



China Sustainable Seafood Assessment (CSSA)

Aquaculture



**Chinese Mitten Crab (*Eriocheir sinensis*)
Pond Farming**

CSSA Team

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Statement

In the assessment of all species, the China Sustainable Seafood Assessment (CSSA) team will strictly follow the assessment criteria and refer to the latest, impartial and objective scientific data. Common sources of reference for evaluation data include literature review, official materials, objective and unbiased media reports, data obtained from field research, and expert interviews. Inevitably, many fisheries face the problem of lacking robust data, and some data are not publicly available, which may affect the assessment results to some extent. The CSSA team is committed to carrying out the assessment and evaluation of the species objectively and impartially, basing on respecting objective facts, making maximum use of open data, and relying on rigorous scrutiny of experts. The results of the species assessment do not represent the opinion of any particular expert, scholar, etc.. The CSSA team has the right to the final interpretation of the assessment results.

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Introduction

China is the world's largest fishing country, and also has a large consumer market for aquatic products. The food choices we make determine the present and future of our marine and freshwater ecosystems. In order to cultivate a new generation of responsible seafood foodies, Qingdao Marine Conservation Society (QMCS) has launched the China Sustainable Seafood Assessment (CSSA) project to customize scientific and interesting sustainable seafood consumption guides for domestic consumers. We hope that by raising public awareness and promoting changes in consumer behavior, we can use the power of the market to force industrial transformation and make a lasting contribution to the continuous improvement of the health of China's marine and freshwater ecosystem.

Executive Summary

The Chinese Mitten Crab (*Eriocheir sinensis*) is a freshwater farmed crab species with important economic value in China, with a yield of more than 800,000 tons in recent years. Multi-species mixed culture is one of the main farming methods for Chinese Mitten Crab at present, while rice-crab mix-culture and open water enclosed net aquaculture are also common in practices. The main production areas are in Jiangsu, Hubei, Anhui, Liaoning provinces. After nearly 30 years of development, the Chinese Mitten Crab aquaculture industry has formed a certain effective regulatory model in both government management and industry self-regulation. A series of industry standards or specifications have been established, and relevant management regulations have been made for major aquaculture procedures such as pond discharge, but the management of environmental impacts feed substitution needs to be further strengthened. The degree of implementation of standards and regulations can be further improved in the future to ensure the safety and efficiency of the aquaculture industry.

The impact of Chinese Mitten Crab aquaculture on the habitat is mainly reflected in the long-term large-scale reclamation of ponds and occupation of lakeshore wetlands, which puts pressure on the lake as well as the surrounding environment and resources. At the same time, when obtaining feed species such as snails, water pumps are used to harvest the snails, or they are harvested after cutting water plants, which causes great damage to the benthic environment.

At present, the diseases of Chinese Mitten Crab are mainly prevented and controlled by medicine, and there are problems such as the improper application of chemicals and the lack of corresponding monitoring and data collection system in the use of aquaculture chemicals. It is necessary to strengthen the promotion of standardized aquaculture models, reduce the morbidity rate of aquaculture, and improve the supervision on the use of medicines.

At present, the Chinese Mitten Crab aquaculture can fully use artificial seedlings and actively carry out seedling selection trails, but the degradation of germplasm should also be considered, and actively protect and restore wild seedling resources. The escape rate is relatively common in the current farming method, and considering the high degree of artificial selection of Chinese Mitten Crab fry, which has a high risk of affecting wild genetic diversity, management needs to be strengthened in terms of farmed crab escapes.

Although the industry is continuing to promote artificial compound feed substitution, the current aquaculture is still highly dependent on juvenile fish and freshwater snails during the gonad development phase, leading to a high degree of utilization of wild fishery resources.

Waterbirds and large carnivorous fish are potential contact objects. At present, farmers generally drive the predators away and apply bird-proof nets to avoid predation on farmed crabs, and the risk of impact on endangered and protected species is relatively small.

To summarize, the CSSA team believes that Chinese Mitten Crab aquaculture currently has certain habitat impacts, a higher risk of escape, and a greater dependence on wild fishery resources, the environmental performance needs to be improved. Therefore, the rating of Chinese Mitten Crab pond farming is Yellow - a category with good overall sustainability, but still room for improvement.



