12	60
1998	444	190	210	234	3	1	12	66
1999	446	191	211	235	1	1	10	64
2000	450	193	213	237	2		11	68
2001	453	191	214	239	1	2	13	70
2002	451	190	212	239	1	1	13	67
2003	450	189	211	239	0	1	14	65
2004	448	188	211	237	1	0	13	63
2005	438	186	210	228	2	0	12	61
2006	444	184	209	235	0	1	13	58
2007	445	184	207	238	1	0	12	57
2008	442	183	208	234	1	1	12	58
2009	440	182	207	233	1	2	12	59
2010	438	180	206	232	0	1	11	58
2011	435	174	206	228	1	1	12	60
2012	431	176	205	226	1	2	14	56
2013	429	174	203	226	1	1	15	57
2014	429	174	204	225	2	1	17	61
2015	431	184	205	226	2	0	18	62
2016	435	186	206	229	1	1	18	55
2017	437	189	207	230	1	2	18	48

Education level of local stakeholders in Dongchudao village is very important for policy implementation and information communication. Figure 4.4 showed number of workers and their average age in Dongchudao Fisheries Company. The average age of those staff reached about 48 years old. People in headquarters were the youngest in all jobs. Tourism owns more staff with higher education, which needs quick effective communication and decision making. Number of staff in refrigerated plant and marine aquaculture took the second place in the village enterprises.

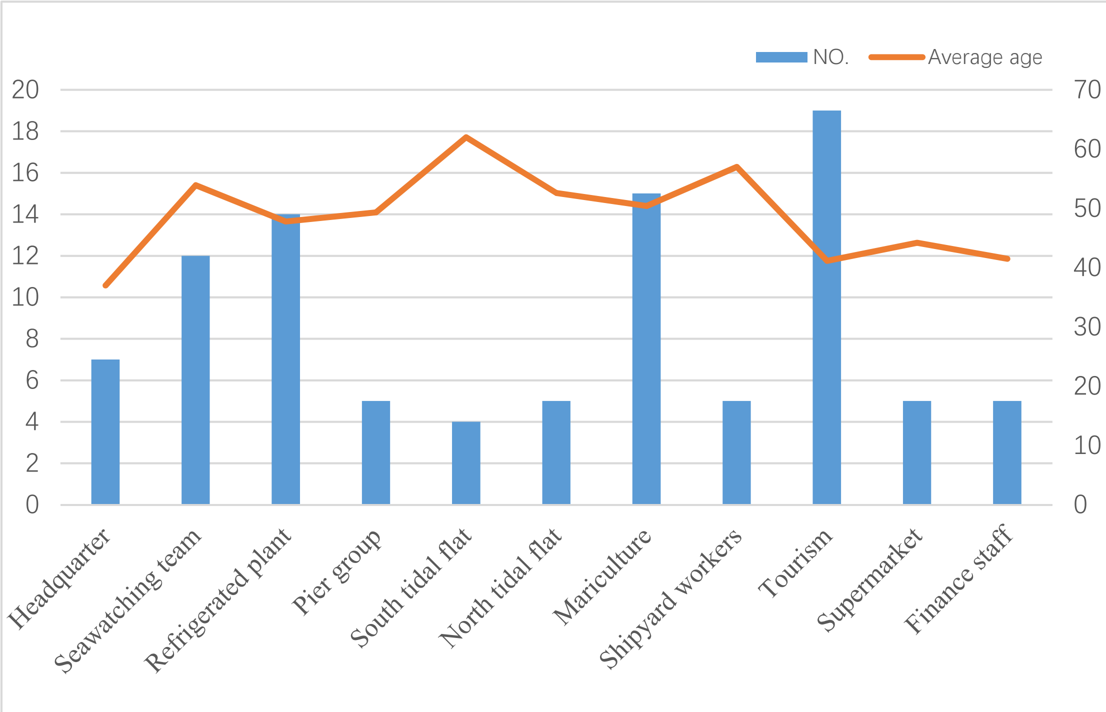


Figure 4.4 Number of workers and their average age in Dongchudao Fisheries Company

4.3 Ecological-friendly good aquaculture practices

The baseline for GAPs in Dongchudao is based on shellfish-seaweed-sea cucumber IMTA system. Many management techniques is provided to farmers by training, such as feeding, fertilization, stocking, liming and monitoring of parameters. Ecosystem-based design, which focusing on producers, consumers, decomposers and detritus, was developed for smooth material cycle and efficient energy flow. Here are the roles of different marine organisms (Figure 4.5):

Energy and outside supplies: Sunlight, seawater, detritus, nutrients, CO_2, etc.

Environmental factors and ecosystem dynamics: hydrodynamic (velocity etc.), chemical (all kinds of nutrients), biological, physical (temperature, etc.) and ecological factors.

Producers: all kinds of seaweeds.

As for macroalgae, the macroalgae species in the integrated shellfish-seaweed culture mainly include brown algae *Saccharina japonica*, *Undria pinnatifida*, *Sargassum thun bergii*, and *S. fusiforme*, red algae *Gracilaria lemaneiformis* and *Eucheuma gelatinae*. Their biological characteristics and ecological habits vary by species.

Consumers: oyster, scallop, mussel, abalone, sea cucumber, etc.

