

# MARINE RANCHING IN CHINA







**DEDICATED TO  
ILLUMINATING, ANALYSING  
AND HELPING TO RESOLVE  
OUR OCEAN CRISIS.**





**Isabel Hilton**  
CEO and Editor of chinadialogue

# The ocean's troubles have their origins on land

In 2006, a handful of people in London and Beijing launched chinadialogue.net. At the time, it was the world's only completely bilingual Chinese-English website, and it sought to promote the exchange of ideas on climate change and the environment across the formidable barriers of language, culture and geography.

Today, chinadialogue embarks on a new, and equally daunting project called chinadialogue ocean.

The parallels with our beginnings in the climate dialogue are striking: the life of the planet depends on the health of the ocean and the ocean is in crisis. And just as China became the world's biggest emitter of greenhouse gases, China today stands as the world's most significant single source of ocean impacts.

The ocean is a common resource: we have all exploited it and we have a shared responsibility to protect it. How we approach the preservation and protection of ocean life will determine whether the ocean will continue to support life – or will progressively fail to give us the oxygen we breathe, the food we rely on and the climate that we need.

Restoring the health of the world's ocean is a global challenge that will require effort, ideas and goodwill from many sectors, including business, government, civil society, science and everyday consumers. We shall be publishing on the key issues of pollution, fishing, climate change, ocean governance and conservation, exploring the impacts of the ocean crisis around the world, as well as in China.

The ocean's troubles have their origins on land. That is where the solutions also have to begin, and they begin with dialogue. We hope you will accompany us on this journey.

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Boats leave the Shipu Fishing Port in Xiangshan county

HE YOUSONG/XINHUA/ALAMY LIVE NEWS

# Restoring China's coastal fisheries

An analysis of the policies that have shaped the country's fishing sector over the last 30 years

By **Tang Damin**

Whether it's to work in tourism or to run a cold store, more and more Chinese fishermen are returning to dry land. Most don't have a choice.

China's coastal waters used to provide rich fishing grounds, but those days have long since passed, and with them many of the jobs. In Xiangshan, once a prosperous fishing town in the south-eastern province of Zhejiang, almost 400 fishing vessels out of about 3,000 will need to be scrapped by 2019.

The crisis affecting China's coastal fisheries has become impossible to ignore. In December 2016, the Ministry of Agriculture published its toughest plan yet to reduce the annual catch size by almost a quarter within three years; from over 13 million tonnes a year to under 10 million. (The ministry calculates that a sustainable catch is 8-10 million tonnes a year.)

China barely ranked as a fishing nation 30 years ago, but it is now the world's largest producer and consumer of seafood products. Yet the rapid growth in coastal fishing, and the pressure this has put on fish stocks, has proved the adage expressed by Britain's chief fisheries scientist Michael Graham, who in 1943 declared that, "fisheries that are unlimited become unprofitable".

## Early limits

The boom in China's coastal fishing dates back to Deng Xiaoping's economic reforms in the late 1970s.

Prior to China adopting market mechanisms, the country's fishing sector was governed according to central government strategy. In the 1960s, fishing boats were limited in number and made of wood. They belonged to village communes, which decided where and when the boats fished. Individuals were not permitted to invest.

China's ossified commune system effectively limited the amount of fish caught.

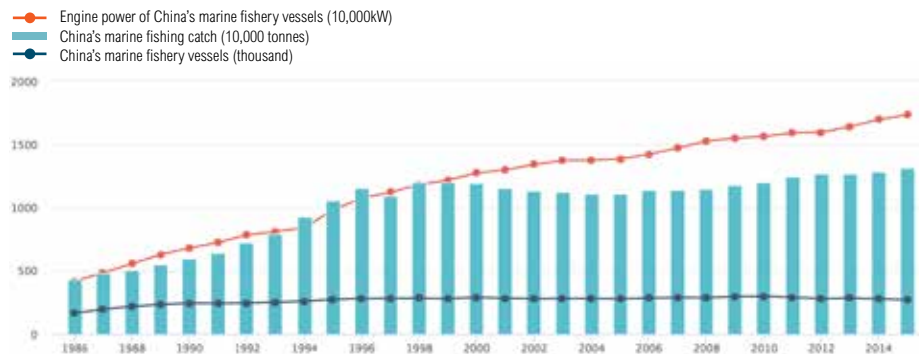
Despite widespread food shortages, China's coastal fishing catch by the mid-1970s was only three million tonnes, according to data from the United Nations Food and Agriculture Organisation (FAO).

## Deng era reforms

In a review of China's fishing policy, Cao Ling, a researcher at Stanford University's Centre on Food Security and the Environment, traced the turning point for the industry to the Fisheries Law of 1986.

The Fisheries Law called for the rapid development of fishing in Chinese waters

## Growth in China's fishing capacity and catch



Data from the Ministry of Agriculture and compiled by Greenpeace show the catch size increased almost 200% between 1986 and 1995.



through the privatisation of fishing vessels and growth of seafood markets.

It stated that, “The state shall encourage and support the development of offshore and deep sea fisheries and make rational arrangements for fishing capacity for inland and inshore fisheries”.

The reforms were effective but the good times did not last. By 1999, additional fishing capacity was failing to deliver an increase in overall catch, which plateaued at around 12 million tonnes a year. In other words, China’s coastal fleet was having to expend more effort just to maintain its existing catch level.

According to Cao Ling’s review, the quality and value of China’s catch has plummeted, too. The large commercial species, such as yellow croaker and large head hairtail that used to be the bulk of the catch, have declined. Nowadays, 80% of the catch is composed of small, low-value fish, such as anchovy and mackerel. In fact, one third of the catch is not deemed sufficiently nutritious for human consumption and is used to produce fodder, according to Greenpeace.

Investing more resources to maintain output is not a sustainable way to deliver long-term food security.

China has 20% of the world’s population but only 7% of its arable land. The pressure to produce food has led it to become the biggest maker and user of pesticides and fertiliser. But fishing isn’t like farming. More investment in fishing has not led to more fish in the sea, but instead to many species being over-exploited.

80%

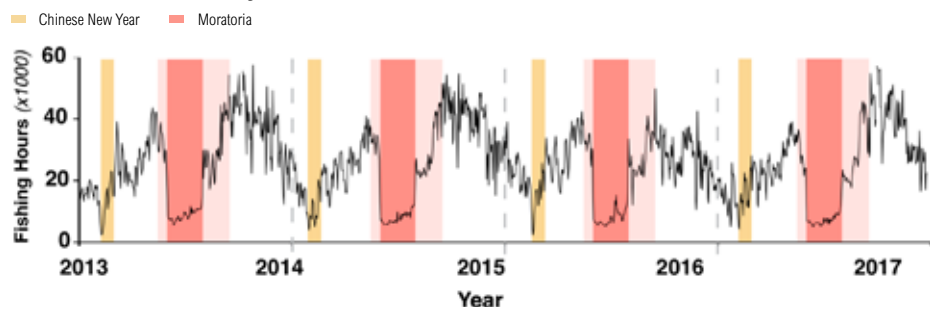
of the catch from China’s coastal fisheries is comprised of small, low-value fish

## Regulating coastal fisheries

By 1995, a decade after the State Council document encouraging privatisation of fishing, China’s catch passed 10 million tonnes a year, marking a turning point in the sustainability of the coastal fisheries, as calculated by the Ministry of Agriculture.

As China’s coastal catch reached that critical point, the government realised the risk of over-exploitation and put in measures from the mid-90s that form the current system of coastal fisheries management. These include:

## Chinese vessel activity



Chinese vessel activity showing the effect of summer closures (Chart: Global Fishing Watch)

### 1. Summer closures

Since 1995, fisheries in the Bohai, Yellow and East China seas are closed during the summer to allow fish populations respite to breed and grow. A summer closure has been in effect in the South China Sea since 1999.

In recent years, the summer closures have been extended. Until 2017 they ran for two or three months above a latitude of 12° from June 15 or July 1 to mid-September, with variations according to the location and type of fishing. From 2017, China has ended fishing from May 1, meaning a closure of four and half months in some places.

### 2. Gear regulation

Rules banning damaging fishing methods such as the use of explosives, poison or electrocution, date back to 1979 but were toughened up in 2013 by the Ministry of Agriculture. Rules on net sizes came into force on June 1, 2014, in the Yellow and Bohai seas, the East China Sea and the South China Sea. Three types of fishing gear that cause damage, including some types of trawling, were also banned.

### 3. Vessel management

China started to exert control over the number of fishing vessels and their engine power in 1987. The number of old and wooden vessels was reduced. The import of fishing vessels for use in Chinese waters was banned. Fishing industry law and regulations require vessels to have test certificates, registration documents and a fishing license. A document issued by the Ministry of Agriculture in 2000 called for “negative growth” in the fishing industry.

In 2002 China started controlling inputs to the industry, with scrappage and buyback schemes offering subsidies to persuade fishermen to give up older boats. In 2003 a policy of encouraging fishermen to change career came into effect.

Unfortunately, China’s efforts to regulate coastal fishing have been undermined by its provision of fuel subsidies, which began in

2006 across a number of sectors, including agriculture and fishing. Fishing vessels receive subsidies based on their engine size and fuel use.

The fishing industry’s fuel subsidy originated to protect vulnerable groups during fuel price reforms, said professor Wang Yamin of Shandong University’s Marine College. Highway maintenance fees were folded into fuel prices, so fishing vessels got a subsidy to compensate them for the additional cost. Unfortunately, the subsidies, which have continually increased in the ten years since launch, had unintended consequences.

Some fishing vessels are now reliant on them, which accounts for the larger part of their income. One-off subsidies for scrapping a vessel can’t compete with the fuel subsidy, which can easily be worth tens of thousands of yuan annually. Fuel accounts for the major part of costs in the fishing industry, and the subsidy has allowed the sector to continue expanding.

## Will ‘ecological civilisation’ save the sea?

But that expansion may be halted if the concept of an ecological civilisation, can spread from land-based action to the ocean. If Deng Xiaoping made economic development the focus for all of China, then Xi Jinping is attempting to do the same for the environment.

Constructing an ecological civilisation has even shaken up the long-standing fuel subsidy policy. In 2015, the ministries of finance and agriculture admitted that the large and sustained subsidies paid since 2006 had distorted price signals and were inconsistent with policies to reduce the vessel numbers and transition fishermen into other jobs.

The central government announced that the subsidy will be cut annually, with the aim of bringing payments down to 40% of the 2014 subsidy level by 2019. This reduction in subsidy is expected to push fishermen (who number between one and four million) to quit the industry.

China is also looking for breakthroughs in fishing technology and working towards a more scientific and detailed management system. In 2014 Zhejiang, a major fishing province, issued China's first provincial standard on the size of fish caught and the proportion of young fish in catches, setting a minimum size for 18 species of fish. Zhejiang and Shandong are also experimenting with catch quotas for horse crab and flame jellyfish, respectively.