Chinese Mitten Crab

Eriocheir sinensis

Think Twice

(Pond Farming)

Overview of the Assessed Species

1. Biological Features

The Chinese Mitten Crab (*Eriocheir sinensis*) belongs to the class Crustacea, order Decapoda, family Archaeopteryx, and genus *Eriocheir*. It is an economically important species in China. The cephalothoracic is rounded to square, with the posterior half wider than the anterior half. The dorsal surface is elevated, the frontal and hepatic part are concave, and there are six symmetrical protuberances on the gastric region, each with a granule. Gastric region prominently demarcated from cardiac region, the former surrounded by a concave point and has four teeth. Upper margin is triangular in shape. Anterolateral margin with four acute teeth, the last being the smallest, and a ramus running obliquely on the outer side of the gill area; also a ramus along the inner side of the posterior lateral margin. The male crabs have larger claws than in females, densely tomentose on the inner and outer parts of the bases of the claws, with a sharp spine on the inner terminal corner, and a sharp spine on the dorsal margin of the long segment near the end. The last three pairs of legs are flattened, and the dorsal margins are setose. ^[13] The life history of the Chinese Mitten Crab refers to the entire life process from the union of sperm and egg, the formation of a fertilized egg, through the zoea stage, megalopae stage, juvenile and adult stage, until the death of senescence. ^[17] The distribution of the Chinese Mitten Crab was originally limited to the coastal areas around the Yellow Sea, including Liaoning, Hebei, Tianjin, Shandong and other northern provinces and municipalities, as well as the western part of the Korean Peninsula, but the distribution area has since expanded. At present, the Chinese Mitten Crab can be found from 24 ° N to 42-43 ° N, and around 124 ° E of the Yalu River estuary, to 112 ° E of Hubei Shashi. The distribution center is located between the Yangtze River and the Huaihe River, in which the Yangtze River

produces the highest yield and the best quality of crabs. [6]

2. Trade related status

Many provinces have Chinese Mitten Crab aquaculture industries, especially the Yangtze River Basin provinces where the development of Chinese Mitten Crab farming is even more rapid. In 2022, the domestic production of adult crabs was 815,318 tons, compared with 17,500 tons in 1993, an increase of more than 46 times. After more than 30 years of development, Chinese Mitten Crab farming has now become a unique aquaculture industry in China, with an output value of more than 95 billion yuan. The import and export trade of Chinese Mitten Crab has also developed rapidly in recent years, with its export volume and value rising year by year. In 2008, Chinese Mitten Crab became the second largest single species industry in China's freshwater aquaculture. The government and relevant departments have attached great importance to the development of Chinese Mitten Crab aquaculture, and Chinese Mitten Crab have been listed as one of the ten key industries by the Ministry of Agriculture and Rural Affairs. The Ministry of Civil Affairs approved the establishment of the Chinese Mitten Crab Society of the China Fisheries Association in 2004 to help promote the development of Chinese Mitten Crab aquaculture. [18]

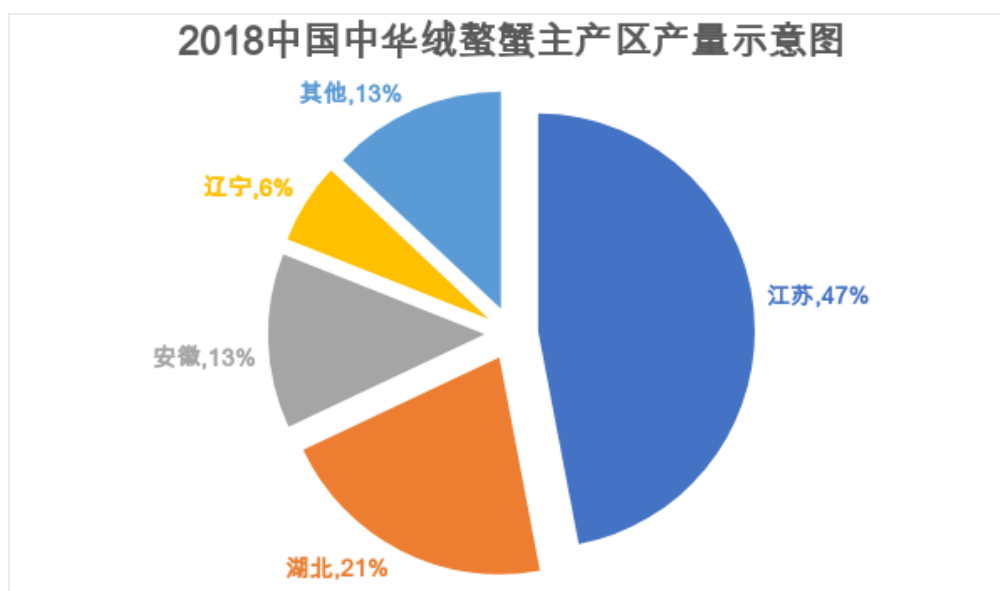


Fig 1. Chinese Mitten Crab production volume of main farming provinces (source: China Fishery Statistical Yearbook)

3. Common names and main production area

The Chinese Mitten Crab (*Eriocheir sinensis*) commonly known as river crab, hairy crab, etc., belongs to the class Crustacea, order Decapoda, family Archaeopteryx, and genus *Eriocheir*. As an important aquaculture species, the farming of Chinese Mitten Crab has been spread throughout the country, the main producing areas are Jiangsu, Hubei, Anhui, Liaoning provinces (four provinces with the largest production volume). [20] Jiangsu Province produces half of total yield, with the production areas of Gucheng Lake, Hongze Lake, Taihu Lake, Gaoyou Lake, and Yangcheng Lake all in Jiangsu, and the most popular Chinese Mitten Crab brand in the market - the Yangcheng Lake and the Hongze Lake - all from Jiangsu.