Consumers in IMTA system can be defined to filter-feeding, deposit feeding, scape feeding, etc. They occupies special ecological niche in IMTA system to activate the whole ecosystem.

Figure 4.5 Framework of shellfish-seaweed-sea cucumber IMTA system

As for filter-feeding animals, most of them also belongs to sessile organisms, which needing a hard surface to attach. In IMTA system, they were delicately put on a suspending multilayer net. Oyster belongs to common species and with more than 100 species distributed in almost all the coastal countries in the world. It is also famous for its delicious and nutritious soft body. It lives as filter-feeding organism, which can filter the microalgae and organic debris of seawater by the wave of the cilia on the gills when slightly opening its shell. Scallops and mussels also feed on algae and organic debris by filtering water and collect the food particles.

Decomposers: Bacteria, fungi and actinomycetes, etc. which living in marine ecosystem.

In IMTA system, the organic or inorganic matter (e.g. waste food, feces) generated from the feeding culture (e.g. fish and shrimp) units provides the nutrients for other culture units (e.g. filter-feeding shellfish) within this culture system combining different tropics. For example, the filter-feeding activities of bivalves will be helpful to the photosynthesis process of the seaweed by filtering particulate matter in seawater. The seaweed will benefit from the carbon dioxide and ammonia generated from the respiratory and metabolic process of the shellfish, and feedback to the shellfish by producing dissolved oxygen through photosynthesis. This mutual process is not only a good way to keep the balance of O_2 and CO_2 in the ecosystem, but also to promote the nitrogen cycle. This approach makes efficient use of nutrients in the system and mitigates the pressure of the local ecosystem, thus improving culture diversity and enhancing profit, which finally contributes to the sustainable development of aquaculture.

This kind of IMTA system is the best solution to achieve remarkable economic benefits and reduce the negative pressure caused by self-pollution. Some basic information need to be considered for a successful IMTA system, such as assessment of environmental capacity of IMTA system, assessment of carrying capacity of farmed seaweeds.

4.4 Social-economic benefits from good aquaculture practices

As for economic benefits form oyster-kelp integrated aquaculture system, after 6-7 months of farming, 28 individuals are harvested in each rope with an average individual wet weight of about 1.30 kg, then the total yield (wet weight) of each rope is 36.4 kg. According to the ratio of dry to wet (1:7), the total dry weight of each backbone is about 452.4 kg, so the gross income of each backbone is about 2714.4 yuan if the price of the dry kelp is rmb 6/kg. the net income of each culture unit (4 backbomes) is about 1600 rmb if the costs of the salary for the farmers and the materials related to the aquaculture are being taken into consideration. The production of each oyster latern net is about 12.5 kg, then the total output of each backbone is about 537.5 kg. the net income of each culture unit (4 backbones) is about 2540 yuan if the costs of the salary for the farmers and the materials related to the aquaculture are being taken into consideration. The net income of each oyster are kelp aquaculture unit is rmb 4130 (Fang et al., 2017).

The abalone-seaweed-sea cucumber IMTA system gives us another good example for more economic benefits of local community income. Abalone is cultured in a cage and fed with seaweeds which is co-cultured on longline, while sea cucumber is co-cultured with abalone in a cage and fed on the feces and residual feed from abalone inside the cages. According to the four backbones of a culture unit, the integrated aquaculture system includes a total of 33,600 abalone and 12,000 kelp. Kelp culture begins from November to June of the following year. When the kelp reaches 1 meter long, it can be used to feed the abalone. The net cage of abalone should be cleaned at least once a week. The abalone can reach commercial size (8-10 cm) in two years. After two years growth cycle, the abalone can reach 900 kg, with an output value of more than rmb 60,000. From September to May of the following year, the average weight of the sea cucumber could reach 150-200 g/individual. According to the price of sea cucumber (140 rmb/kg), the average economic efficiency of each cage can be increased by rmb 210. Correspondingly, each culture unit (4 backbones) of abalone and sea cucumber IMTA system can increase the output value of rmb 16,800. Taking the costs of the seeding of the sea cucumber, the net income of each backbone is rmb 3600.