The 13th Five-Year Plan for the fishing industry states that each of China's 11 coastal provinces must have at least one trial of catch quotas by 2020. It may be a little late, but these initiatives will gather valuable data to be used in the implementation of a "fishing quota system", mentioned in the 2000 revision of the Fisheries Law.

The sustainability of China's coastal fisheries has an impact on the global footprint of the country's distant water fleets. The depletion of coastal fisheries has spurred rapid growth in fishing from more distant waters. China has the world's largest distant water fishing fleet, of 2,600 vessels. If coastal over-fishing can be resolved then work can be found nearer home for the fishing sector's excess capacity.

So what lesson has been learned from these last 30 years? Perhaps that overly-broad and unenforced policies cannot prevent the depletion of fisheries. Talk is easier than action; China must do everything it has said it wants to do if the situation is to be turned around. 🔄

*The author thanks Liu Lijun for contributions to research for this article.*



# China maps its goals for coastal clean-up



HENFAES/THINKSTOCK

## The new Marine Five-Year Plan outlines proposals for cleaner seas and better-managed coastlines

By **Zhang Chun**

In May 2018, China's central government published its marine strategy for the 13th Five-Year Plan period (2016-2020), setting out broad aims and, for the first time, some binding targets.

The Five-Year Plan's (FYP) marine economic development plan is a clear signal that the government is giving greater strategic significance to the oceans. It is only the second time the country's national development blueprint has included a section on the seas, starting with the 12th FYP in 2012.

The plan covers water pollution, land development and coastal conservation targets, and provides a framework for managing regions under pressure.

### Filthy water

China's breakneck economic development took off largely along the eastern seaboard in the 1980s, creating a legacy of serious water pollution and land management problems. Today, almost all of China's economic powerhouses are still in coastal provinces.

The first marine economic development plan, issued in 2012, drew upon locally relevant marine economic strategies that coastal cities and provinces were already producing. Official figures show that between 2006 and 2010 the marine economy, including fishing and shipping, accounted for 10% of China's economy as a whole – but closer to 18% of the economy in the eleven coastal provinces.

Coastal waters have been heavily polluted by industrial pollutants from rivers, and many wetlands drained for development.

According to the annual Report on China's Marine Environmental Quality, issued by the State Oceanic Administration, the percentage of coastal waters classed as

severely polluted fluctuated between 12% and 17% in the period to the end of the last plan in 2016. Seawater is classified as Class I to Class IV. Only Classes I and II are safe for human contact. Water of worse quality than Class IV is effectively useless.

Nor is pollution the only problem. Overfishing has depleted coastal fishery stocks and wiped out many traditional fishing grounds.

### Setting targets

The new FYP document emphasises “stronger comprehensive management of the marine environment”, indicating that onshore economic activity will be increasingly constrained by marine environmental capacity.

It says 70% of coastal waters should be of good (Class I or II) quality by 2020, compared to 50% in 2004.

It contains a coastline conservation goal, that coast not damaged by land reclamation or construction should account for at least 35% of the total coastline.

These are quantified binding targets that will be used to evaluate the performance of officials. Although there are only two binding targets on marine policy, they are a new addition for the 13th FYP period, and significant because local officials' careers depend upon meeting them.

### Better management

A series of management systems will be put in place, laying the foundation for a coherent approach to cleaning up coastal water pollution.

They include caps on pollution in key areas; assessments of coastal water quality; and licenses to permit and control releases of pollutants into coastal waters.

Ecological red lines are among China's most important environmental management systems, and are now being applied to coastal waters.

Red lines will divide coastal waters into zones where development is banned, and those where it is permitted with restrictions. Where development is banned, no construction will be allowed except for the purpose of environmental protection.

### Key zones

The Marine 13th FYP proposes several red line zones, including the Liaodong peninsula, home to the key oil terminal port of Dalian; the Bohai Gulf, which receives river water run off from much of the north-east China plain (and is a crowded shipping way with several major ports); and the sub-tropical island province of Hainan.

The red line zone off Shandong province in the Bohai Gulf covers both current and planned nature reserves. It bans the removal of sand from key estuaries, land reclamation and new waste outlets within the zone, and sets a minimum volume for freshwater flowing from rivers into the sea.

The system builds on trials of marine red lines that started as early as 2012 in some areas.

In July 2016, national standards for setting marine red lines were released. However, as there is still no legislative basis for marine redlines, the requirements are not binding.

Wang Yamin, associate professor at the Marine College of Shandong University, told *chinadialogue*, that any future legislation would need to take account of regional differences, and allow for regional environmental characteristics and development needs.

Gao Ying, senior policy officer with World Wildlife Federation China, said China's desire to deal with marine pollution stems partly



from its need to improve the overall economy by tackling environmental constraints on growth. Wang sees the process as a consistent development from wider concerns.

### Deep-sea strategy

Statistics suggest there may be more scope for economic growth in the marine economy than on land: China's marine economy grew by 8.1% during the 12th FYP period (2011-2015), beating 7.8% growth for the economy as a whole.

Furthermore, there may be more value in developing farther off waters, rather than coastal waters already damaged by pollution and overfishing.

However, China's increasing activity in Antarctica, and illegal fishing by some of China's deep-sea fishing vessels, has raised international concern.

The Marine 13th FYP calls explicitly for expansion into the oceans, including land, sea and air monitoring platforms near the North Pole and South Pole; study and assessment of deep-sea biological resources, the promotion of deep-sea

mining and related equipment manufacturing, and the use of biological resources.

It speaks of "becoming a marine superpower", "protecting marine interests", and "expanding blue economic space".

### Global profile

China's 13th FYP lays out its desire to become more involved in international governance of Antarctica. Liu Nengye, a law lecturer at the University of Adelaide in Australia, has pointed out that as Chinese fishing and tourism in the Antarctic is growing rapidly, China's effective regulation of these industries is needed for sustainable development.

China's fishing fleet first ventured into polar waters in the 1980s. More recently, the rapid expansion of its deep-sea fishing fleet in other seas has also caused international concern and criticism. Subsidies for deep-sea fishing initiated in 2006 led to a rise of 45% in the number of vessels from 2007 to 2014, during a time of unprecedented pressure on global fisheries resulting from years of overfishing.

China is gradually increasing regulation of its fishing industry. Reforms to subsidies started in 2015, with phased cuts to fuel subsidies – by 2019 the subsidy is set to return to 40% of its 2014 level. China is also bringing its distant water fishing fleet into line with international norms, with standardised logs, monitoring of vessel locations, and catch certification.

China's influence in marine governance is growing.

In May, China hosted an annual meeting of signatories to the Antarctic Treaty, the first time it has hosted the meeting since 1983, when it signed up to the 1959 treaty.

As China becomes more aware of its "marine rights", it will also take on more responsibility for global marine governance, says Gao Ying. She pointed out that Xi Jinping stressed at the UN Sustainable Development Summit in 2015 that China would promote global sustainable development, so China cannot avoid the issue of sustainable marine development. 🍷

*Additional research by Yao Shuhao*

# Chinese aquaculture is driving fisheries to the brink

## A lack of regulation and transparency in the world's largest aquaculture industry is threatening over-stretched fisheries

By **Zhang Chun**

The fishing port of Shidao lies on the edge of Rongcheng city at the tip of the Shandong peninsula. It is China's fishmeal manufacturing capital.

At the harbour, lorries loaded to capacity with what look like bricks are waiting to set off. Peer closer and you realise that those "bricks" that have just been removed from cold storage are actually made of fish, compressed and frozen into slabs. These fish are known as "trash fish" and are too small to sell for human consumption. Instead, they are stored and transported to a processing plant, where they will be heated, pressed, dried and pulverised into protein powder. Ultimately, this will become fish meal and used to feed farmed fish, poultry and livestock.

In a report on the trade in trash fish, environmental campaign group Greenpeace

estimates that 30% of the 13 million tonnes of fish caught in China's inshore waters annually, about 4 million tonnes, are small fish that are used as fodder. That's more than Japan's entire annual catch.

In other words, China is catching more fish to feed other fish than the Japanese catch to feed their population.

### Aquaculture harms fishing

Data from the UN Food and Agriculture Organisation (FAO) shows that in the 20 years from 1995 to 2014, China's aquaculture output accounted for more than 60% of the global total. In 2015, the country's aquaculture sector saw output of 49.37 million tonnes.

To maintain this requires the input of huge quantities of fodder. Zhang Wenbo, a lecturer at the College of Fisheries and Life Sciences, Shanghai Ocean University, estimates that annual demand for fish meal in China stands at

2.5 million tonnes. But it is unclear how much China produces domestically.

FAO figures put domestic production at only 400,000-600,000 tonnes per year. Meanwhile, Greenpeace estimates that in 2014 China consumed at least 760,000 tonnes of domestically produced fish meal. Statistics from China's customs authorities show that in 2016 the country imported about 1.04 million tonnes of fish meal. Whichever numbers you look at, there is no indication of how the rest of that 2.5 million tonnes of demand is being met.

Zhang Wenbo thinks that hidden illegal trading in feedstocks accounts for the gap. He says that some fish meal factories are unwilling to reveal even how much they produce, much less where their raw supply comes from.

Greenpeace's investigation confirmed that shortages of fish stocks have prompted some plants in Shandong to employ their own fishing fleets.



“China still has large numbers of small or unregulated fishing vessels, and it’s very hard to monitor their catches,” says Zhang. Shandong province is China’s largest producer of fish meal, accounting for 55% of the national total output, he added.

Alongside low-value fish, such as anchovies (China catches less than one million tonnes of anchovies each year), a significant proportion of the fish meal mixture is made up of trash fish in bycatch.

Greenpeace calculates that China’s annual consumption of fishmeal is produced from over 2.2 million tonnes of trash fish caught inshore.” And many more trash fish, with low nutritional value, are used as fodder directly without being processed into fish meal. Also, in 2014, China used as much as 4.95 million tonnes of domestically caught trash fish as a direct food source for farming.

And so we see a strange phenomenon: With commercial catches dwindling, fishing vessels are landing more trash fish, which include young fish yet to reach maturation. Rather than returning them to the ocean to grow and repopulate fisheries that support commercial fishing activities, they are sold on, thereby creating a vicious cycle.

In its 2016 report on the state of fisheries and aquaculture worldwide, the FAO listed inadequate management of bycatch as a major factor threatening the sustainability of the industry.

Greenpeace’s report points out that in China half of trawler catches are trash bycatch fish. These are often at the bottom of the food chain, prey for carnivorous fish and mammals such as salmon, dolphin, sharks and tuna, as well as penguins and seabirds.

The FAO pointed out that continued use of bottom trawlers and other netting techniques to catch trash fish threatens the very foundation of the food chain. Since 2007 catches in the Mediterranean and Black Sea have fallen by almost one third, due in part to falling populations of fish at the bottom of the food chain, such as sardines and anchovies.