4. Food safety and recommendation

In 2001, the so-called Jiangsu "antibiotic-poisoned crab" fiasco occurred in Hong Kong, and in 2006, Taiwan's Department of Health claimed that carcinogenic nitrofurans had been detected in Chinese Mitten Crabs from Yangcheng Lake sold in Taiwan. These two incidents have caused consumer panic.^[4] In 2003, a reporter reported that crab pharmacies were selling antibiotics in violation of the law, and that antibiotics were being abused by farmers.^[12] As early as 2001, China launched the Chinese Mitten Crab aquaculture standard requirements, water used for freshwater aquaculture must comply with the NY5051 standard, and the aquaculture environment must be in line with GB/T18407. It shows that with insufficient supervision, farmers do not have a strong sense of law-abiding. In recent years, the regulatory efforts of the relevant departments have gradually increased, and China's newly issued National Standard for Food Safety Limits of Pollutants in Food (GB 2762-2017) also clearly stipulates the limits of lead, cadmium, mercury, arsenic, tin, nickel, chromium, nitrite, nitrate, benzo[a]pyrene, N-dimethylnitrosamine, polychlorinated biphenyls (PCBs), 3-chloro-1, 2-propanediol (3-CIPD), and other substances that may be present in the aquaculture environment. According to the recent results of heavy metal and antibiotic testing of farmed Chinese Mitten Crab, most of the test results showed that the heavy metal content was lower than the national limit standards, but antibiotic contamination still existed.^[5]

FULL ASSESSMENT

Criterion 1: Aquaculture Method and Management Status

Aquaculture method and industry overview

Chinese Mitten Crab is an important species in freshwater aquaculture in China, and Chinese Mitten Crab aquaculture is also a unique aquaculture industry. After years of development, the production has changed from a wild capture-oriented mode before the 1990s to an aquaculture-oriented mode after. In the history of the development of Chinese Mitten Crab production, it has also experienced a more difficult period. In the 1950s and 1960s, because of the construction of hydraulic engineering blocked the migratory channel of crabs, as well as the pollution of water and excessive fishing efforts, resulting in the sharp drop of production volume, and the population was once on the verge of depletion. In the 60's and 70's, researchers carried out a lot of studies on artificial reproduction, embryonic development, larvae development, fishing methods and transportation of crab seedlings, etc. In the early 80's, the technical difficulties of artificial nursery were overcome, and there was a rapid development in Chinese Mitten Crab yield. In the late 80's and 90's, the Chinese Mitten Crab development entered the artificial aquaculture period, with the rising of pond culture, net-pen culture and rice-crab mixed culture. After the rapid development in recent years, the Chinese Mitten Crab aquaculture industry not only has a rapid growth in production, but also has made great progress in aquaculture technology. At present, there is a lot of literature on aquaculture technology, seedling cultivation, as well as on disease prevention and control. The scientists have conducted a lot of research on crab disease prevention and control, seedling cultivation methods and mix-culture methods during the farming process of Chinese Mitten Crab. The research results have played a very important role in improving the yield and quality of the industry, and have also played an important role in promoting healthy

development. ^[18]

Chinese Mitten Crab aquaculture is adapted to local conditions, and different regions adopt different farming methods, which are categorized into the following modes according to different regions:

1. Xinghua Early Market Mode

Pond area is large, mostly 30-50 mu (20,000-33,333 m²), generally put in crab seedlings that are sized 80-100 ind./500g with farming density of 1000-1200 ind./mu (1 mu = 666.67 m²). The average yield per mu is 75 kg, and the highest can be close to or more than 100 kg. Feed used is mainly compound feed, but the late weight gaining stage mainly rely on chilled fish, and selling the crabs before the Mid-Autumn Festival, when the price is higher.