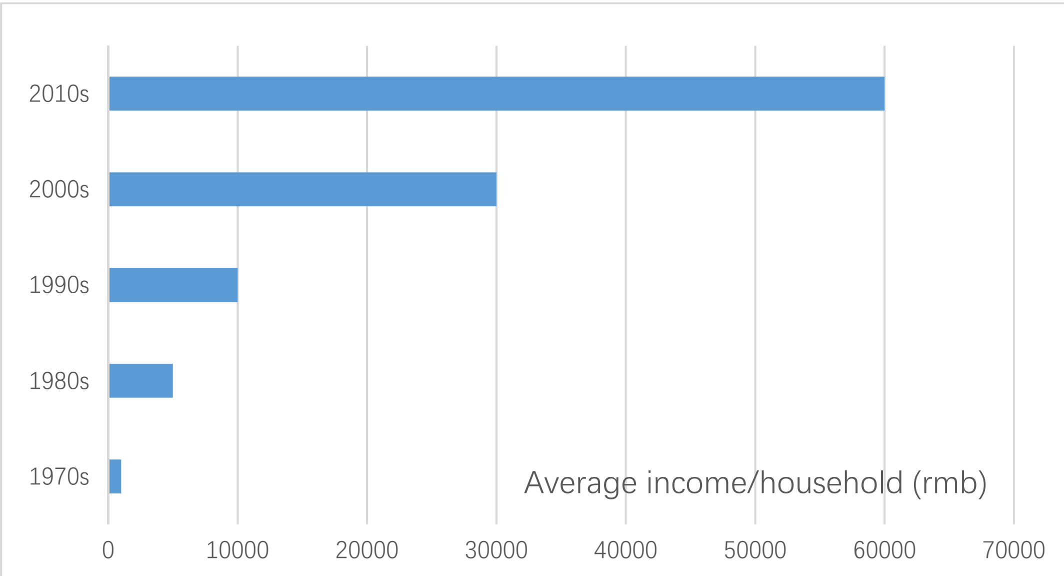


Figure 4.6 Average family income in Dongchudao village since 1970s

The average family income in Dongchudao was about 1000 rmb, without income from aquaculture, tourism or industry in 1970s (Figure 4.6). Agriculture and marine fishing were the two main productive activities in their daily lives. Their average family income reached 5000 rmb in 1980s. Individual fishery and small-sale commercial activity were permitted at that time. Their income grew fast with about 5 times of that in 1970s. The family income increased to 10,000 rmb in 1990s with village-based enterprises' operation. They could get more fish catch because of larger ships and updated fishing nets. Fish processing factories were built for animal feeder or human food. 30,000 rmb were the average income of the family in Dongchudao village in 2000s.

Aquaculture became one of the important production activity for income improvement. Education level also increased a lot with more and more youth went out for colleges or universities. However, marine fishery did not take the dominate place with less and less fish catch in the near seashore waters. Some of them sold their ship and began to take other jobs outside of the village or in their village-owned factories. Their income reached the highest in 2010s.Tourism and recreational fishery has developed quickly. Many activities related to aquaculture, especially marine ranching, have developed and contributed much to the income of local communities. All households in Dongchudao village could receive about 10,000 rmb/year from vllage-owned enterprise shares.

There is no doubt that the introduction of GAPs can gain many benefits to Dongchudao families. This preliminary study recognized the importance of GAPs based on IMTA system, not only of its ecological, economic and social impacts to local communities, but also of its safe quality insurance to consumers in markets. It played an important role in human health for providing health aquacultural goods to markets. Also action at all levels is required for the development of regulations and the provision of resources for enforcement of, education and training in, and research on, responsible practices of aquaculture.

4.5 Culture benefits from good aquaculture practices

The history of Dongchudao village is dated back to 1573 A.D., almost 400 years ago. There were several old dwellings built at 1600 A.D., Ming Dynasty, still existing. The seaweeds houses are famous as one of the ten Chinese Dwellings in China (Figure 4.7). The technique of building seaweeds houses has become a national intangible cultural heritage site for cultural protection. The village was listed as Historical and Cultural Village in 2007, Chinese traditional village in 2012, and many other titles. It is an attractive tourism site which already receiving many tourists both in Shandong Province and in China.

Two important factors, one is its historical culture combined with special seaweeds houses, the other is the delicious seafood from fishery and aquaculture, provide tourists with satisfaction, pleasure and happiness. The tourism income in summer season took half part of their whole-year income. The culture system holds the key to ensuring sustainability and this according to Dalsgaard et al. (1995) can be achieved by focusing on the system and its ecology with a view to minimize the use of external inputs and to maximize the output in an integrated system. This is basically the core concept behind the ecosystem approach to aquaculture (FAO 2010) and it encompasses social dimensions (Staples and Funge-Smith 2009; Johnson 2007), governance (White and Diego-McGlone 2008) and climate change (Burrows et al. 2010).

Figure 4.7 Average family income in Dongchudao village since 1970s

What’s more, the ability of farmers to gain access to technical knowledge and management skills are essential in the development of aquaculture, which includes matter pertaining to training centers, training concepts, and the ability of the teaching staff. In this matter, extension was important in continuing basis, because farmers face different production \problems at different stages of development in IMTA system.

5. Ocean governance assessment based on fishery policies

5.1 Background

Fish populations are of immense global value, shaping ecosystem services for billions of people worldwide. However, out earth is currently facing unprecedented environmental and societal changes that are having dramatic effects on fish and fisheries. Understanding the probable scope of these changes is crucial in allowing us to develop mitigation strategies, manage fish populations and minimize negative effects for those who rely on them. Moreover, the pivotal position of fishes in aquatic ecosystems renders them important indicators of environmental health. Effective assessment and proactive management at the ecosystem level has the potential to considerably improve the resilience of aquatic ecosystems to global change, preventing potentially disastrous declines in fish populations. The success of such management relies on the ability to review the historical status of ocean ecosystem, policy implementation. In the meanwhile, management policies needs to identify current and future threats to fishes and using past successes to develop effective tools for future mitigation strategies.

