

WWF-China / WWF Water Practice

YANGTZE FRESHWATER AQUACULTURE

Using multiple tactics to change aquaculture practices to improve water quality in the Yangtze River

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Map of the Yangtze river basin

Introduction

The Yangtze river basin is of paramount economic, cultural and ecological importance for China and is a hub for freshwater aquaculture at the domestic and international scale. Aquaculture practices, which take place primarily in ponds but also in lakes and reservoirs, negatively impact water quality in those water bodies as well as in the Yangtze River itself. This case study highlights work on sustainable aquaculture by the WWF-China team as part of its Yangtze programme's Fishery Market Transformation component, with funding from the HSBC Water Programme.

WWF-China has adopted a multi-pronged approach to address the challenges posed by the booming aquaculture sector. It seeks to remedy the lack of adequate standards for aquaculture by developing and promoting (through pilot projects and training programmes) a series of integrated practices and standards for aquaculture, taking water quality and environmental impacts into account. In addition, work has been done to develop traceability and certification for fisheries and to connect producers with retailers and consumers.

Defining sustainable aquaculture

The World Bank outlines the environmental, economic and social aspects of sustainable aquaculture. It should: not significantly disrupt ecosystems, cause biodiversity loss or too much pollution; be economically viable on a long-term basis; be socially responsible and contribute to the well-being of communities. Some of the most interesting aspects of the work have included: taking into account local specificities such as the setup of the market and the importance of food safety; targeting a variety of different aquaculture and producer types; building on existing good practices; placing emphasis on livelihoods; considering the whole supply chain including end consumers; partnering with academic institutions and, most importantly, with different levels of government to achieve legitimacy, reach and scale-up.

Context: freshwater aquaculture in China

China is the world leader in freshwater aquaculture production; the sector is important for the country's economy, employment and food security, but also has a big impact on the environment. The ways in which freshwater fish and other species are farmed and sold in China have implications for WWF-China's sustainable aquaculture initiatives.

CHINESE FRESHWATER AQUACULTURE IN NUMBERS

China produces approximately 65% of the world's freshwater aquaculture output (Wang et al., 2015).¹ This industry employs 9.1 million people, and supplies 64.8% of the fish and crustaceans eaten in China (FDMA, 2016),² representing a third of the total animal protein consumed. Freshwater aquaculture has boomed since the early 1980s and, at 30.6 million tonnes per year in 2015, farmed fish now far outstrips wild-caught fish (FDMA, 2016).

The Yangtze river basin is China's hub for freshwater aquaculture. Four out of the top eight freshwater aquacultureproducing provinces are located in the Yangtze basin and approximately 55% of production takes place there (Wang et al., 2015). The basin is also vital in several other ways: it is home to a third of China's population, accounts for 40% of the country's GDP and produces 70% of China's rice.

The central and lower Yangtze is the part of the basin where most aquaculture takes place. It is also an area of high biodiversity, home to over 1,600 aquatic animal species. Hubei province (known as 'the land of a thousand lakes') is China's top freshwater aquaculture producing province with 14% of the total (Wang et al., 2015) and the sector sustains over 1.2 million

¹ Wang, Q., Cheng, L., Liu, J., Li, Z., Xie, S. and De Silva, S. 2015. Freshwater aquaculture in PR China: trends and prospects. *Reviews in Aquaculture*, 7, 283–302.

² Fisheries Department of the Ministry of Agriculture (FDMA). 2016. *China Fisheries Year Book (1982-2016)*. Beijing, China: China Agriculture Press.

peoples' livelihoods there. WWF's sustainable aquaculture work has primarily targeted Hubei province so far.

THE RATIONALE: AQUACULTURE'S IMPACTS ON ECOSYSTEMS

Freshwater aquaculture can affect the environment in different ways:

- Waste from feeding, which can be exacerbated by overfeeding, creates excess nutrients contributing to poor water quality, algal blooms and occasional fish kills. Approximately 75% of the nitrogen and phosphorus in fish feed is not directly taken up by the fish. Faecal waste from fish also contributes excess nutrients.
- Use of **fertilisers** to encourage plankton growth (as a source of food for planktivorous fish), leading to eutrophication.
- Use of prophylactic **antibiotics** and other medicines to combat the detrimental health effects of high density and other factors; only about 30% of the antibiotics are taken up by the fish.
- **Overstocking** of herbivorous species, leading to declines in macrophytes.
- Creation of **enclosures**, ponds and other barriers that cause habitat fragmentation – a particular problem in biodiverse lakes.
- In addition, aquaculture species can be potential **disease vectors** for wild populations.

Aquaculture has been identified as an important polluting practice in the Yangtze and one of the major threats to the Yangtze river basin's ecological integrity. Pressure from market demand over the past few decades has led to high yields being the main priority for the aquaculture sector, to the detriment of action on the environmental impacts of fish farming.

CHALLENGES AND OPPORTUNITIES FOR FRESHWATER AQUACULTURE WORK

The majority of freshwater aquaculture takes place outside of rivers, with around 80% taking place in ponds and a sizable proportion in lakes and rice paddy fields (FDMA, 2016); fish farming in reservoirs is also common. Many of these water bodies, lakes in particular, have their own ecological value and are ultimately connected to rivers.