2. Hongze Lake Late Market Mode

The Chinese Mitten Crab aquaculture in Sihong, Hongze Lake area is relatively backward. The seedling density is high at about 2500-3000 ind./mu, due to the poor quality of seedlings, the survival rate is low. The feed requirements are not high, generally feeding low quality compound feed with 32%-36% protein content. Due to the high density, the size of marketable crabs is small, an average size of male crab is 0.11 kg, female crabs 0.075 kg. In the second half of October, the female crabs weighted 0.075-0.125 kg, and male crabs weighted 0.125-0.15 kg are put back to the lake and continue to feed. Then hit the market until next year around the Spring Festival and Lantern Festival when the amount of Chinese Mitten Crab on the market gradually decreases.

3. Gaochun Production Mode

Gaochun crab farmers follow the idea of high input and high output, costing around 6,000 yuan/mu. The crab ponds in Gaochun area are better constructed, with ditches dug around the perimeter, which is convenient for feeding and also helps the crabs to consume. The Chinese Mitten Crab farmed in Gaochun mainly feed on chilled fish, with the amount of feed used being about 200 kg, and pellet compound feed is rarely used. The marketable size for female crabs are 0.15 kg, while for male crabs are 0.2 kg, and the yield per mu is about 75 kg. The seedling density is between 800-1200 crabs/mu. Gaochun crab farmers use more snails as feed than other regions in southern Jiangsu, usually at 500 kg/mu, with 100-250 kg more freshwater snail used per mu, and a small number of farmers can use as much as 1500 kg/ mu. In addition to the conventional planting of *Elodea nuttallii*, will be accompanied by a small amount of *Hydrilla verticillata* and *Vallisneria natans* commonly known as water leeks, flat grass, noodle grass.

4. Jintan Production Mode

Similar to the Gaochun area, crab ponds in this area are dug with ditches. However, many of the crab ponds in Jintan area are transformed from paddy fields, and the ponds are mostly small (3-10 mu) in size, with deep silt and insufficient water self-purification ability, so the incidence of diseases, water quality and aquatic plant management costs are high. A farmer usually only takes care of a few mu of ponds, small ponds have disadvantages, but can be managed more carefully. Under normal circumstances, 1700-2000 seedlings are released into one mu of water, and there are many farmers who release up to 3000 seedlings/mu. The average yield per mu is 125-150 kg/mu, and can be up to more than 200 kg/mu. Farmers generally believe that

crab feeding on chilled fish grow better and have higher yield than artificial feed, therefore the chilled fish feeding is frequently used, up to 500 kg/mu or higher, pellet feed used is generally 100 kg/mu.

5. 3+5 Mode

"3" refers to three-month crab seedling cultivation stage, every year from December to January farm crab seedlings in small ponds or nets in a large pond, the seedling used are 100-120 ind./500 g crabs, the farming density is 2,000 ind./mu, and to plant low-temperature resilience *Elodea nuttallii*, the survival rate of this stage is about 50%. "5" refers to five months of adult crab cultivation stage, after the crab seedling stage, the size and survival rate of the crab seedling are improved, reducing the stocking density (800-1000 ind./mu) as well as the outbreak of diseases. The efficiency has also improved.

In the past five years, the production volume of Chinese Mitten Crab is shown in the following chart. It can be clearly found that after more than 30 years of development, the Chinese Mitten Crab production tends to stabilize at 75-800,000 tons, and the aquaculture area at about 10 million mu, the output value at 90 billion yuan. The main aquaculture areas are located in the middle and lower reaches of the Yangtze River with the yield occupying more than 80% of the country's total farming volume .^[1] The aquaculture industry is in transition to producing more crabs to producing bigger crabs.

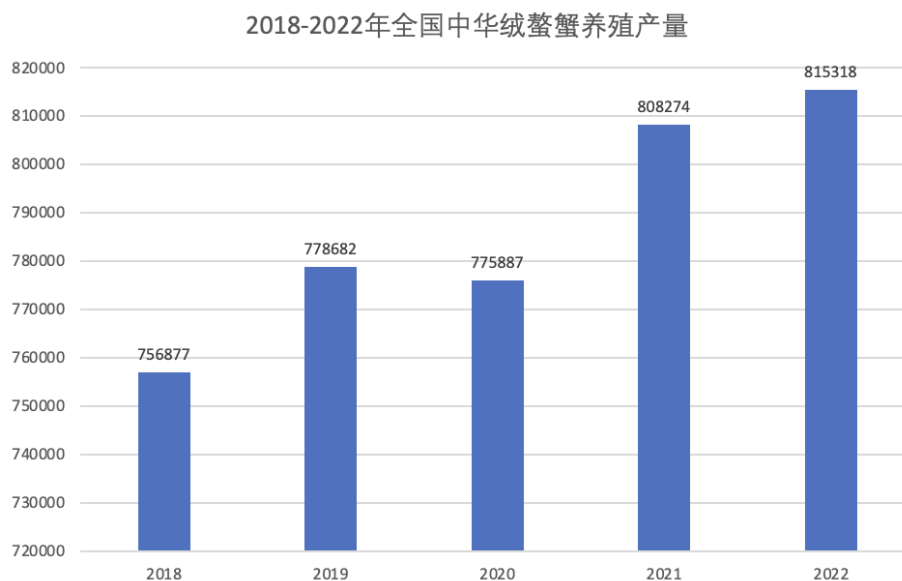


Fig 2. Chinese Mitten Crab production volume from 2018 to 2022 (source: China Fishery Statistical Yearbook)