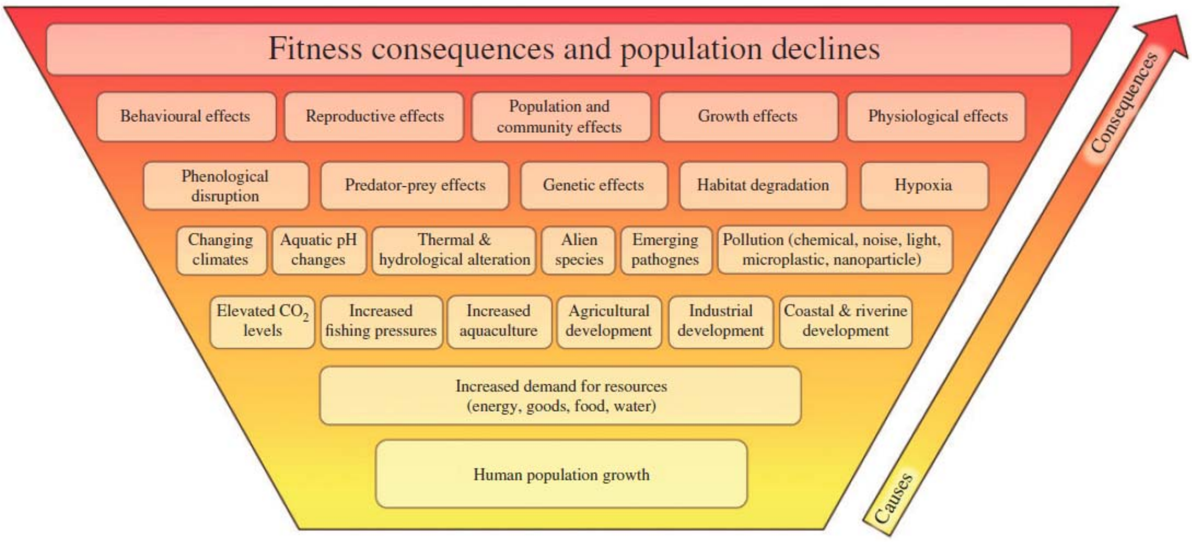


Figure 5.1 Hierarchical structure of threats facing fisher globally (Gordon, et al., 2018)

Figure 5.1 provides us a framework of what issues of fishes are facing today. Fishes in marine, transitional and freshwater habitats face a multitude of threats ultimately driven by increasing human populations and intensifying resource use including for food provision (fishing, irrigation, agriculture, livestock production), energy production (hydropower, wind turbines, oil and gas drilling, fracking, biomass harvesting), water usage (drinking, sanitation, industry) and other goods (mining, forestry, river channelling). The accumulation of threats has resulted in unprecedented effects on ecosystems, with widespread population declines of fauna and extinctions across many taxa. These threats are manifested through multiple biological, chemical, physical and climatic mechanisms. Threats occur across a wide range of spatial and temporal scales, and need to be understood in the context of a combination of local (spatially and temporally variable) and global (large scale, with little spatial and temporal variation) pressures. A combination of local and global mitigation strategies will therefore be required to restore and sustain the health of aquatic system.

Fishery in China has experienced a long history of over 5000 years. However, fishery as both a problem and a sustainable biological resources discussed has a history of less than 70 years. Every policy release has its intrinsic logistics connected to the past, current and future fishery resources management. All of these may be a part of ocean governance.

5.2 Fishery policies in China

Our country has issued a set of fishery policies dealing with social, economic, resources management and fuel subsidy etc. in different developing period when needed. Fishery policy belongs to public policy, which is one of the selective management actions from the government, and it is the action rule made by the government according to the wills of ruling regime. Therefore, public policy on modern fishery is the action rule made by the government in the process of social benefit selection, integration, distribution and implementation in accordance with the development objectives of modern fishery.

Chinese government issued a set of fishery policies since 1980 to cope with fishery resources degradation, overfishing and other fishery problems emerged with both pressure from global climate changes and anthropothenic activities (Figure 5.2). Chinese government issued Fishery Law (1986), Fishery License Regulation (1986), Double Control Regulation (1987), Fishery Proliferation and Release (1989), Off-season Fishing (1995), Zero Growth (2000), Ship Reduction and Conversion (2002), Fishing Vessel Fuel Subsidy (2005), Marine protected areas (2011), Marine Ranching (2015), Total Amount Control and Limited Fishing Control (2017). There are specific complementary regulations in different provinces to cope with these national policies.

All the above-mentioned policies mostly focused on effects management, such as input control (fishery license), output control (fishery amount), double control, technical control and other supporting policies at different stages.

However, an effective policy needs to address a comprehensive coordination mechanism to supervise both fishery resources and their habitat. Different governance mechanisms should be based on marine ecosystem-based level, fully considering their development, endowment conditions, and ecological characteristics of marine fishery resources. It is necessary to strength resources assessment, investigation, and statistical monitoring in order to provide scientific and accurate support for improving the property rights system and ecological compensation for the marine fishery resources in China.

Figure 5.2 National fishery policy issued in China since 1980

5.3 Some policies: a coin with two sides

Here we chose some fishery policies to analyse their effects as all their targets focusing on sustainable fishery resources protection. Our interview and questionnaire design focused on fishery proliferation and release, ship reduction and conversion, fishing vessel fuel subsidy.

1) Fishery Proliferation and Release (1989)

Definition: Artificial methods directly into the natural waters such as oceans, tidal flats, rivers, lakes, reservoirs and other natural waters, into the eggs, larvae or adults of fishery organisms, in order to restore or increase the number of populations, improve and optimize the community structure of the waters. It also includes measures to improve the ecological environment of the waters, and to inject certain resources (such as egg escorters, artificial reefs, etc.) and reproductive protection of wild populations into specific waters.