Low fish prices place additional pressures on farmers. For the past ten years, there has been a steady increase (almost 10% per year) in the quantity of freshwater fish farmed in



The mighty Yangtze River ©Michel Gunther/WWF



Unsustainable aquaculture can cause algal blooms ©Zhang Yifei



Fishing net ©WWF-UK



Feeding farmed fish ©Brent Stirton/Getty Images/WWF-UK

China and the price of artificial feed has gradually increased. Nevertheless, the price commanded by the fish itself (certainly in the case of carp) has remained almost stable, as there is more supply than demand, creating a vicious cycle whereby farmers keep producing more to try and maintain their profit margins. Prices are also low because farmers in a given area tend to all produce the same type of fish and are often unwilling to change established practices. Carp dominate and their production has continued to grow in absolute numbers, but their share of aquaculture production is in decline as other species have become more popular; in particular, China's economic growth has boosted demand for more expensive carnivorous species such as tilapia and snakehead (Wang et al., 2015) as well as mandarin fish. Crustaceans and soft-shelled turtles form a comparatively small but growing share of total aquaculture production (Wang et al., 2015). It is anticipated that the steady increase of high-value species production will continue in the coming years. For brevity, this case study often refers to freshwater fish and fish farmers, with the understanding that this also encompasses crustaceans and reptiles.

Food safety is a growing concern among Chinese

consumers. Several major scandals related to food quality have made the headlines in recent years, causing a breakdown of trust in domestic food producers and making consumers more eager to purchase food they can be assured is safe. This concern has provided an inroad for WWF's work on aquaculture standards.

Chinese consumers have limited interest in the environmental sustainability of freshwater aquaculture. The freshwater fish farmed in China is mostly sold and consumed in China, with few outside markets or global buyers. Because local buyers have a much lower awareness of sustainability issues, this creates less pressure for improved production standards, and there is little exportderived leverage. This is partly why WWF-China is particularly focusing on the food quality and safety angle as a driver for the introduction of improved production standards and traceability systems.

There is a lack of aquaculture industry standards at the national level. As detailed below, WWF has started to remedy this through the setting of integrated standards for several different aquaculture types, and is working to encourage their adoption beyond Hubei province. However, there is still work to be done in terms of full geographic and technical coverage for standards, let alone for monitoring of their implementation.

SETUP OF THE FRESHWATER AQUACULTURE MARKET IN CHINA

Several characteristics of the freshwater aquaculture market in China have a direct bearing on the activities described in this case study.

Freshwater fish in China is typically sold still alive, in water-filled tanks. Freshwater fish are transported in tanks to resellers and transferred to tanks in supermarkets and other retail spaces. Chinese consumers prefer to buy live freshwater fish. This has several implications: first, retailers prefer healthier fish that can better withstand the transport process; second, and most important, because the retail end tanks usually contain fish from various different production origins, traceability becomes more challenging. It is typically not possible to stock fish in separate tanks according to their origin, because of the space and therefore cost implications.

Live freshwater fish in markets is typically not branded. Individual consumers purchase fish of a certain species rather than seeking fish from a particular producer; there are few famous brands and these are more high-end and tend to go to export, as detailed in the case study. In addition, food certification systems apply to crops like rice or corn, but there are no robust certification systems for live animals. This makes it more difficult to build trust with consumers and connect their purchases to particular production methods.

The existence of the reseller market can be an impediment to sustainability initiatives. Producers typically do not sell their fish or crustaceans directly to consumers or even retailers – there is a resale market, which buys fish from many different producers and sells it on to big buyers. Resellers can find buyers for all of the different qualities of fish, and their main interest is the profit margin each type of fish can yield. Indeed, increasing the overall quality of fish sold is not necessarily in their interest, as the margin between purchase and sale price can be equivalent or lower. As a result, resellers are the hardest part of the supply chain to influence, which explains why WWF-China started by targeting producers and is now also linking with big retailers.

Producers are usually either companies or cooperatives. Freshwater aquaculture companies are government-certified; they can have their own aquaculture centres with paid employees, but most instead have purchasing arrangements with nearby farmers who produce fish according to certain criteria. Some other companies do not purchase fish from the producers, but rather help those that produce according to their processes sell the fish to retailers or resellers and also do quality checking. The other main type of producer



Lake Hong ©WWF-UK



Fish market at Honghu City market ©Brent Stirton/Getty Images/WWF-UK



Fish farms on Lake Hong ©Brent Stirton/Getty Images/WWF-UK



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are co-operatives, which combine farmers who have their own production facilities but follow the same methods; grouping together allows farmers to have better negotiating power with resellers. Some co-operatives are extremely large (hundreds or thousands of members), which can pose some management challenges. WWF-China has engaged with both types of producers.

What did we do and how did we do it?

The work described in this case study builds on several years of work within the preceding HSBC Climate Partnership (2007-2011) and the current HSBC Water Programme which started in 2012. As part of the earlier programme WWF-China primarily worked on lake aquaculture: removal of enclosures; seasonal reconnection to the river; restocking of macrophytes, native fish and benthos; running training courses; food safety certification; crab aquaculture guidelines implementation in Hubei province's Lake Hong, Lake Liangzi, Lake Wu, etc. The resulting improvements in water quality, biodiversity, macrophyte coverage, fishery income and the presence of migratory birds convinced WWF to scale up the work to cover different water bodies such as paddy fields, reservoirs and ponds as part of the HSBC Water Programme. WWF also continued to work in places where good relationships had been established, such as Lake Wu and Lake Hong.

WWF's Yangtze Fishery Market Transformation work has focused on a number of fronts: sustainable aquaculture Best Management Practice (BMP) standards, pilot projects, partnerships with local fishery bureaus and aquaculture companies, training of aquaculturists and work with retailers from the point of view of fish consumption. The overall aim is to make freshwater aquaculture more sustainable to improve the long-term health of the river system as well as fish farmers' livelihoods.