The FAO also pointed out that alongside small low-value fish, bycatch often includes the young of many commercial species. As part of its investigation, Greenpeace examined the fish found in bycatch – 38% were juveniles of commercial species. The long term effect of such bycatching will do more economic harm than good.

## Lack of data

It is possible for fisheries authorities to take action to combat the misuse of bycatch. The FAO suggests fishing vessels avoid spawning and hatching periods, and that bottom trawling is banned in certain areas.



GREENPEACE/ZHU LI

Greenpeace report that half the catch on most trawlers goes to fish feed

# 38%

of fish found in Chinese  
bycatch are juveniles

China is starting to realise it has a problem. The Ministry of Agriculture is focused on the reduction of use of chilled trash fish in aquaculture, increasing the use of fodder, and cracking down on illegal trading in trash fish.

But fisheries managers are hampered in achieving these goals by a lack of data. As with fish meal output, there is insufficient information on the size of catches of trash fish.

Zhou Wei, ocean campaigner with Greenpeace, told *chinadialogue* that it is currently difficult to identify trash fish catch quantities because they are made up of a range of different species, many of which are not tracked. There is also no data on the trading of these species.

“Improving these statistics is a focus for the fishery authorities currently,” said Zhou. “Better catch and trade figures would be hugely helpful for fishery management.”

In the report Zhou recommends the Chinese government to include trash fish in catch statistics and to reduce the catch of such fish. Meanwhile changes can be made in farming practices to increase the use of fish meal, or fish meal alternatives, instead of using unprocessed trash fish as a direct food source.

Wang Zhenhua of Shanghai Ocean University told *chinadialogue* that the revision of China’s fisheries law in 2000 proposed a cap on catches. But calculating available fish stocks is a huge

challenge and so it has not been possible to give accurate figures on what catch sizes are sustainable.

## Turning fish veggie

To address the problem, China’s feed producers are using novel techniques to bring new hope to the industry globally.


Kevin Fitzsimmons, a professor at the University of Arizona, and other aquaculture experts have set up a prize for development of a fish-free feed. A Chinese firm, Guangdong Evergreen Feed Industry Co. Ltd., is currently the global leader in such sales.

Cheng Chengrong is in charge of research and development at Evergreen Feed. Via email he told *chinadialogue* that the company has been working on fish-free feed for years. He also explained that sale of fish-free feed during the period of the competition accounted for 16% of the company’s total, and that feedback from customers had been positive.

Due to the high protein content and specific nutrients in fish meal, it would not be possible to end its use in fish farming altogether. But feed manufacturers have been trying to reduce its use.

The manufacturers could also make more use of trimmings from fish processing to reduce reliance on ocean catches. Fitzsimmons said that on average only 10-15% of the raw material for fish meal production globally comes from trimmings – the rest is from ocean-caught fish.

But according to independent fisheries industry site *Undercurrent News*, half the raw material for fish meal production in the EU comes from trimmings, while production in Spain, Italy, France and Germany is entirely from trimmings.

China’s pathway towards more sustainable fishing practices may lie in learning from the experiences of other nations as well as understanding its own sector better. 



# The future of Chinese fish farming

ZHANG XINYAN

## Tilapia farmers turn to natural methods to tackle disease, competition and the overuse of chemicals

By **Shi Yi**

Wang Jinyong, 43, has been farming tilapia in Wenchang village on Hainan Island since 1994. His fish are known for their quality and other local fish farmers often stop by to learn the latest techniques.

Wang and his family moved to Wenchang in the '90s. Originally from Zhejiang province on the mainland, they were drawn by the warm climate and cheap land. Back home land is scarce and he would have struggled to make a living, he says.

Hainan is China's southernmost province and the epicentre of the tilapia industry, accounting for 20% of the total output.

When Wang started farming it was common to raise ducks in the fish ponds, which could be sold in the markets of Haikou, Hainan's capital, 100 kilometres away. In those days, farming methods relied heavily on antibiotics, and disposing of duck manure safely was a persistent problem.

In 1999 overseas buyers started turning up in Wenchang. International demand for local

fish was growing and many farmers switched to raising fish alone.

Tilapia is a white, freshwater fish that originates from Africa. Today it is one of China's major aquaculture exports. According to statistics from the Ministry of Agriculture, China produced 1.86 million tonnes of tilapia in 2016; one third of total global output. Almost a quarter of this was raised for export.

"It's the chicken of the fish world," says Han Han, founder of the China Blue Sustainability Institute, an environmental think-tank based in Hainan.

### Small farmers suffer

Wang and his wife live by their fish ponds in a run-down home divided into three rooms; a living space, a bedroom, and a store for fish feed. He's heard that abroad fish farms are well-equipped and more like factories but here in Wenchang this type of family operation is the norm. To keep costs low he only has one full-time member of staff to help manage a farm of 200 mu (33 acres). The bulk

of the work, from feeding the fish to fixing the lights, they do themselves.

These small-scale operations are vulnerable to bad weather and market instability. Farmers have to provide even the most basic infrastructure themselves, and split the cost of maintaining the nearby roads and power supply.

Another problem is the ongoing slump in tilapia prices. Despite being a major producer, China faces increasing competition from its Asian neighbours. The country's exports have been steadily falling as a proportion of global output.

Wang says that the price of his fish has barely gone up in twenty years. Labour costs and other overheads, however, have increased significantly. The couple have had to borrow money to get through the worst years.

Many farmers have tried to reduce costs by farming more intensively. But the extra waste from too many fish has left ponds polluted. Added pressure to produce healthy fish has led farmers to overuse antibiotics.

### Antibiotic resistance

The overuse of antibiotics in aquaculture has become a major issue in China. It



speeds up the development of antibiotic resistance (when bacteria become resistant to the medicines used to treat infections) in fish and people. In 2016 the State Council's Commission on Food Safety, and other bodies, launched an initiative to investigate and rectify the problem.

Attempts to reduce production costs have, on the whole, been unsuccessful. Wenzhang's farmers say their costs have stayed around 3.70 yuan (US\$0.5) per kilogramme for years, while sale prices have stayed at 4 yuan (US\$ 0.6), keeping profit margins low.

## Certification issues

Small-scale farmers also struggle to meet the international standards demanded by importers in Europe and the United States.

"When the sector started trying to sell on international markets it was met with nit-picking and scepticism," says Han Xuefueng, secretary of the Hainan Tilapia Sustainability Alliance. To meet export standards, processing plants and fish farms must go through the certification processes used by overseas buyers. For small-scale operations it is difficult to meet those standards.

When overseas buyers visited Wang's farm they were concerned about the use of antibiotics and the quality of fodder. Some buyers require farms to fence off ponds in order to prevent infection from nearby livestock. But Wang's ponds can't be fenced off.

This is a common problem for Hainan's fish farmers. Local villagers who own the land often keep a cow or two, and grazing rights are thrown into the bargain.

"It's hard to keep good relationships with the local community if their livestock can't feed off the grass," says Xuefeng.

Han Han has spoken to many farmers about the difficulties of meeting international standards.

"It's not that the farmers are failing, but some [regulations] just aren't suitable for family operations in China," she says.

High costs and bureaucratic formalities put smaller farmers off making changes.

Zhang Wenbo, a lecturer at the College of Fisheries and Life Science at Shanghai Ocean University, studies the development of sustainable aquaculture. He says that few consumers are willing to pay extra for sustainably-farmed fish, even in the US and Europe. Factor in the upfront costs and enthusiasm for doing so is often low.

In countries where aquaculture is more industrialised things are different, says Zhang. In the UK and Norway only a few large companies farm salmon, which makes promoting sustainability easier.



ZHANG XINYAN

International demand for Hainan's fish took off in the late 1990s, prompting many farmers to switch from raising ducks to fish

"The consumer is most worried about food safety, but behind that lies the issue of environmental safety"

### Han Han

founder of the China Blue Sustainability Institute

### Another route

With help from a local industry association the fish farmers of Hainan are testing a new approach.

"With the right stock density, you can improve water and soil quality using natural bacteria and lime," says Wang, wearing a broad-brimmed straw hat as he tours his ponds.

Using a handheld measuring device and pH indicator paper, he can keep track of indices such as dissolved oxygen and ammonia concentrations in his ponds. This tells him if the environment is healthy for the fish or not. He's been recording this data for years.

This is why, when the Hainan Tilapia Sustainability Alliance was choosing 20 model fish farms, Wang's was included.

The Alliance has long worked to bring aquaculture up to standard, and advocates


for data collection and data access to allow consumers to track products back to the source.

The association was founded in 2014, with help from China Blue. Its first task was to bring experts and fish farmers together to produce an operating manual for tilapia farming, and to promote those practices widely among its members. The manual covers the handling of water quality and slurry; the safe use of antibiotics; and relationships with nearby communities.

"The consumer is most worried about food safety, but behind that lies the issue of environmental safety," says Han Han, adding: "When farmers can't use regular methods and have to sacrifice the environment in order to make a profit, you end up with food safety issues for the consumer."

But there are many obstacles to progress. The farmers aren't used to working in a cooperative, and education levels in the sector are generally low. Around 80% of farmers end their education at junior middle school. And as sale prices stagnate, many are choosing to quit the business altogether.

But Han Han remains optimistic. China's middle class is driving online demand for "green foods" and consciousness around sustainability is spreading.

"There's bound to be some consumers willing to pay a fair market price for these products," she says, hopefully. 

# Marine ranching: Can China put the environment first?

As China quadruples the number of sea farming pilot projects, experts warn of the ecological risks of rapid expansion

ZHANG XINYAN

By **Alice Zhang** and **Kang Ning**

On an ordinary August evening, seven fishing vessels leave Lusi harbour for nearby fishing grounds while articulated lorries cram the surrounding roads as they wait for the next catch to land.

The fishing grounds off the coast of Lusi, in Jiangsu province, eastern China, are a spawning ground for the large yellow croaker, a species of important commercial value. Decades of overfishing had left yellow croaker stocks exhausted and fishing grounds badly damaged, but in recent years their numbers have bounced back.

In late 2017, one man brought up a catch worth 400,000-500,000 yuan (US\$60,000-US\$75,000) in a single haul, says local fisherman Pang Yuchang – such is the return of abundance.

“These days, lots of people come from Shanghai at the weekends to buy fresh fish,” he says. “You even have to book your hotel in advance.”

The resurgence of the fishing industry seems to prove that the management policies implemented by the Jiangsu provincial government have had some success. In 2017, it extended the two-month closed fishing season to three months – giving juvenile

yellow croaker a longer period of time to reach maturity.

The placement of artificial reefs – used since 2015 as part of a “marine ranching” approach (also known as sea farming or mariculture) – can also be credited with the species’ resurgence along the Chinese coastline.