Objects: Restoration of fishery resources, water ecosystems, maintenance of ecosystem stability, and sustainable development of fisheries in order to gain ecological, economic and social benefits.

Benefits:

a): Supplement and restore biological resources through proliferation and release, which improving the population structure of the organism and maintaining the diversity of the organism. It also plays a protective role for these endangered species.

b): Improve water quality and water environment. Aquatic organisms also have a carbon sink effect.

c): Increase the income of fishermen and expand the social impacts.

Cost-benefit analysis:

a): Pay much more attention to fishery proliferation and release. Every institutes, organizers who involved in fishery proliferation and release activities had reports of releasing billions of larvae into waters.

b): Despise the assessment of fishery proliferation and release. How many of those larvae can survive until to adults? How much of the fishermen do get promoted income from fishery proliferation and release activities? How much money were input for fishery proliferation and release, including commercial purchasing, Journalism and Communication, release behaviour etc.? Does those release species form a local-based ecosystem food chain to optimize the function and structure of marine ecosystems?

Actually local fishermen gave an idea of less successful activity.

2) Ship Reduction and Conversion (2002)

Definition: There are more fishing boats comparing to the depletion of marine fishery resources. An estimated number of fishing vessels will be reduced and correspondingly some fishermen will face the current situation of converting to other occupations.

Objects: Restore marine biological resources and maintain MSY of fishery.

Benefits: It is useful to maintain the stability ecosystem carrying capacity.

Cost-benefit analysis:

Less income from traditional fishery with the degradation of fishery resources. However, no techniques will support those fishermen for a new job.

There is too many fishery vessels for limited fishery resources. Only 1/5 fishermen (ship owners) admitted that they made money from fishing, with a family income about 70,000-100,000 yuan per year. The income of hired crew in these ships is about 30,000-50,000 yuan. For fishermen, they complained that less fishery resources, too different to hire crew even with higher salary. For crew, they complained too low salary since it belongs to a seasonal job only working in fishing seasons.

What kind of alternative livelihoods are welcome to traditional fishermen in community level?

3) Fishing Vessel Fuel Subsidy (2005)

Definition: The subsidies for finished fishery fuels include fishermen and fishery enterprises engaged in domestic marine fishing, offshore fishing, inland fishing and aquaculture, and using mobile fishing vessels. The auxiliary fishing vessels are not subsidized.

Objects: Compensation for the low income of fishermen facing less and less fishery resources.

Benefits: Fishermen do get compensation subsidy according to their ship size or power. Larger ships, higher power means more subsidies.

Cost-benefit analysis:

Almost no fishermen wants to withdraw their ships since the ship they owned can earn subsidies. Even some fishermen want to buy bigger fishery vessels by selling their older and smaller ships since there will be more subsidies. They also think a big vessel can last long for them to go fishing in open waters instead of patrolling in near seashore waters. There should be more fish in a little faraway open waters. Therefore their expectation for both higher subsidies and more fishery resources can be made up by changing for a big ship.

Is this really true?

If we bring the two policies together, that is, Ship Reduction and Conversion (2002), Fishing Vessel Fuel Subsidy (2005), a clear gap between the goals can be easily found out.

The fundamental reasons of policies: less and less fishery resources, more ships, traditional fishermen needing to find new jobs……

When Ship Reduction and Conversion policy were issued in 2002, many ship owners at the age of 25-40 (now they are around 42-57), had the idea of finding a new job instead of being a fishermen. They really were looking for a new alternative livelihood according to our interviews. They told us they knew the fishery resources are decreasing. It was unsustainable for them to be a fishermen in the long run. They were young at that time and they could find a new job and began a new career at land-based occupations. It belongs to intrinsic driven from their own recognition.

However, when Fishing Vessel Fuel Subsidy policy was issued in 2005, no one, none of them wanted to change for a new job. Most of them were looking for loan, lease, or saving from relatives, friends to buy a large vessel. They all knew that there was less and less fishery resources for them to fish. When facing subsidies from government with larger ships more money, who cares the depletion of fishery resources?

It is really that direct talk with our interviews.

5.4 Assessment of fishery policy factors

Policy design should be in a scientific framework considering social, economic, ecological, historical, psychological and even lawful issues. Most of all, Continuity, stability and equality should also be considered. Therefore, effective communication of the problems facing fish, fisheries, vessels, the scientific solutions and the potential options for the future is of fundamental importance. Public support for management and policy making can be enhanced by instilling an ethos of care and value among communities of people. Promoting the involvement of the non-scientific community in data collection and decision making is important in gaining momentum towards positive change. Improved stakeholder interaction and better use of citizen science also requires development of widening participation of local stakeholders.

Figure 5.3 showed a framework of self-organized marine ecosystem with higher anti-interference ability. It calls for scientific knowledge providing basic carrying capacity, maxim sustainable yield, etc. to keep the system in controllable level. Technology and ecosystem conservation are the two approaches to help the system in transparent, awareness level. However, household size, education level, demands of local stakeholders can never be ignored for better usage and management of fish and fishery resources. All in all, we already knew what a policy gap could produce an exactly opposite consequence facing fish and fishery resources management. Therefore, we should be very careful for future design of fishery resources protection. Future efforts must, use both scientific and societal approaches in order to most effectively secure a future for fishes worldwide.