SETTING FRESHWATER AQUACULTURE STANDARDS

WWF-China signed an MoU in 2014 to **create a knowledge partnership with five of the most renowned freshwater fishery research institutions in China**: the Institute of Hydrobiology of the Chinese Academy of Science; Huazhong Agricultural University; the Yangtze River Fishery Institute of the Chinese Academy of Fishery Science, the National Engineering & Technology Research Centre of Freshwater Fishery and the Hubei Aquaculture Research Institute. This 'responsible fishery' promotion platform has had the advantage of bringing together institutions that **are renowned and have extensive networks** within China (with both the government and private companies) and also have complementary areas of specialisation and expertise. Some are very much focused on biological science, while others undertake research linked to aquaculture markets, meat quality and traceability. Hubei province's Fishery Bureau and almost 20 city- and county-level Fishery Bureaus acted as witnesses for the platform, lending it legitimacy as well as influence, particularly as Hubei is the biggest producer of freshwater aquaculture.

As part of this knowledge partnership, a set of BMP standards has been developed based on current research about the impacts of aquaculture on the environment. They are **integrated standards for aquaculture, considering water resources, aquatic health, habitats, biodiversity protection and social responsibility**. Existing aquaculture standards were not integrated or comprehensive: they tended to focus on one aspect (e.g. feed quality) and were not sufficient to address aquaculture's impact on water quality and therefore habitats and biodiversity.

The new BMPs cover over twenty types of aquaculture, called "modes" e.g.: pond, reservoir, high value fish, grass carp, or mixed modes such as crab or fish reared in rice paddies, etc. The standards are both technical and management-related; they were written in a way that is **not overly detailed or demanding** so as to secure buy-in from various stakeholders. Carp aquaculture is one of the main focus points, because it is the dominant aquaculture type in the basin and its ecological footprint is the largest. The BMPs are quite general and provide guidance on density, chemical types and dosage, etc., depending on the type of aquaculture in question. However, the BMPs permit a certain degree of freedom in their application, for example allowing for better local knowledge about water conditions and technologies. The BMPs will be improved and upgraded as part of a continual review process.

The standards were put together with the involvement of multiple stakeholders, including WWF, the research institutions, aquaculture companies and co-operatives as well as county- and provincial-level government representatives. The involvement of government in creating the standards was seen as essential for securing their future adoption as official policy. There are many aquaculture companies and big cooperatives in China, many of which already had production standards for the various types of aquaculture that they used. WWF and the knowledge partnership **built on these existing** **standards**, combining them into one structure and making improvements to them – a time-consuming process. The relationships the five research institutions had with the companies and co-operatives meant these could contribute to the BMP process by sharing their own good practices and technologies.

PILOT PROJECTS

WWF and its partners set up six pilot projects with companies and co-operatives to demonstrate the application of the BMP standards for improved aquaculture practices. Table 1 summarises the characteristics of these companies and cooperatives, which cover a range of different aquaculture types.

Name of company or co- operative	Туре	Types of freshwater aquaculture (& specialisation)	Main species targeted	Area of aquaculture (hectares)	Output value (RMB yuan)	Number of people involved	Location
Wuhu	Company	Lake	Carp, crab, yellow catfish, etc.	667	30 million	260	Wuhan City, Hubei Province
Chonghu	Company	Pond (water recirculation)	Yellow catfish & turtle	1,753	200 million	2,139	Gong'an County, Hubei Province
Tianhong	Company	Pond and paddy field	Crayfish	933	100 million	20,000	Jianli City, Hubei Province
Hongxianxi	Co-op.	Pond (grass and artificial mixed feeding)	Grass carp	2,000	200 million	2,240	Honghu City, Hubei Province
Qingjiang Pengbo	Company	Reservoir (integrated three- layer net cage)	Channel catfish, sturgeon, carp, etc.	67	100 million	672	Changyang County, Hubei Province
Chunyan	Co-op.	Pond	Crab, crayfish, rice-paddy eel, etc.	829	Not known	672	Jianli City, Hubei Province

Table 1: Information about the pilot companies / co-operatives

The pilots were set up at various times since 2014, with some of the companies and co-operatives that were involved in creating the integrated BMP standards mentioned above. All are located in Hubei province; three are in Honghu and Jianli Counties which are respectively ranked number one and two in terms of aquaculture production quantity in Hubei. WWF chose to work with large and/or well-known companies/co-operatives so as to achieve more scale and also take advantage of their influence.

Contracts were signed with all six; the additional cost of compliance with the BMPs was calculated in co-operation with the companies/co-operatives. They have been eager to participate despite the low level of financial support from WWF, thanks to the involvement and support for the standards from the government and the five expert partners. The Hongxianxi and Qingjiang Pengbo pilots are covered in the next section; the other four are:

 Wuhu aquaculture company – Lake Wu is located within Wuhan, Hubei province's capital city. Wuhu is an



Grass carp pond ©WWF-UK



Chonghu aquaculture company © Marialivia Iotti/WWF-UK



Tianhong aquaculture company © Marialivia Iotti/WWF-UK



Tianhong aquaculture company © Marialivia Iotti/WWF-UK

aquaculture company which exclusively manages the lake's aquaculture activities. WWF has been working in this area for some time, but previous work focused more on wetland conservation, while more recent work relates to aquaculture more specifically. Some of the measures introduced included stopping the application of fertiliser, planting aquatic macrophytes and stocking snails, implementing a fishing ban, stocking fish fry from the Yangtze and adjusting the lake's fish species mix. Improvements in water quality were registered; however, the fact that the pilot started in 2013, at a time when the BMP standards hadn't been drafted, contributed to its relative lack of success. Also, the company employs workers directly rather than contracting with local farmers, so the influence of the pilot in terms of fish farmer numbers and livelihoods was relatively modest.