## The rise of marine ranching

Marine ranching was developed in the 1970s. It is a type of aquaculture involving the cultivation of marine organisms for food and

other products in open sea or in an enclosed section of ocean.

Early attempts involved sinking old boats and using manufactured reefs to change seabed currents and encourage algae to grow, which in turn attracted other marine species. Today the approach involves placing artificial reefs on the seabed, releasing juvenile fish, and encouraging the growth of kelp forests. There are more equipment-intensive approaches to marine ranching, which are used to raise high-value fish species but these are less common in China.



Ailunwan marine ranch operations terminal

KANG NING



Historically, China's approach to the sustainable management of coastal fisheries has been to reduce capacity: cut the number of fishing boats, extend the closed season, and reduce fuel subsidies. But in the last few years, the pace has quickened on more production-focused and technical approaches.

### Profit to be made

China's 200 existing marine ranches are also popular destinations for tourism and leisure fishing, attracting 16 million visitors per year. So while each ranch costs on average 5.6 billion yuan (US\$820 million) to create, the industry can generate as much as 31.9 billion yuan (US\$4.7 billion) in revenue each year, according to the national pilot plan.

The Ministry of Agriculture is planning to increase the number of national marine ranching pilot projects from 42 to 178, and the amount of sea area covered from 850 to 2,700 square kilometres, by 2025. To achieve this goal, 50 million cubic metres of artificial reefs will be created, generating 15 billion yuan (US\$2.2 billion) a year in fishing and tourism revenues, according to "conservative estimates" from the Ministry of Agriculture.

### The risks of overexpansion

But creating marine ranches is complicated and the risks of rapid overexpansion must be considered.

Dr Yang Hongsheng, deputy head of the Institute of Oceanology at the Chinese Academy of Sciences, told *chinadialogue* that problems can arise during the management, planning and construction of marine ranches. He says that the variety of marine environments along the north-south coastline makes the selection of locations a challenge. Examples of the environmental risks include damage to the seabed from marine infrastructure, disruption to the food chain and pollution from intensive aquaculture and tourism.

Ownership and management of the ranches is split between local government

**19.1**  
billion yuan  
of state investment planned  
for marine ranching

**200**  
existing marine ranches  
are also popular destinations for  
tourism and leisure fishing

**50**  
million cubic metres  
of artificial reefs will be created to  
build marine ranching pilots  
by 2025

and aquaculture companies.

China's marine ranches are currently concentrated in the Bohai and Yellow Sea and its surrounding area. There are only nine pilots in the South China Sea. There are none in the tropical regions.

China does not yet have any specific regulations on the construction of marine

ranches. But according to guidelines from the United States' Bureau of Safety and Environmental Enforcement, artificial reefs should not be created in a way that might damage natural habitats; and should not be placed on coral reefs or beds of aquatic grasses, microalgae or shellfish.

In China, locations should be chosen following a scientific survey of the seabed (under the purview of the Ministry of Agriculture and Rural Affairs), says Yang. They must also meet a minimum surface area – marine ranches of less than 10,000 hectares are of little environmental or economic benefit, he adds.

"The definition of a marine ranch used in China is too broad," Yang told *China Science Daily*. "Placing artificial reefs, the release of juvenile fish and even the use of cages are all defined as marine ranching. There's also confusion between coastal fish farming and marine ranching, leading to a proliferation of marine ranches."

With 19.1 billion yuan of state investment planned, local governments and businesses are expected to be drawn to the sector – and possibly be willing to ignore expert advice for the sake of being awarded a national pilot project.

### Environmental impact

Marine ranches are relatively new in China. It is not yet known how these larger-scale human interventions will affect the marine environment. Deciding how to prevent and minimise these impacts is crucial. The concern is that currently marine ranching takes place without a full understanding of the impacts, says Xu Qiang, a professor at Hainan University and specialist on ranching in the South China Sea.

The majority of China's marine ranches have been designed to increase the output of "economically-valuable" marine life. Disruption to marine ecosystems such as mangrove forests, kelp beds, and oyster and coral reefs are rarely taken into consideration, nor is the genetic diversity of wild fish populations.

Ranches designed solely to increase the population of a single species reduce the stability and sustainability of the ecosystem, says Yang. Meanwhile, the release of farmed juvenile fish affect the genetic structure and diversity of wild populations.

In some places, the release of juvenile fish, coupled with remediation and better protection, may be enough to restore ecosystems without the need for artificial reefs.

"If the environment is to be put first, the builders of marine ranches need to respect the oceans and nature," says Xu. "The rapid transfer of marine environmental technologies and expertise will be crucial. Investment alone won't ensure marine ranches are a success."



Workers in a seafood shop is sorting the newly-arrived swimming crab

KANG NING

# A bizarre ‘swimming with tuna’ attraction puts Australia’s controversial aquaculture in the spotlight

Is this an opportunity for conservation education, or another example of the government bending to Big Tuna?

By **Jessica Wynne Lockhart**

A handful of sardines is tossed into the water. And another. The little fish vanish as other, much bigger fish rocket up from the murky black depths to gobble them. The tuna slice through the water with the precision and speed befitting their nickname, “Ferraris of the ocean”.

A boy pops his head up from the water. “Is this real life?” he screams from the floating fish pen. It’s a weekday in Port Lincoln, Australia, and bluefin tuna purveyors Yasmin Stehr and Michael Dyer are playing hooky with family and friends. They’re testing out their latest commercial venture, Oceanic Victor, which focuses on the coveted bluefin – not as food, but as entertainment.

Behind the boy’s snorkel mask is a look of sheer glee. It’s the kind of look Stehr and Dyer hope to elicit from many more people when they launch their swim-with-tuna operation in Victor Harbor, a small coastal town and tourist hub over 700 kilometres away.

First, however, they have to overcome the protestors.

Within a few months of Stehr and Dyer applying for permits, there was public uproar in Victor Harbor. In December 2015, the same month Oceanic Victor was scheduled to open, 83 objections were lodged against the proposal, citing concerns that the pen – identical to the kind used in tuna aquaculture – would cause danger to other species and environmental degradation. Local businesses hung protest fliers in their windows, opponents circulated a petition, and the lifeguards erected a massive banner across their watchtower. By mid-February, protesters had filed four separate appeals against Oceanic Victor, stalling its launch.

“We were blindsided,” says Stehr, later adding, “We thought that we were the good guys coming in with an educational facility”.

Instead, the battle over the attraction has exposed a general rift about the much-

lauded, and valuable, industry it symbolises – tuna aquaculture in Australia – sparking accusations of governmental kowtowing to the tuna ranchers and doubts about the fishery’s true level of sustainability.

Before Stehr and Dyer took over the floating tuna tank and made plans to relocate it, a similar operation ran without objection in Port Lincoln for years. The polarity in public opinion boils down to this: The people of Port Lincoln were naturally more open to the attraction because it’s emblematic of their livelihoods. As many as 4,000 of the 14,900 or so residents work in the fishing industry.

Yet Port Lincoln, a winding 8-hour drive from Victor Harbor, isn’t exactly what springs to mind when you say “fishing town”. Beyond the city’s agricultural outskirts, wealth subtly glimmers. Evenly spaced palms line the road to the Lincoln Cove Marina, home to the largest fishing fleet in the southern hemisphere, an indoor pool, and a four-star hotel. Just down the street, glossy SUVs sit in front of new condominiums on roads with names like “Laguna Drive”. And the archetype grizzled fisherman is nowhere to be found: the “seafood capital of Australia” is reported to have the most millionaires per capita in the country.

While the region is also known for shellfish such as abalone and mussels, and the oyster industry alone is estimated to be worth US\$22 million, it’s most famous for southern bluefin tuna, Port Lincoln’s pearl. A single tuna – later transformed into as many as 10,000 pieces of sushi – can sell for US\$2,500 at Tokyo’s famous Tsukiji Market. (In 2013, one fish that was considered auspicious reportedly sold for \$1.76 million.)

At the airport, a life-size tuna greets arrivals, and during the annual Tunarama Festival, spectators watch the “world famous” tuna toss competition. Documentaries such as *Tuna Cowboys* and *Tuna Wranglers* have profiled the wealthy anglers who call Port Lincoln home.

Once on the brink of bankruptcy, the



**FLICKR/JOSEPH AZZOPARDI**  
Captive bluefin tuna

community is revelling in its good fortune. The southern bluefin tuna, a highly migratory fish found in the Atlantic, Indian, and Pacific Oceans, has been heavily targeted since the 1950s. Just 20 years ago, both the species and the fishery were staring down extinction. Australian fishermen had begun to reel in as little as 5,000 tonnes annually – 20,000 tonnes less than just three decades earlier. As little as 3% of the original southern bluefin population remained.

In 1993, the three nations responsible for 80% of the catch – Australia, Japan and New Zealand – rallied. They agreed to a yearly quota system, managed by the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), in an effort to curb the decline. The restrictions inspired creativity: How, the Australian fishermen wondered, to produce more meat with fewer fish?

The solution was floating feedlots. Each year, the fish travel from their spawning grounds off northwest Australia in the Indian Ocean south and then east to the reefs of the Great Australian Bight to feed, making them an easy target. Between December and March,





A bird's-eye view of the marine farm

FLICKR/MIKE KNEEC



ILLUSTRATION BY MARK GARRISON

fishermen capture around 5,500 tonnes of wild juvenile tuna – roughly 367,000 fish – using a purse seine method, which involves encircling a school with a weighted fishing net

and then cinching it closed at the bottom, like an underwater drawstring bag.

Over two weeks, the fish are towed in the net behind the boat at a glacial pace to

Spencer Gulf, near Port Lincoln, before being transferred to “ranches”. For the next three to six months, the tuna live in large pens – each containing between 2,200 and 3,500 fish – where they’re plumped up on a steady diet of high-fat sardines. Once ready for market, the tuna are shipped by freezer boats or live airfreight to their final destination, usually Japan. A single pen full of tuna can net upward of \$2 million.

While the method of aquaculture has since been adopted along Mexico and in the Mediterranean Sea to raise northern bluefin and Atlantic bluefin, Port Lincoln remains the only place in the world where southern bluefin are ranched. It’s also the only place that doesn’t catch southern bluefin by longlining, a controversial commercial fishing method that uses a long hooked line to trawl waters and often kills other species in the process.

Today, tuna aquaculture is one of Australia’s fastest growing sectors; about 15 tuna ranching companies operate in South Australia, bringing in between \$114 and \$227 million annually. (Compare that to Canada, where the entire country’s commercial tuna industry is only worth \$17 million.) Pioneers of the ranching method became rich and put Port Lincoln on the map as a leader in sustainable seafood production.



Tuna auction in Tsukiji Fish Market, Tokyo, Japan

FLICKR/MIKE KNIEC

“The future is not the Internet; it’s aquaculture,” local fishing baron Hagen Stehr, Yasmin Stehr’s father, told *Forbes* in 2006.