At present, the main problems existing in the Chinese Mitten Crab farming industry are: 1) germplasm resources degradation, due to the double effects of technology and market price, the parent crabs now used are mainly selected from the local farmed adult crabs, without strict selection and taking the necessary technical measures, the qualities of Chinese Mitten Crabs have gradual degraded.^[24] 2) more serious water pollution, industrial wastes and pesticides pollution is becoming more and more severe, polluted waters leading to higher mortality rate and lower efficiency of crab farming. 3) due to the weak fundamental research in pathology and pathogens, rapid diagnostic techniques, prevention and treatment. Disease

outbreaks and abuse of prohibited drugs are common. 4) Lack of systematic research on feed nutrition, although the Chinese Mitten Crab feed industry develops faster and has a certain scale of production and sales, Chinese Mitten Crab feed producers basically focus on the production of fish feeds, and lack of research on the nutritional requirements for crabs. In addition, due to the cost, the price of Chinese Mitten Crab feed is high and the market application is not ideal, which restricts the development of the Chinese Mitten Crab feed industry.

Government supervision

China has established a series of industry standards or specifications for Chinese Mitten Crab, including the *Technical Specification for Chinese Mitten Crab Aquaculture (NY/T5065-2001)* issued by the Ministry of Agriculture in 2001, the *Technical Specification for Artificial Nursery of Chinese Mitten Crab (SC/T1099-2007)* issued in 2007, and the *National Standard for Food Safety Limits of Food Pollutants (GB 2762-2017)* issued by the National Food and Drug Administration in 2017. The laws and regulations monitor water quality, aquaculture environment, feed and heavy metal residues. Some of these standards are common regulations applicable to all aquaculture activities, and some of the regulations are specific to Chinese Mitten Crab. China has also issued relevant regulations for the protection of wild Chinese Mitten Crab resources. The *Fisheries Law* and its implementing rules state that: If, for the purpose of aquaculture or other special needs, the capture of fry or egg-laying females of eel, anchovy, Chinese Mitten Crab, red sea bream, groupers and other economically important aquatic animals is prohibited. Such behaviour must be approved by the national or provincial or local authorities, and with special permits. Then fishing in the designated area and time period is authorized. The capture of other economically important aquatic animal fry shall be authorized by the competent department.

In 2007, the *Pond Aquaculture Water Discharge Requirements* was released and implemented, characterized freshwater aquaculture water discharges into three types - special protection waters, key protection waters and general waters, and discharge standards are stipulated respectively. Many places across the country have also promoted the policies of recovering lakes, wetlands, agricultural land to their original status, and further strengthened the comprehensive law enforcement of the water environment in an effort to achieve the harmonious unification of economy and ecology. The “Opinions of the State Council of the Central Committee of the Communist Party of China on Deepening the Battle Against Pollution” requires the standardization of aquaculture pond outlets, and the promotion of aquaculture effluent management in the main aquaculture production areas. In order to promote the management of aquaculture pollution, MEE and MARA jointly issued the *Implementation Plan for the Management and Supervision of Agricultural Pollution (for Trial Implementation)*, proposing to guide local authorities in the development of standards and specifications for aquaculture effluent, etc.; and jointly issued the *Opinions on Strengthening the Regulation of Mariculture Ecosystem*, which requires that coastal provinces (districts and municipalities), in accordance with the relevant requirements of the guidelines on the formulation of local standards for the aquaculture effluent control, issue relevant standards for the discharge of mariculture effluent before the end of 2023. To this end, MEE issued the *Technical Guidelines for the Formulation of Local Effluent Control Standards for Aquaculture*, which is used to guide and standardize the formulation of standards and has been in force since March 1, 2023. ^[14] Jiangsu Province, the province with the highest production of Chinese

Mitten Crab, introduced the *Standard for Discharge of Pond Farming Effluent (DB32/4043-2021)* as a mandatory standard in 2021, which requires that the discharge of aquaculture pond in new (altered or expanded) ponds be implemented since August 1, 2021, and the discharge of aquaculture pond in existing ponds be implemented since June 1, 2023, with the Jiangsu Province Department of Ecology and Environment and the Provincial Department of Agriculture and Rural Affairs to implement the standards. ^[10]