- **Chonghu aquaculture company** The company specialises in pond recirculating aquaculture systems, whereby natural biological processes are used to purify the wastewater effluent from aquaculture ponds, enabling its reuse in production processes and reducing the discharge of nutrient-laden water to rivers. This technique was applied to an area of over 1,500 hectares; reductions in nitrogen and phosphorus levels by 30-70% have been measured, and the incidence of fish diseases has been reduced by 40%, leading to yield increases from 3,000kg to 7,500kg per hectare. The company also rears two symbiotic high-value species within the ponds: soft-shelled turtle and vellow catfish. The catfish feed on microorganisms living on the turtles' shells, thereby removing potentially harmful bacteria. The Chonghu pilot was one of three established in 2014, but there has not been much interaction with the company so far. Chonghu company felt that their production practices - using modern and highly mechanised feeding techniques - were already more advanced than the national standards and the BMPs, allowing them to achieve the production quantities they required. They were therefore unwilling to take up the BMPs.
- **Tianhong aquaculture company** This company runs a mixed mode of aquaculture, rearing crayfish in rice paddy fields. Started in 2014, this pilot has faced some challenges. The company believed their current management practices were already complying with government discharge regulations, and did not see much scope for co-operation with WWF. Based on this experience, WWF now understands the need for partnering not just with companies but also with

governmental fishery bureaus, who are more motivated to improve management and technology. Indeed, even if all companies are currently compliant, the sheer size of the aquaculture industry means that government agencies have to take the total environmental pressure into account and be prepared to enact stricter regulations in future.

• **Chunyan co-operative** – This large-scale co-operative was recommended by the Jianli County Fishery Bureau. The pilot project (the final one planned for the programme) started in early 2016, so there has only been limited contact made so far. The aim is to undertake training with the co-operative and promote the implementation of sustainable pond aquaculture BMPs. The advantage of Chunyan is not only its large membership (over 600 families) but also its wider reach and influence within the aquaculture sector; for example, prior to its involvement with the pilot, the co-operative had already trained over 3,000 fish farmers – most of them not part of the co-operative.

TRAINING OF FISH FARMERS

In addition to setting up pilot projects on implementation of the BMPs, the Yangtze programme has also instigated a widereaching training programme for farmers near the pilot programme areas. This has focused on **training a large number of aquaculturists in order to have wider-scale impact on aquaculture practices** for the improvement of water quality and livelihoods.

WWF-China **partnered with several city- and countylevel fishery bureaus** to create integrated training materials and deliver the training. Working with multiple counties means that many fish farmers can be reached and also allows the targeting of many different types of aquaculture; some counties primarily have reservoir aquaculture, others pond, other crab or high-value fish, etc.

The first stage of training has been aimed at "pioneer" fish farmers identified by the fishery bureaus. These receive very detailed training, three to five days in total, covering the BMPs and other content from the fishery bureaus. In order for the training to achieve real scale in a cost-effective and timely way, the idea for the second stage is for these **initially trained farmers to themselves train at least eight other fish farmer families** in their local area.

The number of fish farmers reached through training has greatly increased in the last couple of years as **WWF and the fishery bureaus have improved their integrated** **training methodology**. For example, in Honghu City the initial training on crab aquaculture was modestly-sized, while the subsequent training on 'mixed mode' aquaculture has been delivered to a much larger number of fish farmers. So far, counting both the training done as part of the pilot project implementation as well as the direct and indirect training of fish farmers mentioned here, **over 65,000 aquaculturists have received training** on sustainable aquaculture practices, most of them in Honghu City. Many more thousands will be trained as a result of the co-operation with the Jianli County Fishery Bureau and the Chunyan co-operative by the end of the programme. More information about how the impacts of training are measured is presented on page 15.

INFLUENCING PRODUCTION PRACTICES FROM THE CONSUMPTION SIDE

As well as working with producers by setting standards and running training, WWF has also been **seeking to influence aquaculture practices by working with retailers** at the other end of the supply chain. Specifically, WWF has been working with the multinational retailer Carrefour in relation to two of the six pilot projects, with the Carrefour Foundation providing match-funding to the programme. Ultimately, WWF-China's water team plans to run a campaign with Carrefour and the WWF Markets Practice aimed at educating consumers about certification, particularly if good results about the impacts of sustainable aquaculture on meat quality are obtained.

WWF has created a direct relationship with the Hongxianxi cooperative for Carrefour, bypassing the reseller market, because of the best practice mixed feeding method it uses and the fact that the fish it produces is of higher quality. The **Hongxianxi** fish's quality is important for Carrefour not only in terms of taste and appearance but also in terms of overall fish health. The fish meat is darker and less fatty and the carps are also healthier, which makes them easier to transport. Indeed, while normal carp can be transported live for around 10 hours, the Hongxianxi carp is stronger and able to last 15 hours, which has positive logistical implications for Carrefour. As described previously, the reseller market wasn't rewarding better production practices because it didn't pay a premium for this higher quality fish, so the establishment of this direct relationship with the retailer – which is willing to pay a premium – also benefited the producers.

While Carrefour would typically buy live fish from resellers, **for some of the well-known brands of fish they were already keen to buy directly from the producer**. It was therefore in their interest to be directly connected by WWF with the Qingjiang Pengbo aquaculture company, as this is the most famous brand of fish in the middle Yangtze region. The aim is to formalise the relationship via a MoU covering the purchase price of the fish, its sale in provincial supermarkets, as well as involving Carrefour with a planned public education centre on the banks of the Qingjiang Pengbo reservoir.