Figure 5.3 Framework for marine ecosystem based management

Growing concerns surrounding the consequences of anthropogenic climate change have resulted in a dramatic increase in related research. Furthermore, despite the problem of ocean acidification having only been recognized within the past decade or so, there is now significant progress towards understanding the effects of temperature and changing ocean pH, both as individual stressors and in the context of a complex suite of other environmental pressures. Other factors, such as chemical pollution, overexploitation should be considered together with protected areas, biotechnologies, big data, modelling, interdisciplinary and holistic thinking when promoting a national fishery policies. Human population growth as a driver leads to altered resource use and subsequently to fitness consequences and population declines by a wide range of varied and inter-linking mechanisms.

6. Conclusion and suggestion

1) Local stakeholders realized fishery reduction and biodiversity threats in YSLME and expecting effective ocean governance for sustainable management based on semi-interviewing

2) Captains in traditional fishery villages have different views referring to double reduction policy, mostly depending on the cost and benefit analysis of their fishery vessels

3) Fishery immigrants from Liaoning to Shandong using destructive fishing gears should be stopped for better management of marine ecosystem health

4) Captains and crews with the age between 35 and 55, have no idea of starting a new career in land-based factories instead of working in fishing vessels

5) Fuel Subsidy Policy issued in 2005 has caused a dilemma considering Double Reduction policy

6) Science-based ecosystem management, such as IMTA, GAPs, had better expand to local fishery stakeholders for future sustainable development

7) Eco-tourism, recreational fishery were among the most welcomed development activities by local fishery communities

8) Implementation of improving education level, technique is suggested for future development facing local fishery communities

Effective implementation of fishery management policies?

Sustainable fish catch based on single species in Yellow (Bohai) Sea

Ecosystem? The role of single species in food web?

Single species population health in food web of Yellow (Bohai) Sea Ecosystem?

Suggestions: Launch a fishing ban? How long? Ecological mitigation and compensation facing fishermen?

7. Acknowledgements

We would like to show our sincere thanks to the following bureaus for organizing discussion forum with local stakeholders in village-town-county level. They also helped us with questionnaires distribution and collection, interviewee visiting, accommodation booking, etc.

Jiangsu Province: Jiangsu Provincial Fishery Administration, Ganyu Marine and Fishery Bureau, and Qinkou and Haitou Village committee;

Shandong Province: Weihai Marine and Fishery Bureau, Dongchudao Village committee, Duyudao Village committee, Xinfa and Xushan Group;

Liaoning Province: National Marine Environmental Monitoring Center, Dandong Marine and Fishery Bureau, Panjin Marine and Fishery Bureau.

We also must say thanks so many friends we met in our journey for the first time. All of you are so nice that try to help us as possible as you could.

At last, we would like to show our thanks to Yellow Sea Large Marine Ecosystem Programme Office, for providing our group the great chance to learn about the knowledge of fishing vessel buy-back scheme and fish restocking, mariculture and climate change impact adaptation measures northern coast of P.R. China.

8. References

Chopin T., Buschmann A H, Halling C, et al. 2001. Integrating seaweeds into marine aquaculture systems: a key towards sustainability [J]. J. Phycol, 37: 975-986.

Chopin T., 2006. Integrated Multi-Trophic Aquaculture. What it is and why you should care and don't confuse it with polyculture [J]. N Aquacult., 12(4): 4.

DONG Shuanglin. 2011. History, principles, and classification of integrated aquaculture in China [J].Journal of Fishery Sciences of China, 18(5):1202-1209. (in Chinese with English abstract)

Fang J G, Sun H L, Yan J P, et al. 1996. Polyculture of scallop Chlamys farreri and kelp Laminria japonica in Sungo Bay[J]. Chin J Oceanol Limnol, 14(4): 322-329.

Fang J.G., 2018. (eds.) Training Module for Integrated Multitrophic Aquaculture in P.R., China (Draft). UNDP/GEF YSLME Phase II Project.

FAO, 2016. The state of world fisheries and aquaculture: contributing to food security and nutrition for all. Fisheries and Aquaculture Department, FAO, Rome.

Han, Y., 2018. Marine fishery resources management and policy adjustment in China since 1949. Chinese Rural Economy. 09: 14-28. (In Chinese with English abstract).

Kamaruddin R., Baharuddin A.H., 2015. The importance of good aquaculture practices in improving fish farmer's income: A case of Malaysia. International Journal of Social Economics. 42(12): 1090-1105.

Gordon, T.A.C., Harding, H.R., Clever, F.K., Davidson, I.K., Davison, W., Montgomery D.W>, Weatherhead R.C., Windsor, F.M., Armstrong, J.D., Bardonnet, A., Bergman, E., 2018. Fishes in a changing world: Learning from the past to promote sustainability of fish population. Journal of Fish Biology 92: 804-827.

Ottinger M., Clauss K., Kuenzer C., 2016. Aquaculture: relevance, distribution, impacts and spatial assessment---A review. Ocean & Coastal Management. 119: 244-266.