After nearly 30 years of development, the Chinese Mitten Crab aquaculture industry has formed an effective regulatory model in terms of government management and industry self-regulation. In view of the various types of disease outbreaks, the lack of effective supervision on the circulation and sales, the neglect of environmental costs during farming, and the counterfeiting of aquaculture used drugs and feeds, it is suggested that the government should increase the control and supervision of aquaculture medicines, feeds, and other important factors of production related to Chinese Mitten Crab aquaculture, vigorously promote the use of feeds, and reduce the use of wild resources as feed such as chilled fish, which is the future trend of the culture of Chinese Mitten Crab aquaculture. Early adaptation to the new policy requirements and accumulation of more experience will give the farmers a head start. Strengthen the supervision and inspection of the producing and marketing, formulate scientific development plans, to guide the scientific and effective development of Chinese Mitten Crab aquaculture, to establish relevant management systems for aquaculture behaviors that jeopardize the ecological environment (e.g., direct discharge of aquaculture wastewater, chemical abuse, etc.), and, for the ponds that originally are farmland, they should be returned to the crop farming use, and carry out the promotion of integrated farming on rice paddies. Strengthen the control of the environmental impacts of aquaculture, develop and promote aquaculture guidelines conducive to good practices in the industry.

Criterion 2: Habitat Impact

Habitat impacts

Chinese Mitten Crab aquaculture areas are mainly concentrated in coastal, river and lake areas, and the farming methods include enclosure net farming, pond culture and rice-crab mixed culture. Among them, enclosure net farming would directly affect lake habitats and indirectly affect benthic organisms and their natural habitats in non-enclosed areas. Pond culture of Chinese Mitten Crab is mainly constructed along the lakes, affecting a large amount of lakeshore wetlands. After the strict control of enclosure net farming in lakes nationwide, most of the Chinese Mitten Crab aquaculture shifted to ponds in the lagoon area, which did not alleviate the pressure on the environment and resources of the lakes. Meanwhile, the soil pond farming of Chinese Mitten Crab has to occupy a large amount of coastal wetland resources. Farmers have established a large number of indoor nurseries and conducted coastal construction projects, which are deserted when there is no high profit. ^[9]

In addition, a large number of freshwater snails have to be used during the process of Chinese Mitten Crab aquaculture. In lakes, freshwater snails are mostly harvested by pumps, which has a negative impact on the substrate. In rivers, freshwater snails are harvested by cutting the aquatic plants. Freshwater snails inhabit dense water plants, which are difficult to catch, so the aquatic plants are cut and then separate the snails after dragging the plants to land.

This causes devastating damage to submerged vegetation, especially the *Vallisneria natans* that freshwater snails like to inhabit. The submerged vegetation is critical to the health of lake and river ecosystems.

There is also the problem of waste water discharge in Chinese Mitten Crab farming. Due to the feeding of chilled fish and compound feeds, and the low conversion rate of nitrogen and phosphorus in feed, the waste water contains high levels of nitrogen and phosphorus pollutants. A large amount of nutrient-rich effluent will be discharged directly into rivers and lakes or along the coast, resulting in excessive nitrogen and phosphorus, which can easily pollute the natural environment.

Based on assessment results, CSSA team believes that Chinese Mitten Crab aquaculture has caused a certain degree of negative impact on the habitat, mainly manifested in the destruction of natural habitats when obtaining natural feed species such as freshwater snails and clams, wastewater discharged directly into the lakes and rivers, wetlands and lakes area developed into ponds, and the destruction of enclosed-net farming method. It is recommended that the government and relevant departments strengthen the protection of natural habitats, reinforce the implementation of effluent standards, encourage the development of environmentally friendly farming methods, gradually restore the function of damaged habitats, and attenuate the negative effects of aquaculture practices on the surrounding environmental habitats.

Criterion 3: Chemical Use and Disease Control

Chemical use

Chinese Mitten Crab aquaculture is large in scale and highly intensive, and the problem of bacterial diseases has become more serious in recent years. Drug control is the main measure to treat Chinese Mitten Crab disease, and it is also the most direct, economic and effective method. At present, the main medical treatments used in the process of disease control are insect repellent (insecticide), disinfectant, water quality (substrate) improver, Chinese herbal medicine and antibacterial drugs. According to the national aquatic animal disease monitoring results from the National Aquatic Technology Promotion Station, bacterial diseases accounted for more than 48.0% of all disease types of the Chinese Mitten Crab, and the pathogenic bacteria are mainly *Aeromonas*, *Vibrio*, and hydrophilic *Aeromonas*, etc. The bacterial infection has the characteristics of quick outbreak and high mortality rate, which leads to significant economic losses and seriously hinder the sustainable development of the Chinese Mitten Crab aquaculture industry. Antimicrobials are the most effective way to prevent and treat bacterial diseases. At present, the antibacterial drugs applied mainly include antibiotics, tetracyclines, sulfonamides, quinolones, etc.