Spotlight on two pilot projects

The most successful pilot projects so far have been the Hongxianxi co-operative, where a traditional feeding method was revived by poor farmers, and the Qingjiang Pengbo company, where an innovative cage culture system maximises the use of resources.

HONGXIANXI: MIXED FEEDING FOR POND GRASS CARPS

This demonstration project covers 120 hectares located near Lake Hong, and relates to the work of the Hongxianxi cooperative on feeding techniques for rearing pond-based grass carp (*Ctenopharyngodon idella*). Hongxianxi is a big cooperative in terms of membership and area covered, and its members are mostly poor fish farmers. Hongxianxi was not necessarily a market leader in terms of pollution control or production quantity, but WWF and its partners saw an opportunity in terms of the co-operative's methods and its good relationships with the partners.

As the name indicates, grass carp in the wild typically feed on aquatic plants and submerged terrestrial vegetation. In Hongxianxi, grass carp are reared in ponds, and are given a mix of traditional (grass) and artificial feed. Grass is grown on the sides of the ponds and on the sides of islands created in the middle of the ponds. Water levels are increased and lowered methodically to allow feeding and regrowth of the grass. In addition, some manual grass scything also takes place. Over five different types of grass are grown according to the location and the season, including ryegrass, millet grass and sudangrass. Artificial feed is also used at certain times. This traditional grass feeding, which has mostly stopped in the rest of China, allowed the farmers to buy less artificial feed and therefore to protect their profits from increases in artificial feed prices. As detailed later, this technique is however much more time consuming.

The co-operative members were already using this specific feeding method before, based on their traditional and experiential knowledge, but it had not enabled them to obtain better prices for their fish. Starting in 2014, WWF and its expert partners were able to build on this methodology to make



Hongxianxi carp rearing pond with grass edges © Sun Xiaodong/ WWF-UK



Grass carp, the main fish species reared by Chinese fish farmers ©WWF-UK



Grass being scythed manually to feed grass carp at the Hongxianxi cooperative ©WWF-UK

Qingjiang reservoir © Marialivia Iotti/WWF-UK



Net cages © Liu Yifeng/WWF-China



Processing Qingjiang Pengbo products © Liu Yifeng/WWF-China



© Marialivia Iotti/WWF-UK

it more strongly based on science. They were also able to **connect the feeding practices to fish health and meat quality**, enabling the co-operative to gain better access to markets (the relationship with Carrefour is explored on page 11). In addition to the feeding method, Hongxianxi also promotes fish health through the use of probiotics to maintain good health, which reduces the need for use of antibiotics.

QINGJIANG PENGBO: NET CAGE AQUACULTURE IN A RESERVOIR

Qingjiang Pengbo is a very well-known aquaculture company that sells the most **famous brand of fish in the middle Yangtze**, most of which is sold abroad, still alive; the top three export markets are Korea, Japan and Hong Kong. What little is sold domestically goes to big hotels or restaurants and is only consumed by more affluent people – the fish costs around three times as much as standard varieties. Qingjiang Pengbo is based next to a reservoir in Hubei province which is famed for the quality of its water – the Qingjiang River's name means 'pure river' – part of the reason why the fish commands a higher price. This famed water quality makes the potential impacts of excess unsustainable aquaculture particularly relevant.

A few years ago, Qingjiang Pengbo developed an **innovative fish rearing technique** in partnership with one of WWF's academic partners. The technique is a variation on the standard aquaculture net cage in that it has three layers: two cages on top of each other, and another bigger cage around those. The top inner cage contains the most high-value fish species; the cage underneath that contains fish species that are not of high value and that eat the faecal waste from the top cage fish; the outer cage contains fish species that eat uneaten food from the target species, as well as algae and microorganisms growing on the nets. Finally, vegetables are grown on the top of the outer cage for nitrogen uptake. All three types of fish within the cages end up being sold, simply at different prices.

By minimising the amount of faecal and food waste exiting the cages, this method helps preserve the water quality that contributes to the fish's high price. The **three-layer net cage requires a big initial investment** which the average fish farmer could not afford. Qingjiang Pengbo has subsidised this investment for aquaculturists who sign a more restrictive contract with the company. The higher price commanded by the fish reared in this way is an opportunity but also a threat: there is a danger that more people will get into fish farming as a result. Local government (the Changyang Fishery Bureau) had set a fixed total acreage in the Qingjiang River, but tight government regulation on the number of families certified to practice aquaculture will be needed, while sufficient numbers

of three-layer cage farmers will need to be maintained to ensure access to markets.

Aquaculture in this reservoir is highly regulated: Only about 400 families living around it have the required certification to be able to practice aquaculture. Qingjiang Pengbo is only allowed to purchase the fish produced from half of these families - other aquaculture companies as well as independent producers also operate within the reservoir. The company is therefore only able to influence the production methods of half of the reservoir's aquaculturists. This has both positive and negative consequences. The introduction of the three-layer net cage is beneficial to the overall quality of the reservoir's water. However, Qingjiang Pengbo's involvement also has some downsides: the company requires the cages to be placed quite close together to make management easier, meaning that in some areas of this very large reservoir the cages are more densely concentrated and place more pressure on the environment.