Salin K.R., Arome Ataguba G., 2018. Aquaculture and the Environment: Towards Sustainability. In: Hai F., Visvanathan C., Boopathy R. (eds.) Sustainable Aquaculture. Applied Environmental Science and Engineering for a Sustainable Future. Springer, Cham.

Soto K. Integrated mariculture: A global review[R]//FAO Fisheries and Aquaculture Technical Paper.

Vivero J.L.S., Mateos, J.C.R., Corral, D.F.D., Barragan, M.J., Calado, H., Kjellevold, M., Miasik, E.J., 2019. Food security and maritime security: A new challenge for the European Union's ocean policy. Marine Policy 108: https://doi.org/10.1016/j.marpol.2019.103640.

9. Workplan

Under supervision of the Chief Technical Advisor and technical guidance of RWG-F in close collaboration with the local project teams on demonstration of IMTA, restocking, climate change adaptive management, the subcontractor will conduct the following activities to fulfill the project:

- **Objectives**
  - Implementation of the fishing vessel buy-back scheme;
  - Demonstration of sustainable mariculture and MPAs development;
  - Adaptation to Climate change.
- **Activities**
  - **Month 1-3**: Literature review. Desktop review of published and grey literature (reports, thesis, newspaper, online articles, Statistics Fishery in local and national) on ecological, socio-economic, and governance aspects on fisheries in Liaoning, Shandong and Jiangsu Provinces, including YSLME.
  - **At the end of month 1**: 1st project team member meeting focusing on project inception, project task distribution, group team responsibility, work schedule, technique issues related to indicators of assessment methodologies, sampling data collection methods, questionnaire survey design, demonstration sites chosen, etc.
  - **Month 2-3**: based on literature review, field trips and discussion with stakeholders from all levels, determine of study areas in collaboration with members of the Inter-Ministerial Coordination Committee members. At least 2 lines will be covered from Provincial Fishery Division → County and City Fishery Division→ Township, Village and household Fishery; Provincial Marine Resources Protection Division→ County and City Marine Resources Protection Division→ Marine Protected Areas, Marine Parks in P.R. China.

    Note: Principles for choosing study/ demonstration areas. Two villages in Dalian, Weihai and Liangyungang separately. Multi-indicators will be considered on history of fishery, mariculture and eco-tourism, in or out of MPAs, pollution, research background, major livelihoods and so on to choose those study sites.
  - **Month 4-6**: Develop the assessment methodologies, sampling data collection methods, questionnaire survey, governance analysis and prepare baseline report for socio-economic assessment of buy-back scheme and demonstration sites in Dalian, Weihai and Dandong.

    Note: Socio-economic assessment will focus on human impacts (changes in impacts, impacts by activities, impacts by national policy, impacts driven by climate change, land/sea-source based pollution, household status and threats in village level) to form Indicators of Regional Human Impacts in YSLME (China side). Contingent Valuation Method will be used to analyze the questionnaire survey based on 3 demonstration sites in Dalian, Weihai and Liangyungang. This work has almost finished now by literature review and remote sensing data.

- **At the end of month 6**: 2nd project team member meeting focusing on final decisions of assessment methodologies, sampling data collection methods, questionnaire survey, demonstration sites. Village interviewers and interviewees preparation related to fishing, mariculture role in local stakeholders' daily life, such as vessel purchased, possessed, duration, fish catch, inputs and benefits, amount in yearly household income. All indicators will be in detailed discussion.
- **Month 7-12**: Sampling data collection (current fishing, vessels or horse power, changes in history, fishery policy, natural accidents, oil spilling and other human pollution) and questionnaire survey (around 600, depending on how many families in one village) in demonstration sites. Desktop analysis focuses on buy-back scheme, fishery, mariculture, eco-tourism, MPAs, pollution, and stakeholders in demonstration sites.
- **At the end of month 12**: 3rd project team member meeting (mid-term meeting) focusing on quality analysis of collected data, data process facing management strategy evaluation (MSE). The assessment will refer to frameworks in figure 1 & figure 2 but not limited to it.
- **Month 13-18**: Science-based management of fisheries using Ecopath model, or Ocean Health Index (OHI), or regional-based Marine Trophic Level index (RMTI) to evaluate the YSLME health based on village catch or fish landing. Part of the work is finished in our group. Socio-economic assessment of buy-back scheme based on questionnaire survey of demonstration sites in Dalian, Weihai and Dandong, with consideration of the attitudes, preference, substitute livelihoods, women involvement, social welfare system, children education, village factories, pollution, life-time involvement of fishery and mariculture of typical family households in village level.
- **Month 9-20**: Follow-up survey of sampled households lasting 1-year period based on close interaction with villagers by full consideration of trust, responsibility, culture and personal involvement between researches and villages. A proper subsidy will be offered to sampled households in order to stimulate the sustainability of follow-up survey. Scenarios cover status quo, MPAs, existing land based source of pollution, catch limit, total allowable catch, effective policy, women's role, etc.