Based on the above assessment results, the CSSA team believes that there are problems in the use of chemicals in Chinese Mitten Crab aquaculture, which are mainly manifested in the lack of implementation of the relevant regulations on the use of chemicals, and the lack of corresponding monitoring and data collection system. It is suggested that in the process of promoting industrial upgrading in the future, the research and development of disease prevention and control methods should be emphasized, and it is necessary improve the

quality of seedling to enhance the disease-resistant ability, reduce the morbidity rate, and reduce the dependence on and the use of chemicals; strengthen the supervision and regulation on production to reduce the occurrence of the illegal use of chemicals; enhance the farmers' knowledge of scientific use of medication, and strengthen their understanding of the rational use of compliant chemicals and the illegal use of chemicals.

Disease control

There are four main categories of diseases that may occur during the farming of Chinese Mitten Crab: bacterial, viral, physiological and parasitic diseases.

Bacterial pathogens are highly prevalent microbial pathogens in Chinese Mitten Crab aquaculture, and the pathogens are mainly *Aeromonas*, *Vibrio parahaemolyticus*, *Vibrio harveyi*, and hydrophilic *Aeromonas*. Its main manifestations include gastroenteritis disease, edema, gill rot, and crustacean ulcer disease.

Viral diseases are mainly manifested as trembling disease, which is named because of the shaking of capture legs when onset. It shows a rapid outbreak of disease, and the mortality rate is very high, with outbreak rate as high as 90% and mortality rate of 70%, serious cases even lead to extinction, resulting in the massive losses.

Physiological diseases are mainly shown as moulting failure, and mostly due to lack of minerals in the feed or discomfort environment. [8]

The most harmful parasite to the Chinese Mitten Crab is the Sessiliasis, which is a disease caused by the parasitism of ciliate such as *Zoothamnium*, *Vorticella*, *Carchesium*, etc. It mainly occurs in the summer, and it can jeopardize the eggs, larvae, egg-holding female crabs and adult Chinese Mitten Crab, and it is especially harmful to the larvae. [19]



Fig 3. Sessiliasis treatment

To summarize, CSSA team believes that there are many diseases in the Chinese Mitten Crab aquaculture industry, and although certain achievements have been made in the treatment and control of diseases, there is still room for improvement in the fields of effectively guiding farmers to cope with various types of disease outbreaks, scientifically dealing with diseases, and effectively mitigating the occurrence of diseases.

Criterion 4: Escape Risk and Response Method

Escape risk

Chinese Mitten Crab is the most important freshwater farmed crab species in China, which is widely distributed in East Asia, and the production areas are mainly concentrated in the Yangtze, Yellow and Liao River basins. The study of wild and farmed populations in the above Rivers revealed that both aquaculture and wild populations in the three water systems have high genetic diversity, and that the crabs in the Liao and Yangtze River systems are relatively genetical close to each other, which provides a reference for germplasm resource assessment, conservation and exploitation of the Chinese Mitten Crab. ^[15]

Due to the farming practices, the escape rate of Chinese Mitten Crab is high. Although the species has natural distribution in China, with the breakthrough of large-scale breeding technology since the 1990s, the seedlings used in large-scale crab farming are artificial selection. The parent crabs used for breeding are basically selected from locally farmed adult crabs, resulting in the gradual degradation of genetic diversity. At the same time, there is also the introduction of crabs from other regions, resulting in the mixing of germplasm resources. In coastal areas with natural populations of Chinese Mitten Crabs, there is a potential risk of contaminating the genetic diversity of wild populations caused by escaped individuals from aquaculture farms.

There is a lack of assessment of the impacts of farmed crab escapes. Given the large number of introduced and genetically-improved crabs in China, there is a high risk that the escapes may have an impact on wild populations. In the future, a mechanism should be established to control the escape from farms, as well as timely and effective monitoring and record-keeping measures, and carry out relevant risk assessments.