Qingjiang Pengbo checks the quality of the fish it buys from farmers and then sells it on. Qingjiang Pengbo, in partnership with the local fishery bureau and one of the academic partners, has instigated a **traceability system pilot which is seen as a model to learn from** within Hubei and even in other provinces. It is a simple system with a website and an app: a number can be inputted or the QR code scanned to reveal a one-page report with data relating to fish harvesting date, timing of chemical applications, fish meat test results, etc. For now, this system is aimed at retailers rather than individual consumers; as detailed previously, there are inherent difficulties for live fish traceability systems.

What have we achieved?

WWF has noticed a substantial increase in awareness of sustainability issues over the 15 years it has been working on freshwater aquaculture, not only on the part of the fish farmers but also within local government. The work on BMP standards has also allowed WWF's research partners to benefit from increased government funding, allowing them to undertake more in-depth research.

Monitoring and evaluation has been a particular challenge for the Fishery Market Transformation work in the Yangtze river basin. There are difficulties in terms of availability of and access to data, and WWF-China has also been conscious about not putting fish farmers off engaging through excessive evaluation. The team has focused on monitoring the reach of



Preparing fish © WWF-UK



Lake Hong fisher © Zhang Yifei



Fishers on the Yangtze © Zhang Yifei



Honghu City fish market © Brent Stirton/Getty Images/WWF-UK



Hubei boat © Michel Gunther/WWF

training as well as impacts on water quality, livelihoods and fish meat quality.

UNDERSTANDING THE IMPACT OF TRAINING

Over 65,000 fish farmers have so far been trained in Honghu City, Jianli City and other counties by WWF and the county fishery bureaus (for the pioneer farmers) and by the pioneer farmers in the case of normal aquaculturists. For the pioneer farmers, basic information about them and their aquaculture activities as well as a signature is obtained so that attendance of training sessions can be monitored.

WWF and its partners have had to tread carefully in terms of monitoring the training done by the pioneer farmers with normal aquaculturists, so as not to place undue pressure on them. **Pioneer farmers are encouraged – but not required – to prove they've trained others** by sending pictures or calling WWF and/or the government when they have trained someone else. Occasionally, WWF asks the local government to verify via impromptu phone calls.

For some of the pilot projects there is a more direct relationship between training received and changes in practices, since some of the companies monitor the production methods and the outputs associated with their brand. However, WWF-China **does not require fish farmers who have received training on BMP standards to actually apply these** to their own aquaculture activities. The idea is that the pilot projects and the examples demonstrated during the training will show aquaculturists the livelihood benefits of applying the BMPs. The challenge with this approach is then to make the connection between training activities and potential improvements in water quality in the Yangtze, which is one of the assumptions underlying the Yangtze programmes Fishery Market Transformation work.

IMPACTS ON LIVELIHOODS

In creating the BMP standards, WWF and its partners have always been mindful of the economic implications of aquaculture practices, and the **chosen BMPs were those that did not decrease farmers' and companies' profit margins**, though they might alter the various flows of money because of changing production styles. Indeed, there would be no uptake of the standards otherwise.

In the case of the mixed grass and artificial feed carp farming in Hongxianxi, this feeding method is ultimately more profitable than the purely artificial feeding method, although some inputs are more expensive. For example, the mixed grass feeding method, for comparable acreage, requires a bigger expenditure on grass seed and wheat (but takes advantage of free solar energy for photosynthesis!), while the artificial feeding method is more costly in terms of electricity and fish medicine for example. Because grass is more easily digested by the fish, the incidence of diseases is reduced, as is the need for use of medicines. Overall, the mixed method reduces feed costs by 30 to 40%. Although the fish yield for comparable acreage is less for the mixed feeding method – because those ponds are less densely stocked – reduced input costs still make it more profitable. The ultimate aim is for fish reared in this way to be able to command a higher retail price, which will further increase comparative profitability.

For Hongxianxi, the major difference is in terms of the labour required. Although the sum of all other inputs makes the mixed grass feeding method more profitable, it does **require a lot more labour than the artificial feeding method**. The artificial feeding is almost fully automated, while the mixed feeding method requires a lot of labour not only to set up (the pond shape has to be altered) but also on an ongoing basis because of grass seeding and harvesting as well as the constant management of pond water height. This method is not ideal for aquaculturists who want to supplement their income via secondary employment.

Ongoing operation costs are not the only consideration; initial investments also matter. The Qingjiang Pengbo company subsidises the initial cost associated with the purchase of its three-layer net cage. For Hongxianxi, the higher costs associated with setup mean profitability increases over time.

Although 'baseline' information on income levels for typical aquaculture farmers is available, it is **not always easy to make a connection between improved practices and peoples' livelihoods**, because detailed data about livelihoods is hard to obtain and may not take into account remittances, other sources of income, availability of family labour etc. Finally, local farmers may benefit from these improved aquaculture practices in other ways, e.g. due to reduced chemical use or improved river water quality, though such health and well-being impacts have not been measured yet.

IMPACTS ON WATER QUALITY

In China, only a small percentage of freshwater aquaculture takes place within river channels themselves. However, **pond**, **lake and reservoir aquaculture does ultimately impact rivers** via infiltration, overland flow and when they are directly connected to a river or its tributaries. Some of the lakes and reservoirs used for aquaculture are themselves important habitats within river basins and can be adversely impacted by



Mr Xiao, Manager Hongxianxi Sustainable Fishery

Hongxianxi Sustainable Fishery uses traditional and scientifically-proven aquaculture methods to produce grass carp.

The Manager, Mr Xiao, has lived and worked in Honghu (Lake Hong) for 50 over years. Ten years ago Mr Xiao saw potential for growth of fisheries in the area and with the support of WWF and its partners, he was able to establish a sustainable fishery.