- **Month 16-20**: Assessment on income generation and contribution of fishing of sampled households, and social attitude to buy-back scheme, governance analysis, economic implications of participation in buy-back scheme of sampled households, opportunities of alternative livelihoods for subsistence of participating households (integrated multitrophic aquaculture) and assess adequacy and sustainability of social safeguards, women's role changes affected by buy-back scheme.
- **At the end of month 21**: 4th project team member meeting focusing on discussion for sustainable livelihoods of participating households, final technical/financial reports preparation, papers publication, etc.
- **Month 19-21**: Assess income generation and contribution of fisheries and mariculture of sampled households, and social attitude to innovation and interventions of GEF Project; Complete final technical/financial reports and site-specific baseline reports of demonstration sites, submit papers or related materials, etc.

Our timetable shows as following:

Table 9.1 working timetable for the programme

Objectives and procedure	Year	Y-18			Y-19			Y-19			Y-19			Y-19			Y-19		
	Month	09-11			12-02			02-05			06-08			09-11			12		
1. Report on the social economic implications of the fishing vessel buy-back scheme to participating households in 3 sites																			
Literature review																			
Field trips and discussion with all stakeholders																			
Develop methodologies, methods, and questionnaire survey																			
Sampling data collection, questionnaire survey																			
Socio-economic assessment of buy-back scheme																			
Follow-up survey of sampled households for 1-year period																			
2. Governance analysis and socioeconomic assessment of demonstration of integrated multitrophic aquaculture in 3 sites																			
Literature review																			
Field trips and discussion with all stakeholders																			
Develop methodologies, methods, and questionnaire survey																			
Sampling data collection, questionnaire survey																			
Socio-economic assessment of governance																			
Assess income generation, contribution and social attitude																			
3. Important due time																			
End of month 1: 1st project team member meeting																			
End of month 6: 2nd project team member meeting																			
End of month 12: Mid-term meeting																			
End of month 24: 4th project team member meeting																			
Final technical/financial reports																			

10. Second payment request

According to contract 5.4 LOT 2, the first payment will be paid as the following LOT:

> LOT 2: Baseline and interim report for governance and socio-economic assessment, CNY 181,669.3 (60% of the contractual amount).

We have carried on our research as workplan. We will return the receipt to your office as soon as possible one the second payment arrives Nanjing University.

Attachment 1

调 查 问 卷

g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g g

尊敬的公民，您好！我们来自南京大学、烟台大学，为更好地了解您的生活与海洋渔业的关系，即鱼类减少后对您生活的影响，我们特此进行调查，希望您能抽出宝贵时间积极参与。您的回答将对我们的调查结果有很大的帮助！请您能帮助我们填写这份问卷，谢谢您的合作！

1、您的性别： 男 □； 女 □。

2、您家有几口人（家庭关系）？ ______

3、您的年龄区间： 0-20 岁 □； 21-40 岁 □； 41-60 岁 □； 61-80 岁 □。

4、您的最高学历： 无 □； 小学及以下 □； 初中 □； 高中 □； 专科及以上 □。

5、您的职业： 经理 □； 船长 □； 大副 □； 打工 □； 其它______。

6、您有渔船吗？多少艘？ 无 □； 如有请填数量：______。

7、您家渔船的吨位 / 马力？ ______。

8、您每年一般会出海几次？ ______。

9、您主要去哪片海区捕鱼？ 周边区域 □； 黄海区 □； 大洋区 □；

10、与 10 年前相比，您认为现在鱼多吗？ 多 □； 不多 □；

11、如果当前渔船总量降低 10%，您认为每只渔船捕鱼量可能会上升多少？

1% □； 3 % □； 5% □； 10% ； 其它______。

11、哪些鱼最好卖，价格分别怎么样？（有水产收购公司，可以调查往年数据）

______

______

______。

12、您认为最近几年鱼大/小了？多/少了？您认为造成这种变化的原因是什么？

______

______

______。

13、（根据这种变化）您会添置新的渔船？还是卖掉现有的渔船？

______

____

____。

14、您对现在的国家渔业政策有啥看法？哪些不合理的？哪些是有进步的？

____

____

____。

15、平时捕鱼时，您会受到哪些政策的限制？请列出。

____

____

____。

16、如果渔业产量低了，您认为是什么导致的？环境污染？捕鱼的船多？渔网等工具有问题（全捕捞）？养海护海意识低？

____

____

____。

17、为了进一步保护海洋渔业资源的可持续性，如果国家给钱，想让您减少渔船或减少捕捞量，您会不会同意？请给出理由。

____

____

____。

18、国家会根据您的减渔减船贡献给出补偿，您认为如何补偿，补偿多少会比较合适？

____

____

____。

19、您认为国家应该怎样裁减渔船？排序表明优先考虑等级（使用年限、捕捞效率、减少每年新发放的捕鱼船牌照、近几年暂缓发放捕鱼船牌照等）

____

____

____。

20、万一国家不允许您捕鱼了，您想从事什么职业？

。

21、您现在的家庭年收入大概有多少？够用吗？主要支出是什么？

。

22、您家庭中用于养船的开支是多少？（购买时间，价格，现在能卖多少，每年投入多少）

。

23、作为家庭成员，您最担心的是什么？

。

23、如果国家政策不让您捕鱼了，或者让你卖掉船只，您认为补偿多少合适？

。

24、万一出现这种政策，您会配合吗？您是否还会坚持捕鱼呢？

。

再次谢谢您的配合与参与！祝您身体健康，万事如意！

南京大学、烟台大学问卷调查小组