Criterion 5: Feed Requirements

Wild caught fishery resources ratio and sustainability in aquaculture feed

Since the 1980s, the domestic aquatic feed industry has been developing rapidly, which has played an important role in guaranteeing the high and stable yield of China's aquaculture industry, but there is a lack of research on the feed for Chinese Mitten Crab, and most of the Chinese Mitten Crab aquaculture is still fed with traditional feeds, such as chilled fish, maize, wheat, soybeans, etc. With the continuous improvement of aquaculture awareness, it has gradually developed into a farming method based on compound feeds, but after the reproductive molting of adult crabs, there are still many farmers feeding chilled fish and freshwater snails to promote the gonadal development of Chinese Mitten Crab. Among them, the chilled fish fed are mainly seawater juvenile fish and occasionally freshwater fish. Frozen fish need to be defrosted and cut, which results in a large amount of labor and low feed utilization rate. Feeding chilled fish is also likely to lead to deterioration of pond water quality, resulting in disease outbreaks and unstable quality of crabs. However, at present, due to the high price of specialized crab feeds, the use of artificial feed is not ideal, which restricts the development of the industry, so it is particularly important to develop high-quality compound feeds to replace chilled fish especially for late fattening. ^[2] Most farmers lack knowledge about

the nutrition requirement of Chinese Mitten Crab at each growth stage and choose fish as feeds after considering the price. In addition, most of the farmers lack scientific knowledge about the amount of feed to be applied, and there is a lack of monitoring of the feed consumption, which can easily lead to excessive feed. Coupled with the influence of the unpredictable weather changing, resulting in the damage of the aquaculture environment. ^[21]

Therefore, there is much room for improvement in the use of feed in Chinese Mitten Crab aquaculture, and the current aquaculture practice of direct feeding of frozen and fresh juvenile miscellaneous fish is unsustainable, which also is the common practice. The coefficient of artificially compounded feeds can be less than 1, which corresponds to the dependence of feed fish and fishmeal/fish oil is also gradually reduced. It is recommended to gradually reduce the use of juvenile fish as feed, strengthen and guide the application of artificial feeds, and continue to increase the research and development of feed efficiency, so as to further reduce the dependence on wild fishery resources.

Criterion 6: Source of Stock

Source of seedlings

Historically, the rivers entering the sea have had natural distribution of Chinese Mitten Crab, and formed unique geographic populations in different water systems. Since the 1950s, due to the construction of water engineering facilities blocking the migration channel, along with industrial wastewater discharges, the natural environment of Chinese Mitten Crab has been seriously damaged, and the wild resources are gradually decreasing. At present, mainly in the Liao River, Yangtze River, Oujiang River, there are still a certain amount of wild populations, but the population is not large. With the development of the Chinese Mitten Crab aquaculture industry, the seedlings needed for aquaculture almost completely rely on artificial selection, with the major farming areas being the Yangtze River system and the Liao River system. Due to years of disorderly selection and breeding, the mixing of germplasm from different geographic regions is common.

Mostly the parent crabs of nurseries come from farmed adult crabs. After generations of breeding, the crabs have shown smaller size, low survival rate, early maturation and low yield, which are all signs of germplasm degeneration. In order to reverse the degraded germplasm resources, aquaculture scientists have done massive work to select crabs with better genetic performance, and have cultivated strains with stable genetic traits, such as "Yangtze River #1" and "Yangtze River #2", "Guanghe #1", "Jianghai #21", etc. ^[3]

Generally speaking, Chinese Mitten Crab seedling cultivation technology is becoming more and more innovative, but the degradation remains serious, threatening the genetic diversity of Chinese Mitten Crab. It is recommended to increase the protection of the wild population, to continue increasing the research on better genetic diversity, to improve the awareness of enterprises and farms, and to realize the stable supply of good crab seedlings. At the same time, it is recommended to study and assess whether there is a competitive relationship between the artificial selected crabs and the wild population, to avoid the genetically improved crabs entering the natural environment, and to rationalize the use of artificial germplasm resources.

Criterion 7: Wildlife Interaction

Wildlife (especially threatened species) interaction

Chinese Mitten Crab aquaculture is mainly concentrated in coastal, river and lake areas, and such areas are also the natural habitats and feeding grounds for some wild animals, especially water birds, so there is a possibility of contact with wild animals during farming practices. Herons, egrets, seagulls, plovers and other waterbirds, small mammals such as brown house mice and carnivorous fish are potential threats to the farmed Chinese Mitten Crab, especially during the juvenile crab stage and just after moulting, when the crabs are vulnerable to predation.

Usually, the farmers will adopt the methods to reduce crab predation by strengthening the regular patrolling of the ponds, expelling the birds manually or covering the pond with nets; installing trapping devices to kill the rodents; and prevent wild carnivorous fish from entering the pond when changing the water. At present, there is a general lack of monitoring records on the expulsion of predator species during production, and a lack of regulations for the interaction measures of wild animals, except for nationally protected species. In practice, the contact and disposal of wildlife (even if protected species are involved) is more dependent on the farmers' will, and there is a lack of effective monitoring and management system.



Fig 4. Grey Heron injured by trap set on crab farm

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