Mr Xiao commented; "Traditional fisheries in this area used artificial feed and unsustainable methods to produce higher numbers of fish, but I felt strongly that this wasn't the best product for the consumer so I adopted a traditional and sustainable model of feeding carp with grass."

Mr Xiao believes that the government is now more focussed on food safety. "This ecological model is producing healthier fish which is good for the people of this country, but this model should also continue because it benefits fisherman to be trained in more traditional and sustainable methods." aquaculture. This is why WWF' activities cover a number of different aquaculture types.

Measuring the impact of interventions on water quality in China is somewhat complicated by **restrictions placed on the availability of data**. Basin- or county-level water quality data is not publicly available and WWF is not able to obtain it directly from the government; however, some of the academic partners are trusted government data recipients and are able to undertake the analysis of data and share results with WWF.

Data from some of the pilot projects are more readily available to WWF; water quality testing is done in Hongxianxi and Qingjiang Pengbo, and data on feeding regimes and chemical inputs are also available. For example for Hongxianxi comparative measurements have shown that water in the mixed grass feeding ponds has **significantly lower total nitrogen content** than that in the artificial feeding ponds. WWF-China will eventually produce a report based on pilot project-level data as well as larger scale data provided by the partners, and is confident that water quality improvements will be demonstrated.

Part of WWF's work with the fish farmer communities has also been to help promote the message about the government ban on the use of certain chemicals, for example malachite green which is used to control fish diseases but can be toxic to humans.

IMPACTS ON FISH MEAT QUALITY

The assumption is that there will be higher uptake of the BMP standards if these allow aquaculturists to produce fish that is of higher quality and therefore can be sold for a higher price. *Perception* of quality on the part of consumers can play a role. For instance, the nitrogen content of the water does not itself affect the fish meat, but some consumers will be receptive to the idea of consuming fish reared in less polluted water. In a few of the pilot projects **physical changes are apparent**, e.g. changes in the colour of channel catfish or in the morphology of grass carp.

However, one of the main drivers for scientifically measuring the impact of the application of BMPs on fish nutrition has been the involvement of Carrefour, as the retailer wants to be able to **prove the link between improved water quality and better meat quality**. As a result, testing of fish meat has only started relatively recently for Hongxianxi and Qingjiang Pengbo; it is an expensive and time-consuming process.

Initial comparative testing for Hongxianxi has been done over two seasons (winter 2015 and spring 2016) and will continue each season until the end of the project. **Results are not yet representative** (particularly as fish feeding methods vary seasonally), but indicatively show improved water muscle retention and more of one of the amino acids; these are factors that contribute to improved fish taste and nutrition.

What helped to ensure our success?

Several things have contributed to the programme's success:

- WWF's partnership with different levels of government has been the most important success factor for the Fishery Market Transformation work, certainly in terms of legitimacy, influence, reach and upscaling. Government fishery bureaus – at local and regional scales – have been involved in creating the BMPs, setting up the pilot projects and training thousands of fish farmers. WWF has been able to take advantage of several policy opportunities, including national-level promotion of traceability systems, as well as governmental interest in food safety and water pollution issues. A shared goal – the sustainability of freshwater aquaculture – has enabled long-lasting and effective engagement with government.
- **Partnering with academic and expert institutions** has helped tap into their varied and extensive expertise as well as their existing networks of contacts with producers. Their involvement has brought authoritativeness to the proceedings and has allowed WWF to gain access to data that would otherwise not be available to it as an NGO.
- Working with multiple stakeholders has helped build trust between those involved: WWF, the government, the academic institutes, the aquaculture companies and co-operatives. The multi-stakeholder approach was particularly effective when applied to the creation of the BMPs.
- Not reinventing the wheel by building on existing good practices helped WWF and its partners to work more efficiently in creating the BMPs. It also created recognition for some of the good practices aquaculture companies and co-operatives had in place already, and helped to provide a more scientific basis for some of the methods.
- Having a good understanding of and taking into account the local specificities and market conditions allowed the programme to target its interventions most appropriately. For instance, producers and retailers and in future consumers were recognised as the actors that



Yangtze fisher © Brent Stirton/Getty Images/WWF-UK



Yangtze River © Zhang Yifei



Small-scale fishing © Brent Stirton/ Getty Images/WWF-UK



Former poacher © Brent Stirton/ Getty Images/WWF-UK

could most effectively be influenced, and the importance of food safety within the national context was taken into account when designing activities.

- **Targeting the highest freshwater aquacultureproducing province** in the Yangtze basin (Hubei) and some of the top districts within Hubei not only makes sense in terms of maximising reach and numbers of fish farmers involved, but should also help influence basinwide and national policy.
- **Choosing very varied pilot projects** has helped create legitimacy and reach for the BMPs by demonstrating them for a variety of different aquaculture species, locations, sizes and producer types. It has also helped incorporate some of the different innovative practices already being used into the BMPs.
- **Grounding the BMPs in practice** and making them neither too demanding nor prescriptive has helped secure the involvement of the pilot producers. Efforts made to understand and limit the negative cost implications of the application of BMPs also helped make them willing to participate and alter their practices. The same emphasis on livelihoods has also been key in getting fish farmers to participate in training activities.
- **Using a 'train the trainer' approach** for multiplication of programme benefits in a timely and cost-effective way.
- **Considering the whole supply chain**, from producers to end consumers, has allowed WWF to take advantage of a range of tactics and leverage points for making freshwater aquaculture more sustainable.
- Working with retailers based on issues that are of most interest to them; for example, conversations with Carrefour haven't just focused on CSR, but have mostly related to meat quality, logistical benefits and profit margins.
- Adaptive management and willingness to take risks has paid off for the team, allowing them to abandon an initial unsuccessful direction of work in favour of implementing more successful measures. WWF and its partners have continued to learn while doing, as reflected in the improvements made to later farmer training programmes and the fact that the pilots set up in the latter stages have been more successful.