The CCSBT claims the quota system is working. Evidence from aerial surveys, tagging and data projections suggests that tuna have rebounded to about 9% of their original spawning biomass, up from the low of 3%. By 2035, CCSBT predicts, the wild stock will have returned to 20% of its original spawning biomass. That estimate may seem underwhelming, but it’s enough to make the commission reassess its policies.

“We’re actually getting increases in quotas because the population is so robust,” says Kirsten Rough, a research scientist with the Australian Southern Bluefin Tuna Industry Association. Just last December, Port Lincoln’s fishing industry was awarded sustainability accreditation by the NGO Friend of the Sea.

However, while tuna aquaculture is touted as an ecologically friendly way to meet the insatiable demands of the Japanese sashimi market, there’s evidence that tuna are actually floundering.

Fish are tricky to count, which makes determining their population an inexact science. More conservative estimates put the current percentage of spawning biomass closer to 5%. The CCSBT’s efforts to conserve the species are good, but according to other monitoring bodies, they’re far from good enough. While

Australia’s Environment Protection and Biodiversity Conservation Act only classifies the fish as “conservation dependent,” they remain on the International Union for Conservation of Nature’s critically endangered list.

As the world’s population grows, aquaculture has become increasingly important to food security. The Food and Agriculture Organization of the United Nations estimated in 2010 that an additional 27 million tonnes of farmed fish would be needed to maintain the present level of global fish consumption per capita in 2030. Today, aquaculture provides half of all fish consumed by people globally.

But while aquaculture typically has a lower environmental footprint than traditional commercial fishing methods, tuna is an exception. The species’ feed conversion ratio is exceptionally low compared to other farmed fish; a tuna needs to chow down on as much as six times more food than a salmon does. Australia catches more than 38,000 tonnes of sardines every year just to satiate the demands of Port Lincoln’s fisheries, making sardines the most heavily fished species in the country.

Tuna are also notoriously difficult to breed. The young are especially fragile and sensitive to water temperature, currents, and changes in their environment. The ranchers’ reliance on juvenile wild stock means that tuna are possibly being caught before they can reproduce. And although the quota system was developed to

“We’re actually getting increases in quotas because the population is so robust”

**Kirsten Rough**

A research scientist with the Australian Southern Bluefin Tuna Industry Association



ensure the long-term survival of the species, it's managed by the same industry that profits from it. Tuna ranch operators are rarely subject to independent third-party assessments. The result, says University of Technology Sydney researcher Kate Barclay, who specialises in the sustainable development of tuna fisheries, is systemic overfishing and false counting.

When compared to the fishing practices that nearly decimated the tuna population, it's undeniable that aquaculture is a necessary alternative. Industry spokespeople are justified in boasting about how they've reduced by-catch by eliminating longlining, yet they overlook an important point – pens take a toll on the environment, too. Ranches collectively release 1,946 tonnes of nitrogen every year – a common stressor in marine ecosystems, known to promote algal growth and smother marine life – making them the largest industrial contributor of pollution to the Spencer Gulf.

For critics of Oceanic Victor and the industry at large, such as Nisa Schebella, a protestor from Victor Harbor, putting people into a pen to swim with the species is overexploiting an already beleaguered species. It's one thing to keep highly migratory animals in a pen for food – it's another to do it solely for frivolity. “The more I research, the more I'm bamboozled by the whole fishing industry at large and its dismissal of tuna's critically endangered status,” she says.

On a blazing February morning in Victor Harbor, hundreds of people have gathered on the lawn in front of the local yacht club to rally against Oceanic Victor. Mark Parnell, the leader of the South Australia Greens party, hollers into a loudspeaker: “What the proponents will tell you is, ‘Oh you silly people, you don't understand anything.’ I think you have every right to be suspicious and every right to be concerned.”

United, the protesters stream into the water of Encounter Bay toward Granite Island, with their surfboards, catamarans and float toys, forming a circle in view of the proposed site of Oceanic Victor.

The proposal Oceanic Victor presented in 2015 was an easy sell for the Victor Harbor Council. Worth \$2.4 billion, tourism in South Australia is even bigger business than tuna, but Victor Harbor has been struggling to attract its share of attention so the council fast-tracked the application and Oceanic Victor received its aquaculture licence and approvals from both the Victor Harbor Council and the state government to lease a section of water in the Encounter Bay Marine Park, a protected area.

“They went through the process and got a tick box for an aquaculture licence – even though it's in ... a habitat protection zone. So what's to stop it from happening in the future?” says one conservationist, who asked

not to be named. “When [the tuna industry] says ‘jump,’ the government jumps.”

The pedigrees of Oceanic Victor's owners add to the suspicion. Yasmin Stehr's father, Hagen, made millions with Clean Seas, his fishing company based in Port Lincoln. Her partner, Dyer, is the operations manager of Tony's Tuna International, another industry heavyweight, and Oceanic Victor is co-owned by “Tony” himself, Tony Santic.

Although Oceanic Victor's licence prohibits them from farming fish (the fish will live out the entirety of their lives in the pen) critics believe that moving the pontoon into Encounter Bay could have untold ripple effects. Although no bird or mammal deaths, entanglements or even shark interactions – the main concern of this particular group of protesters – were reported during the four years that the attraction was located in Port Lincoln under its former ownership, Encounter Bay is a different ecosystem.

**2.4**  
**billion dollars**

the value South Australia's  
tourism sector

Every year, endangered migratory southern right whales use the bay as a nursery. Any increase to predators means that whales may pass by, putting both their population and the town's main tourism draw at risk. While experts think it's unlikely that sharks from outside the local area will be attracted to the pen, the same can't be said of long-nosed fur seals, which have a taste for tuna meat. If attracted to the area, the seals are also likely to hunt and decimate the vulnerable population of little penguins in the area.

While the stocking density of the pen will be low, with only 60 fish, compared to thousands kept in commercial pens, Victor Harbor's Encounter Bay is shallow. Oceanic Victor went through what Stehr says was a “vigorous and exhaustive application process” – including public consultations and government environmental evaluations – yet no assessments were conducted regarding the area's water flow or the potential effects of nitrogen discharge.


The protesters' fixation on sharks has helped keep the opposition a front-page news item, but is detracting from what could be

their strongest argument – in an era when SeaWorld's profits are crashing and tourists are increasingly questioning whether animals should be kept in pens for entertainment, swimming with tuna is an antiquated approach to how we interact with wildlife.

“The political landscape with respect to keeping animals in captivity is changing rapidly,” Tony Bertram, a member of the Kangaroo Island/Victor Harbor Dolphin Watch, wrote in an appeal letter to the state government. “Is this really something the people of Victor Harbor wish to link themselves to?”

If approved, Oceanic Victor also arguably has the potential for good. As marine scientist Kirsten Rough points out, allowing children to interact with wildlife could play a role in conserving the threatened species. “I gained my love and respect for the sea and my desire to learn more about ecosystems and the importance of looking after what we have through hands-on experience,” Rough says of her own childhood growing up seaside. Oceanic Victor, she argues, will spark that same interest in future generations.

Researchers at Kindai University in Japan have demonstrated that industry can be a powerful driver of conservation, too. With the financial support of the domestic fishing industry, they've recently developed the technology to breed Pacific bluefin tuna, closing the lifecycle. In due time, the technology will likely be adopted in the Port Lincoln area, reducing the industry's reliance on wild-caught fish – and potentially affecting the entire industry's balance of supply, demand and valuation.

To the average bystander, Oceanic Victor may seem as bizarre as it is controversial. Sure, we swim with dolphins, sharks, rays and a whole host of other marine creatures – but tuna? Dip your head in the water and watch an 80-kilogramme fish whip toward you at highway speeds and you'll quickly understand the appealing mix of terror and exhilaration. Australia's tuna industry may be poised to change at the same breakneck speed, but one thing will always hold true: for as long as South Australia is located by the sea, the livelihood of its people will depend on fishing and tourism. Balancing the demand for one species with the negative ripple effects of that demand will always be a challenge. Critics and proponents will be waiting for the final ruling on Oceanic Victor's fate in Victor Harbor to see which way, this time, the tuna scales will tip. 

*Update: Oceanic Victory opened to the public on 2 September, 2017.*

*Originally published in October 2016 in **Hakai Magazine**, an online publication about science and society in coastal ecosystems.*



# Opinion:

## “Artificial reefs come with environmental risks”

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**A**long with Japan and the United States, China was among the first nations to propose the “agriculturisation” of the oceans in the 1960s and 70s.

The technology that underpins marine farming – of macroalgae such as kelp and seaweed; shellfish such as oysters, mussels, scallops and abalone; and fish such as butterfish and salmon – is mature and practiced globally, but marine ranching (using artificial reefs) is still in its early days, both in terms of technology and scale of practice.

China is one of the leading investors in marine ranching. So far it has focused on experiments with artificial fish reefs; the release and seeding of fish, shrimp, crabs and shellfish; and the rehabilitation of algae and kelp beds. However, there has not yet been a long-term, in-depth study of the ecological, social and economic benefits or drawbacks of this approach.

It is worth noting that a significant proportion of China’s planned marine ranches rely on the creation of artificial reefs. Any approach has both appropriate uses and limitations, and artificial reefs come with environmental risks because they substantially change the topology of the seabed. There is currently a lack of technology, experience and regulation to guide the use of artificial reefs, and the evaluation and management of associated environmental risks needs improving.

To ensure the ecological health and security of the coasts and the ocean, the development of marine ranching in China should focus on exploring suitable practices. When planning marine ranches in or near marine reserves, or key fishing grounds, it is particularly important to consider the local circumstances (ocean currents, the type of seabed, the food chain, primary productivity), the needs of endangered species, scenic value, and then proceed with caution.

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By *Wang Songlin*, founder and chair at the Qingdao Marine Conservation Society,  
and *Cao Man*, researcher at the Qingdao Marine Conservation Society



POLICY ANALYSIS

# Explainer: China's plan to expand marine ranching by 2025

Six things you need to know about Beijing's plan to cultivate coastal fish stocks

By **Zhang Chun**

**D**ecades of pollution, overdevelopment and overfishing have left China's coastal environment degraded and fish stocks in peril.

But in recent years, the government has taken steps to restore the country's coastal waters. It has tightened regulation on industry to stem pollution, placed restrictions on coastal development, and is reducing the size of coastal fishing fleets and limiting fishing activity.

But there's another way of restoring the coastal environment, which the government wants to expand – marine ranching. This is a type of aquaculture that refers to the cultivation of marine organisms in an enclosed part of the ocean. After years of experiments conducted by several coastal cities, the idea is moving centre stage as China attempts to transform its fishing industry.

First developed in the 1970s, marine ranching holds the promise of restoring the marine environment while allowing the sustainable use of fishery resources. Typically, it involves creating artificial reefs in specific areas in order to farm fish and

other marine creatures, although there is no uniform practice or definition.