What hasn't gone so well?

The programme has faced a number of challenges:

- There are difficulties in quantifying the benefits linked to activities. For several aspects of the programme, it is too early to quantify benefits, whether because data are not yet sufficiently available (e.g. nutrition value of fish meat) or difficult to obtain (e.g. livelihood benefits). Restrictions placed on the availability of data for NGOs are also a part of the problem.
- The ability to attribute the work to improvements in the Yangtze's water quality is imperative. Currently, the link between pollution from pond, lake and reservoir aquaculture and deteriorating water quality in the main river has not been adequately proven. Such quantification is vital for the appropriate targeting of sustainable aquaculture work going forward. WWF-China is aware of the need to enhance water quality analysis going forward.
- At this initial stage, upscaling remains elusive. Even though the numbers of farmers trained in Hubei are impressive, they only represent around 3% of the total. This is WWF's main concern, and a big reason for it building relationships with fishery bureaus at the provincial and even Yangtze-wide scale.
- The success of the training programme is based on a key assumption: that fish farmers will eventually apply the BMPs to their own production. Emphasising the costeffectiveness or even increased profitability of the measures is therefore important, though as noted for Hongxianxi, not necessarily straightforward.
- Low consumer awareness of and interest in sustainability in China remains a barrier, particularly given the almost exclusively domestic market for freshwater fish and crustaceans. Until now, WWF's focus on aspects relating to food safety and quality has been successful, but not being able to 'sell' the sustainability aspect could limit the range of options going forward.
- **Co-operation with supermarkets has not been fully straightforward**; procurement decisions don't just relate to product quality – WWF has come to realise procurement is not a fully transparent process. Regular staff changes within supermarkets have also had an impact on the progress of that part of the programme.
- **Further price differentiation is required** to encourage more sustainable forms of production.



Fisherman, Dongting Lake. China ©Michel Gunther/WWF



Tongchuan Lu fish market © Holly McKinlay/WWF-UK



Traditional wooden boat © Brent Stirton/ Getty Images/WWF-UK

Currently, sustainably-produced freshwater aquaculture products generally are not sold for a high enough price, and form too small a percentage of the fish sold. More policy support would allow for further price differentiation pending the full functioning of market mechanisms.

Where will we go from here?

In the short term, the team is hoping to work with the Yangtze Fishery Administration Office (YFAO) to promote the BMP standards and co-run training for aquaculturists, which would achieve impacts at a basin-wide scale – particularly in relation to wetland aquaculture over which the YFAO has jurisdiction. In addition, WWF-China is collaborating with 60 leading freshwater and marine experts on the compilation of a book of sustainable aquaculture case studies which will be published in English and Chinese. Finally, it is anticipated that the BMPs mentioned in this case study will be officially released by the Hubei provincial-level standardisation organisation in 2017, which will move them from voluntary to mandatory in Hubei.

More long-term, the Yangtze aquaculture work's aims will continue to include the reduction of negative environmental impacts and the improvement of livelihoods. Generally, the focus will not just be on the production side via pilot projects such as the ones detailed in this case study, but will also be more strongly linked to consumption, in order to use pressure from consumers to influence producers. The food safety angle is particularly relevant in China, which has suffered from repeated food scandals; a trusted certification and traceability for live fish should help command higher prices. Some anticipated areas of work are:

- **Create standards for live fish** to make it easier for consumers to make informed choices, and connect these to aquaculture production standards; other global certification systems have provided inspiration for standardising all the elements of the supply chain. There is currently a lack of standards for fish meat in China; these would attribute meat characteristics (e.g. nutritional value) to the existing BMP production standards, and help obtain a higher price for the producers of fish of proven high quality. Ultimately, if the standards were to be successful, they could be developed into a certification system.
- **Promote a traceability system** (for both live and packaged fish) throughout the supply chain, from producers to consumers; this links to the certification system mentioned above. This will help create links with retailers and provide consumers with information about

meat quality and food safety, helping to build trust. Currently, there is little traceability for locally-consumed freshwater fish, particularly in comparison with exported fish. The technical and management-related data such a system would provide would help improve monitoring and target interventions towards more serious types of pollution and the real source of problems. Any traceability system needs to consider incentives for aquaculturists to use it; a lack of obvious benefits to them has so far been a major barrier to the adoption of traceability systems.

- Generate guidance for the mixed natural and artificial feeding method to better establish the work done in Hongxianxi, with a focus on cost savings, meat quality and lack of yield losses. The aim is to help spread the use of this feeding method beyond grass carps to other species; scientific research has shown that four other fish species could also benefit from it.
- Undertake scientific research regarding local precision feeding methods, which can have positive implications on waste generation and input costs without adversely impacting yields. Precision feeding can benefit several different species. At present, there is only anecdotal evidence about the benefits of precision feeding, a method used by some older local people. More research is needed to quantify the local benefits and understand their scientific basis.
- Use modern communication technology to extend the reach of training activities; the idea is to create a television- or internet-based training platform for freshwater aquaculture. The reach of technology in China – even in rural areas – would make this technically feasible. The challenge for the team will be to foster positive relationships with the media. Options could include televised training with a follow-up survey using social media to obtain feedback on the reach and impact of the training.

FOR MORE INFORMATION

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Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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