As of 2016, China had 850 square kilometres of marine ranches, an area about half the size of Beijing. Despite the scale of activity there is no integrated and scientific approach to marine ranching techniques. This stems partly from the local differences in environment along China's coast from north to south; a lack of basic research, overall planning and management for the sector; and varying levels of local economic development.

In response to these issues, the Ministry of Agriculture released a 2017-2025 plan for the creation of national marine ranching pilots. It's hoped that high-quality pilot projects will improve the standard of marine ranch construction and management, and promote a shift in the fishing industry toward improving quality rather than increasing quantity.

*NB: Two lists of approved national marine ranching pilots were published in 2015 and 2016, with a third list published in December 2017. All pilots on that third list are shown in Appendix 1.*



# Construction of marine ranches in China up to 2016

- Bohai Sea & Yellow Sea
- East China Sea
- South China Sea

Sea area  
**77,000 km<sup>2</sup>**

Number of approved national marine ranching pilots

**32**

346.7 km<sup>2</sup>

Construction funds already invested

**4.452**

billion yuan

Sea area  
**380,000 km<sup>2</sup>**

Number of approved national marine ranching pilots

**5**

235.7 km<sup>2</sup>

Construction funds already invested

**383**

million yuan

Sea area  
**770,000 km<sup>2</sup>**

Number of approved national marine ranching pilots

**5**

270.2 km<sup>2</sup>

Construction funds already invested

**745**

million yuan

Sea area  
**3,500,000 km<sup>2</sup>**

South China Sea

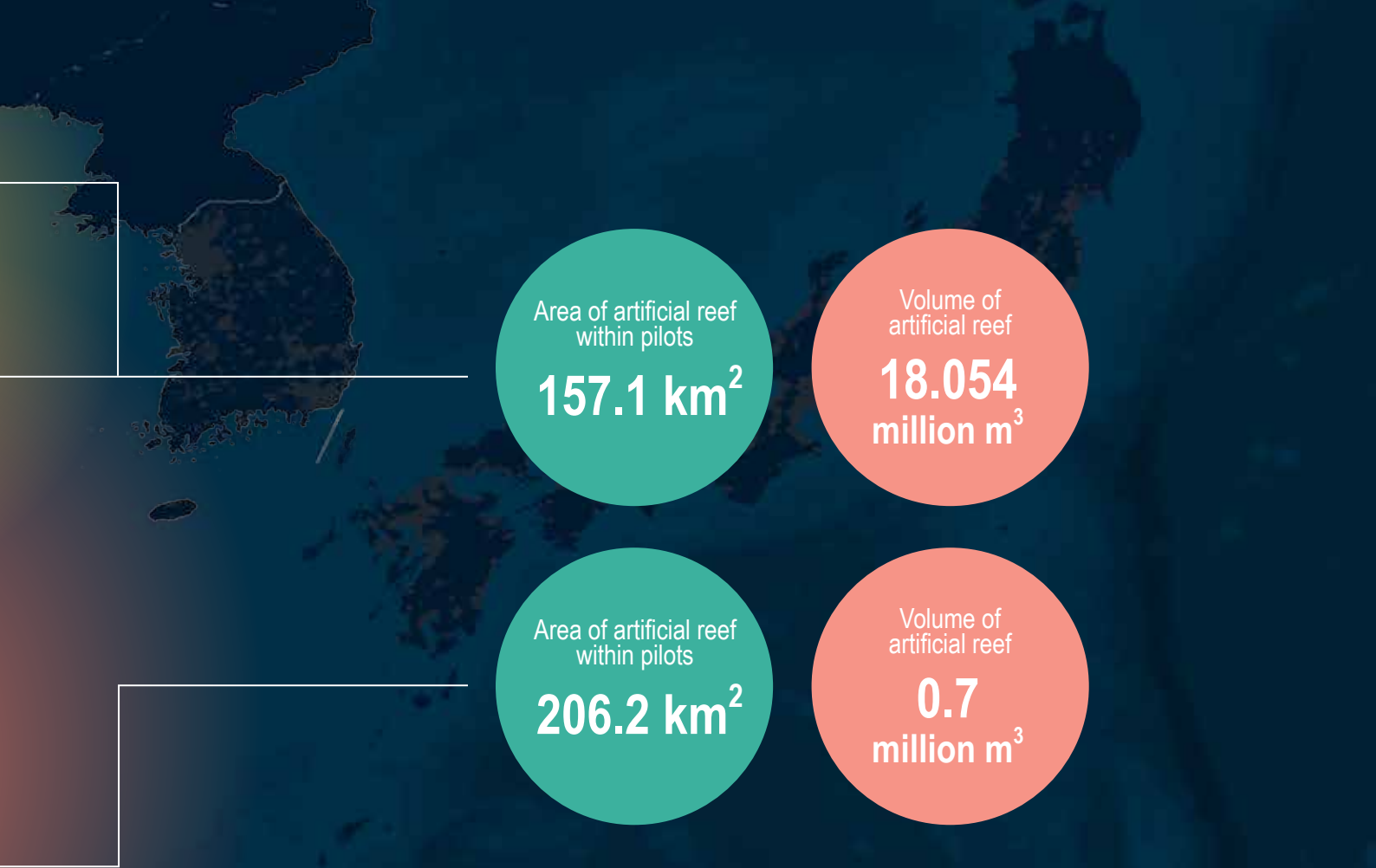
Area of artificial reef within pilots

**256.6 km<sup>2</sup>**

Volume of artificial reef

**42.191 million m<sup>3</sup>**





## 1. How developed is marine ranching worldwide and in China?

The idea of marine ranching was developed in the United States and Japan in the 1970s. According to the United Nations Food and Agriculture Organisation, 64 countries are now engaged in marine ranching. China proposed the “agriculturalisation” of the ocean at the same time as the US in the 70s, but early development was slow. Despite more consistent efforts over the past 30 years, marine ranching in China is still at an early stage.

However, the pace of marine ranch development in China is increasing, in part, because China has adopted techniques used in Korea and Japan over the past decade, particularly in the Bohai and Yellow Sea areas. These areas are ahead of the South China Sea in creating marine ranches and developing farming techniques.

In fact, Korea and Japan are ahead of the US and Europe in terms of environmental protection and systems management when it comes to marine ranching, according to Tian Tao, a deputy professor at Dalian Ocean University.

China’s marine ranching efforts include re-stocking fish by releasing juveniles; environmental remediation, such as algae and seagrass plantation; and attempts at effective control and management.

## 2. There are fewer marine ranches in the South China Sea, so why are there more artificial reefs there than in the Bohai and Yellow Sea areas?

Coastal waters in the Bohai and Yellow Sea are on average no more than 100-metres deep, while the South China Sea has an average depth of 1,200 metres. Local conditions affect what species can be cultivated, so the approach to marine ranching differs from place-to-place.

Tian Tao explains that in the South China Sea artificial reefs that are three or four metres high have been placed in the water to help fish populations recover. But in China’s northern waters, smaller artificial reefs, designed to stimulate the propagation of shellfish and sea cucumber, are mainly used.

Rehabilitation reefs are designed mainly to attract fish populations, whereas stock-enhancing reefs are designed to increase catches.

# Plan for national marine ranching pilots 2017-2025

- Bohai Sea & Yellow Sea
- East China Sea
- South China Sea

Sea area  
**77,000 km<sup>2</sup>**

*Expected  
number of  
national  
marine  
ranching pilots*

**113**

**1,200 km<sup>2</sup>**

Sea area  
**380,000 km<sup>2</sup>**

*Expected  
number of  
national  
marine  
ranching pilots*

Sea area  
**770,000 km<sup>2</sup>**

**20**

**500 km<sup>2</sup>**

Sea area  
**3,500,000 km<sup>2</sup>**

*Expected  
number of  
national  
marine  
ranching pilots*

**45**

**1,000 km<sup>2</sup>**

Area of artificial reef  
within pilots

**1100 km<sup>2</sup>**

Volume of  
artificial reef

**3 million m<sup>3</sup>**

Bohai  
Sea

Yellow  
Sea

East  
China  
Sea

South  
China  
Sea





### 3. Why are the pilot projects concentrated in the Bohai and Yellow seas rather than the much larger East China or South China seas?

Xu Qiang, a professor at Hainan University, says that the Bohai and Yellow Sea areas first pioneered fish farming in China and have better infrastructure and technology. The Ministry of Agriculture has approved more pilot projects in these areas so they can shift from fish farming to marine ranching more readily. The artificial reefs involved in marine ranching encourage the growth of algae that provide a safe environment for fish.

In the East China Sea, marine ranches are mainly designed to restore the environment and provide leisure opportunities through fishing. Pilot projects there are concentrated in eastern China's Zhejiang province, where coastal currents tend to be faster, the water turbid, and the soft seabed unsuitable for the placement of reefs. The viability of marine ranching is also limited by seasonal typhoons.

Development of marine ranches in the South China Sea has lagged behind other areas because the water is not shallow enough. In southern provinces, such as Guangdong, Guangxi and Hainan, marine ranches are planned primarily to rehabilitate fish stocks through the restoration of resources.

### 4. Why does the plan emphasise the placement of artificial reefs?

The Ministry of Agriculture is planning marine ranches to serve different goals: rehabilitation, recreation, and stock-enhancing.

All three of these goals might require the placement of reefs.

Tian Tao says the Ministry of Agriculture's plans show artificial reefs and seagrass beds, along with cultivating fish, are key techniques for marine ranching pilots. The aim of the creation of marine ranches is to restore the environment and increase and rehabilitate resources, as well as make profits.

Xu Qiang agrees that these choices are due to environmental considerations. Reefs will restore the local ecology and provide habitats for marine life – unlike equipment-intensive and cage-farm marine ranching.

# Area of algae and seagrass beds in 2025

■ Bohai Sea & Yellow Sea  
■ East China Sea  
■ South China Sea



## 5. Why specify areas of algae and seagrass beds to be created?

Algae and seagrass are the most fundamental sources of nutrition in the ocean, providing the basis of food and oxygen for fish, shellfish and other species. These organisms also help clean the water and are an essential part of the marine ecology. Algae and seagrass beds are crucial to the health of marine ecosystems.

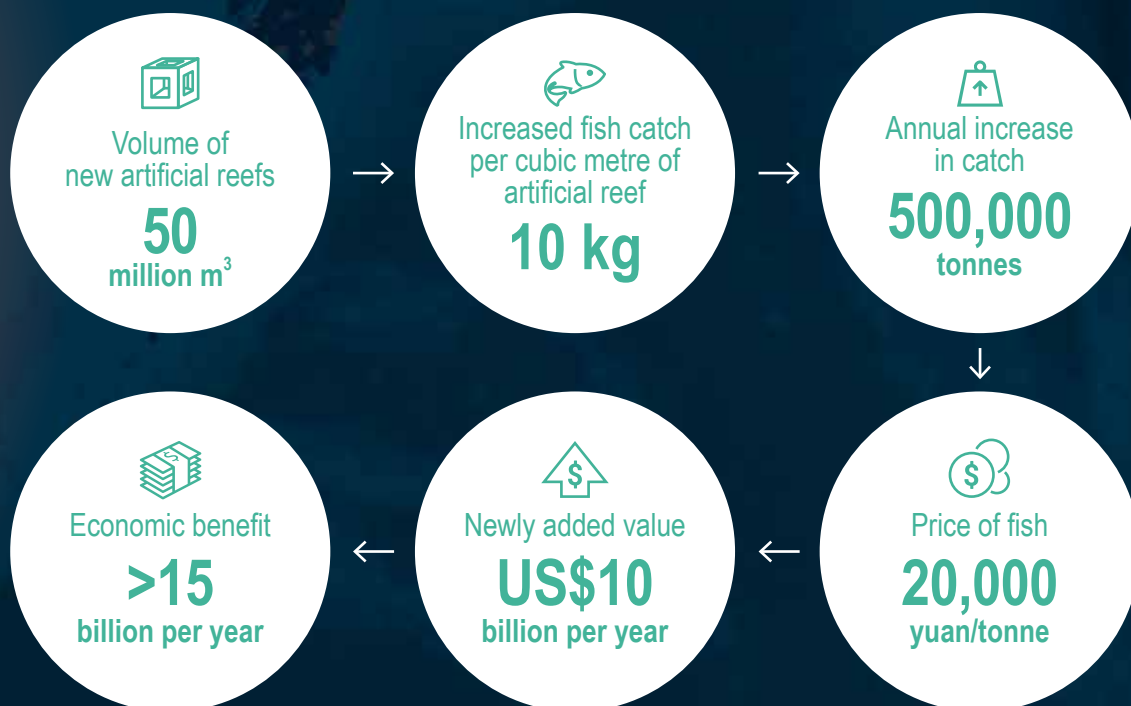
China's earliest marine ranches generally involved placing artificial reefs. By contrast, the marine ranching pilots announced by the Ministry of Agriculture include the planting of algae and seagrass beds, with experts saying this will be hugely helpful in rehabilitating fishery stocks. Artificially created beds play much the same ecological role as their natural equivalents.







## Economic benefits of marine ranching



### 6. Is it reasonable to calculate potential profits based on the number of artificial reefs?

According to the Ministry of Agriculture, the 850 square kilometres of marine ranches created in the past three decades have seen the placement of 6,000 cubic metres of artificial reefs. The ministry estimates this has created direct economic and ecological benefits worth 90 billion yuan (US\$13 billion).

However, Xu Qiang says that marine ranching is just getting started, so the estimates may not be accurate.

### POLICY

# Marine ranching in other national plans

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## *National Agricultural Modernisation Plan (2016-2020)*

“Strengthen protection of fishery resources. Create a number of marine wildlife and marine genetic resource reserves; restore spawning grounds, feeding grounds, wintering grounds and migration routes. Strictly protect endangered species such as the Chinese sturgeon, finless porpoise and the Chinese white dolphin. Promote sustainable use of fishery resources, expand the breeding and release of marine life, build artificial reefs and marine ranches. Impose caps on use of marine fishery resources, strengthen monitoring of fishery resources, complete a monitoring network for the fisheries environment, and start ecological compensation payments for fisheries. (To be led by the Ministry of Agriculture, with participation from the National Development and Reform Commission, Ministry of Finance, Ministry of Environmental Protection and State Oceanic Administration)”

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## *13<sup>th</sup> FYP for National Fisheries Development (2016-2020)*

Develop Enhanced Fisheries. Produce a development plan for enhanced fisheries and scientifically determine the waters and shallows suitable for enhanced fisheries. Increase the breeding and release of fish, strengthen the management of this process, evaluate success, boost oversight and ensure positive outcomes. Promote comprehensive regional development, primarily in the form of marine ranching, with marine ranching pilots based around artificial reefs and relying on bottom-seeding, with supplementary release of farmed fish. Promote the coordinated use of fish to purify water, the upgrade of lake fisheries, and environmental reinstatement.

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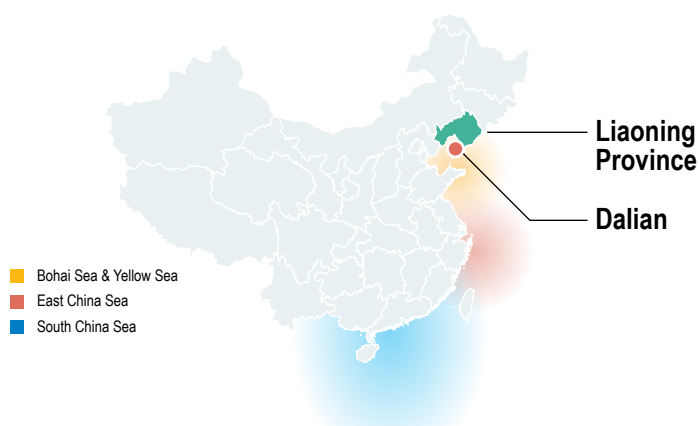
## *13<sup>th</sup> FYP for the National Marine Economy*

Ocean fisheries: Strict control of intensity of coastal fishing, with a policy of negative growth in catches, enforcement of closed seasons, and barriers to entry. Faster adjustments and reforms to fishing industry fuel subsidies, reduction in vessel numbers and lower domestic catch capacity. Promote comprehensive regional development, primarily in the form of marine ranching, with marine ranching pilots based around artificial reefs and relying on bottom-seeding, with supplementary release of bred fish, to realise sustainable development of ocean fisheries. Develop distant-water fishing, with better auxiliary services such as processing, logistics and supply; lengthen industrial chains; improve infrastructure and equipment for distant-water fishing; build overseas fishery service bases; encourage distant-water fishing firms to grow through mergers and restructuring. Make reasonable adjustments to aquaculture, with development of healthy aquaculture and support for deep-water wave-resistant cage farming and industrialised circular aquaculture.

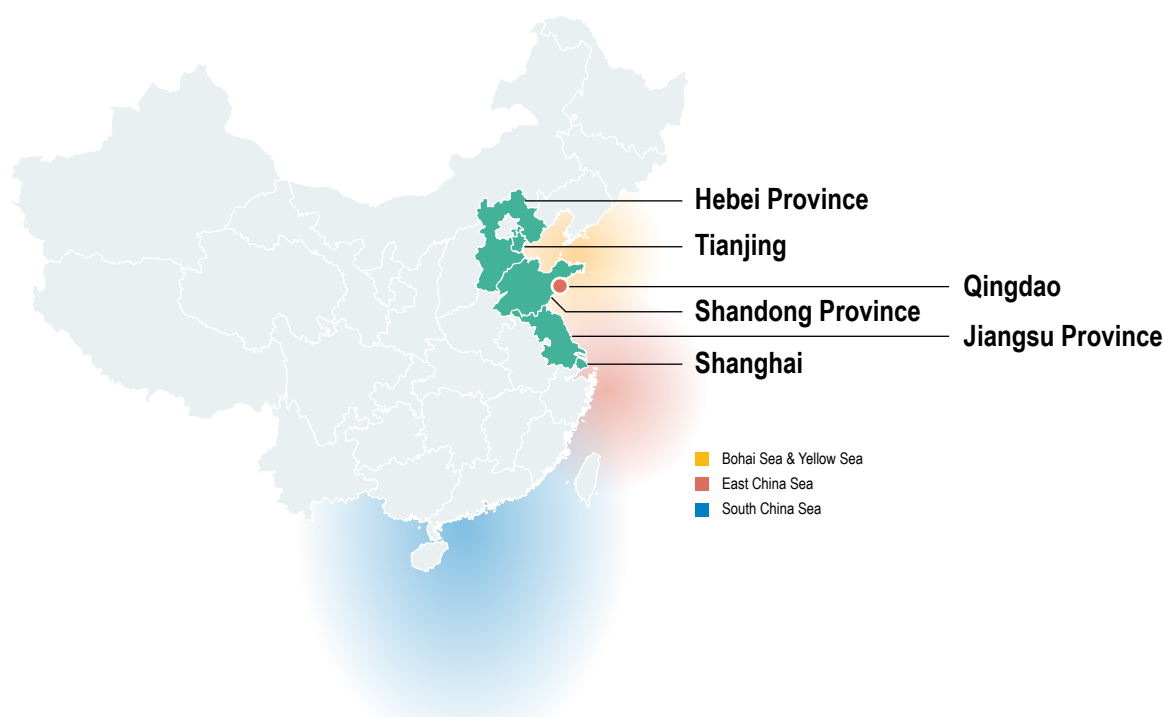
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# National marine ranching pilots (2015-2017)



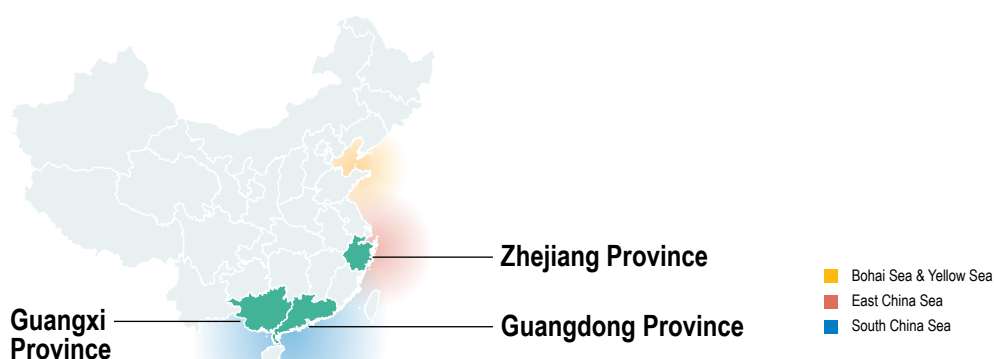
Location	No.	Name of pilot	Size (hectares)	Who is in charge?	How will it work?
Liaoning	1	Liaoning Dandong National Marine Ranching Pilot	1400	Donggang Artificial Fish Reef Management Office	<p>Mainly by raising valuable aquatic products such as sea cucumber, abalone and Yesso scallops. These and various species of clam will be bottom-seeded, while young fish will be bred and released, with artificial reefs placed to protect both ecological and fishery resources. Dalian has published a 2016-2025 plan for developing the marine ranching sector.</p>
	2	Liaoning Panshan County National Marine Ranching Pilot	667	Panshan County Marine and Fishing Technology Centre	
	3	Liaoning Jinzhou City National Marine Ranching Pilot	573	Jinzhou Marine and Fisheries Institute	
	4	Liaoning Huludao Juehua Island National Marine Ranching Pilot	1338	Huludao Aquatic Product Quality Management Office	
Dalian (Liaoning)	5	Dalian Zhangzi Island National Marine Ranching Pilot	2196	Zhangzi Island Group Ltd.	
	6	Dalian Haiyang Island National Marine Ranching Pilot	600	Dalian Haiyang Island Group Ltd.	
	7	Dalian Caishen Island National Marine Ranching Pilot	822.4	Dalian Caishen Island Group Ltd.	
	8	Dalian Mayi Island National Marine Ranching Pilot	666.6	Dalian Mayi Island Marine Produce Ltd.	
	9	Dalian Dachangshan Island Jinmao National Marine Ranching Pilot	665.1	Dalian Changhai County Xingguo Jinmao Marine Produce Ltd.	
	10	Dalian Xiaochangshan Jingdian National Marine Ranching Pilot	666.6	Dalian Jingdian Marine Delicacies Aquaculture Ltd.	
	11	Dalian Wangjia Island Fuyu National Marine Ranching Pilot	709	Dalian Fuyu Foods Ltd.	
	12	Dalian Shicheng Shangpintang National Marine Ranching Pilot	680.53	Dalian Shangpintang Marine Products Ltd.	
	13	Dalian Haiyang Island Yide National Marine Ranching Pilot	598.3	Dalian Changhai Yide Aquaculture Ltd.	
	14	Dalian Ping Island Xinyulong National Marine Ranching Pilot	445.59	Dalian Xinyulong Aquaculture Technologies Ltd.	



Location	No.	Name of pilot	Size (hectares)	Who is in charge?	How will it work?
Hebei	1	Liaoning Panshan County National Marine Ranching Pilot	650	Qinhuangdao National Marine Genetic Resources Reserve Management Office	Mainly by producing sea cucumber, blood clams and Yesso scallops. Situated primarily in the waters around Qinhuangdao and based on artificial reefs to facilitate the release of juvenile fish and algae transfers.
	2	Liaoning Jinzhou City National Marine Ranching Pilot	820	Qinhuangdao Haixin Aquaculture Technologies Ltd.	
	3	Liaoning Huludao Juehua Island National Marine Ranching Pilot	533	Tangshan Marine Ranching Industries Ltd.	
	4	Dalian Zhangzi Island National Marine Ranching Pilot	581	Qinhuangdao Chensheng Aquaculture Ltd.	
	5	Dalian Haiyang Island National Marine Ranching Pilot	551.1	Qinhuangdao Marine Ranching and Aquaculture Ltd.	
	6	Dalian Caishen Island National Marine Ranching Pilot	724.4	Lexiang County Aquaculture Cooperative	
	7	Dalian Mayi Island National Marine Ranching Pilot	518.25	Changli County Longxin Aquaculture Ltd.	
	8	Dalian Dachangshan Island Jinmao National Marine Ranching Pilot	519.09	Changli County Wanghai Aquaculture Cooperative	
	9	Dalian Xiaochangshan Jingdian National Marine Ranching Pilot	555	Qinhuangdao Xinyuan Marine Engineering Ltd.	
	10	Dalian Wangjia Island Fuyu National Marine Ranching Pilot	711.8	Qinhuangdao Yongyuan Marine Products Ltd.	
Tianjin	1	Tianjin Dashentang National Marine Ranching Pilot	2360	Tianjin Binhai New District Hangu Marine Products Bureau	Mainly with the placement of artificial reefs to attract fish populations and hamper fishing. Dozens of fish species will also be bred and released.

Location	No.	Name of pilot	Size (hectares)	Who is in charge?	How will it work?
Shandong	1	Shandong Furong Island West National Marine Ranching Pilot	10700	Shandong Blue Ocean Technologies Ltd.	Five types of marine ranches are to be created: artificial reefs, bottom-seeding, pastoral, equipment-heavy and angling. The equipment-heavy approach uses large offshore net cages; while pastoral marine ranching takes place in wetlands and shallow coastal waters, with the aim of protecting the environment. Three-year Plan for Marine Ranching Pilots in Shandong (2018-2020)
	2	Shandong Rongcheng North National Marine Ranching Pilot	676	Shandong Xiciakou Marine Delicacies Ltd.	
	3	Shandong Mouping North National Marine Ranching Pilot	1216	Shandong Oriental Marine Technologies Ltd.	
	4	Shandong Ailianwan National Marine Ranching Pilot	623	Weihai Changqing Marine Technology Ltd.	
	5	Shandong Lanshan East Wanzefeng National Marine Ranching Pilot	524.6	Rizhao Wanzefeng Fishing Ltd.	
	6	Shandong Laizhou Taipingwan Mingbo National Marine Ranching Pilot	1507	Laizhou Mingbo Marine Products Ltd.	
	7	Shandong Rongcheng South Haodangjia National Marine Ranching Pilot	647.5	Shandong Haodangjia Marine Development Ltd.	
	8	Shandong Miaodao Archipelago North National Marine Ranching Pilot	1120	Changdao Hongxiang Marine Delicacies Ltd.; Yantai Nanhuanqcheng Marine Delicacies Development Ltd.	
	9	Shandong Laicheng Sanggouwan National Marine Ranching Pilot	873.9	Rongcheng Chudao Marine Products Ltd.; Rongcheng Hongtai Marine Leisure Ltd.	
	10	Shandong Miaodao Archipelago East National Marine Ranching Pilot	1100	Changdao Guiyi Marine Delicacies Development Ltd.	
	11	Shandong Li Island East Hongyuan National Marine Ranching Pilot	503	Rongcheng Chengshan Hongyuan Marine Products Ltd.	
	12	Shandong Haizhouwan Shunfeng National Marine Ranching Pilot	611.5	Rizhao Shunfeng Yangguang Marine Ranching Ltd.	
	13	Shandong Pipakou Fuhan National Marine Ranching Pilot	848	Shandong Fuhan Marine Technology Ltd.	
	14	Shandong Jinshangang East Dongyu National Marine Ranching Pilot	1075	Yantai Dongyu Marine Delicacies Ltd.	
	15	Shandong Huangjiatangwan Wanbao National Marine Ranching Pilot	335	Rizhao Wanbao Marine Products Group	
Qingdao (Shandong)	16	Qingdao Shiquetan National Marine Ranching Pilot	867	Qingdao Lufeng Food Group Ltd.	
	17	Qingdao Laoshanwan National Marine Ranching Pilot	500	Qingdao Haiquan Laoshan Speciality Marine Products Ltd.	
	18	Qingdao Laoshanwan Longpan National Marine Ranching Pilot	519	Qingdao Longpan Marine Ecology Aquaculture Ltd.	
	19	Qingdao Lingshanwan Lingshan National Marine Ranching Pilot	524	Qingdao Lingshan Ecological Marine Products Ltd.	
	20	Qingdao Lingshanwan West Coast National Marine Ranching Pilot	886.6	Qingdao West Coast Fishery Technology Development Ltd.	
	21	Qingdao Zhaitang Island Zhaitang National Marine Ranching Pilot	575.6	Qingdao Zhaitang Island Marine Ecology Aquaculture Ltd.	
Jiangsu	1	Jiangsu Haizhouwan National Marine Ranching Pilot	4000	Lianyungang Oceans and Fisheries Bureau	Both these locations were once well-known fisheries and important breeding grounds. The Nanhuanqhai site is a reserve for breeding populations of the little yellow croaker and silvery pomfret.
	2	Jiangsu Nanhuanqhai National Marine Ranching Pilot	3420	Jiangsu Ocean Fisheries Headquarters	
Shanghai	1	Shanghai Changjiangkou National Marine Ranching Pilot	1440	Shanghai Changjiangkou Chinese Sturgeon Reserve Management Office	The only pilot to be aimed at restoration of a river mouth, this is situated within the Changjiangkou Chinese Sturgeon Reserve. Three approaches will be used: artificial reaches, bottom-seeding of bottom-dwelling species, and transplants of kelp.





Location	No.	Name of pilot	Size (hectares)	Who is in charge?	How will it work?
Zhejiang	1	Zhejiang Zhongjieshan Archipelago National Marine Ranching Pilot	4180	Zhoushan Oceans and Fisheries Bureau	With the placement of both ecological and commercial reefs. Release of young or eggs of over 20 species, including the large yellow croaker, sea bream, spineless cuttlefish, flame jellyfish, horse crab, Japanese tiger prawn, Korean mussel, red seabream and bass.
	2	Zhejiang Nanji Archipelago National Marine Ranching Pilot	698.5	Pingyang County Oceans and Fisheries Bureau	
	3	Ningbo Yushan Archipelago National Marine Ranching Pilot	2250	Xiangshan County Oceans and Fisheries Bureau	
	4	Zhejiang Taizhou City Jiaojiao Dachen Islands National Marine Ranching Pilot	702	Taizhou Jiaojiao Oceans and Fisheries Enforcement Team; Taizhou Jiaojiao Port Economy Development Ltd.; Taizhou Marine Product Technology Centre	
	5	Zhejiang Wenzhou Dongtou National Marine Ranching Pilot	1160	Wenzhou Dongtou Oceans and Fisheries Enforcement Team; Wenzhou Dongtou Marine Park Promotion Centre	
	6	Zhejiang Ma'an Archipelago National Marine Ranching Pilot	6960	Shengsi County Haisheng Aquaculture Investments Ltd.	
Guangdong	1	Guangdong Wanshan National Marine Ranching Pilot	31200	Wanshan Ocean Development Pilot Zone Oceans and Fisheries Bureau	By focusing on conservation. These marine ranches will both restore the environment and provide a tourist attraction.
	2	Guangdong Guiling Island National Marine Ranching Pilot	2028	Shanwei City District Ocean and Fisheries Bureau	
	3	Guangdong Nan'ao Island National Marine Ranching Pilot	3000	Nan'ao County Oceans and Fisheries Bureau	
	4	Guangdong Shanwei Zhelangjiao West National Marine Ranching Pilot	2100	Shanwei Oceans and Fisheries Bureau	
	5	Guangdong Lufeng Jinxiang South National Marine Ranching Pilot	3200	Lufeng Oceans and Fisheries Bureau	
	6	Guangdong Yangjiang Shanwai East National Marine Ranching Pilot	6800	Yangjiang Oceans and Fisheries Bureau	
	7	Guangdong Maoming Dafangji National Marine Ranching Pilot	3308	Maoming Oceans and Fisheries Bureau, Dianbai branch	
	8	Guangdong Suixi Jianghong National Marine Ranching Pilot	6700	Suixi Oceans and Fisheries Bureau	
Guangxi	1	Guangxi Fangchenggang Bailong Zhenzhuwan National Marine Ranching Pilot	1040	Fangchenggang Marine Products, Livestock and Veterinary Medicine Bureau	A famous source of pearls, Bailong Zhenzhuwan was first planned in 2012, with the first stage of production completed in April 2017. A comprehensive marine ranch is planned using artificial reefs, kelp and net enclosures.



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