

# Influences of Aquaculture on Ecological Environment

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## Abstract

Since reforming and opening to the outside world, Chinese aquaculture has developed very quickly. The total output of aquaculture has been ranking first in the world over ten years, but it still has many problems. In the article, these problems which existing in the aquaculture of China are listed, and they have seriously influenced the quality of aquatic products of China and destroyed the whole ecological environment of aquaculture. The factors influencing the water environment include: (1) residual feeds and excrements, (2) chemical medicines used in aquaculture, (3) escaping aquatic animals. And the aspects which were influenced including: (1) the influence on the physiochemical factor of water, (2) the influence on the bottom matters, (3) the influence on the plankton, and (4) the influence on the bottom dwellers are analyzed. To reduce the influence and pollution of aquaculture on the ecological environment, enhancing the quality of composite feed is one important approach.

**Keywords:** Aquaculture, Ecological environment, Pollution

In recent years, with the gradual enhancement of living level, people's demands for aquatic products are more and more. Since 1999, China began to implement the "zero increase" of fishing outputs, and implemented the "negative increase" of fishing outputs in recent years, so the supply of aquatic products becomes more and more depends on the aquaculture (Li, 2002, P.7-9). And the aquaculture is quickly developed because of people's more and more demands for the aquatic products. But some unreasonable phenomena such as the random discharge of aquaculture waste water, the abuse of medical medicines, and the escaping of aquatic animals have seriously influenced the ecological environment. In the article, the problems existing in Chinese aquaculture and the influences on the ecological environment are summarized, and corresponding advices are proposed.

## 1. Problems existing in Chinese aquaculture

### 1.1 Employees' overall cultural quality is low

There are over ten millions personnel to directly or indirectly engage in the aquaculture, but they universally

have lower cultural level, deficient relative professional knowledge, and lower management level, and they can not creatively study and apply their knowledge. The popularization degree and depth of the aquaculture is still deficient, and the pertinence and the technical content are lower.

### *1.2 The research of fishery diseases is sufficient, and the abuse of medicines is universal*

New or stubborn fishery diseases can not be treated, and most diagnosis departments of aquatic diseases only have undeveloped instruments and weak technical power, and they can not distinguish bacteria, virus, vermin, nutritional disease, or syndrome, which directly influence correct medicine using. Once the disease comes on, the abuse of medicines is very universal. The medicines are mainly composed by human medicines and animal medicines, lack in pertinence and have bad treatment effect. And seriously residual medicines are polluting the environment and reducing the quality of water products.

### *1.3 The environment protection consciousness in aquaculture is weak*

In aquaculture, some aquaculture enterprises or individuals only give attention to their immediate interests, and the traditional fishery which sacrificing natural resources and consuming large numerous materials still exists universally. Though various high-yield aquaculture methods such as industrial fish farming, cage fish culture, and running water fish culture are developed to some extent, but the ecological fishing and the environment protection consciousness are still deficient, and the random discharge of aquaculture waste waters without any disposal has deteriorated the whole aquaculture environment, and blocked the healthy and sustainable development of this industry.

## **2. Harm of Chinese aquaculture to the ecological environment**

### *2.1 Factors influencing the ecological environment in aquaculture*

#### *2.1.1 Residual feeds and excrements*

Feeds are the material base of aquaculture, and the source of main nutritional matters. Most feeds of aquaculture are outside source foods and given to aquatic animals directly (Li, 1996, P.8-84). Large numerous of residual feeds and the excrements of aquatic animals all impact the water environment. Braaten found that in the seawater cage culture of abalone, 20% of wet or dry feeds can not be eaten by aquatic animals, and directly disperse in the aquatic waters and become into the pollution source (Braaten B, 1983, P.6-7).

In the eaten feeds, there are only 25% N to be used for the growth of fishes, and other 65% of them are used for excrement, and 10% of them are excreted out of the fishes as excrements. That means that only 1/5 feeds are utilized effectively, and others are discharged to the environment as the environmental pollution matters (Gowen R J, 1987, P.563-575 & O'Sullivan A J, 1992, P.405-412). In the cage culture or the pond fish culture, the waste and the pollution of feeds of fresh or chilled small mixed fishes are more serious (Dong, 2000, P.572-582).

In Lin Yongtai's research (Lin, 1995, P.6-10) about the influence of Heilongtan Reservoir cage fish culture on the water environment, the content of total nitrogen (TN) in the feeds is 5.22%, the content of total phosphor (TP) is 1.43%, and there are 131.2t TN and 35.9t TP. And the TN entering into the waters from feeds is 96.27t (73.38% of TN in feeds), and the TP entering into the waters from feeds is 34.04t (94.81% of TP in feeds). It is obvious that the feeds which have not been eaten seriously impact the water environment. Funge-Smith et al (Funge-smith, 1998, P.117-133) studied the material balance in the shrimp pond of paddyfield, and found that only 10% N and 7% P were utilized in the aquaculture, and others all entered into the environment by various forms.

#### *2.1.2 Pollution of aquatic medicines*

In modern aquaculture, especially in high-density aquaculture, to prevent diseases, eliminate harmful biology, disinfect and restrain polluted and damaged biology, multiple chemical medicines are used. The treatment medicines and disinfectors in aquaculture have been another big pollution source. Especially in the aquaculture of China, the abuse of medicines is very serious, which has impacted the environment seriously.

Solbe had reported that there were 23 kinds of chemical medicines used in the aquaculture of England, and the antibiotics used in the aquaculture of Norway in 1990 were more than the antibiotics in the agriculture (Gowen R J, 1992, P.23-48). In the aquaculture, quite part of used medicines would disperse into the environment, which would induce short-term or long-term regression of the environment. In the coastwise of Zhu-jiang Delta, bluestone was slathered to treat the shrimp disease, and the Cu pollution still exist in the water environment of this region quite seriously (Jia, 1997, P.78-82).

### 2.1.3 Escaping aquatic animals

The escaping fishes in the aquaculture may diffuse diseases and change the inheritance composing of wild swarm, and seal lice might be one example (Jia, 1997, P.78-82). In many aquatic farms, when the epidemics happen in aquatic juvenile prawns, the prawns and waters will be discharged to the exterior environment, which may induce the diseases to be diffused to the nature, and bring harms for wide swarms.

At present, the output of haddocks around North Atlantic Ocean has exceeded  $4 \times 10^5$  tons. The potential influence of the escaping aquatic fishes on the wide swarms has been emphasized by these countries. According to the report (ICES, 1997, P.102-106), there were 34%~54% escaping haddocks in the captured haddocks along the seashore of Norway from 1989 to 1996, and the escaping aquatic salmon occupied 10%~21% of the captured haddocks in Firth, and in Scotland, North Ireland, Canada and US, escaping aquatic salmon were also be inspected.

The experiments in Ireland, Norway and Spain showed that the energy of escaping aquatic fishes was less than the energy of wild ones. The escaping fishes would impact the amount change and spawning sites of wild swarms. To avoid these influences, experts advised to use sterile fishes such as triploid fishes and gynogenesis fishes or the swarms close to the local wild swarms. Iceland has constituted some rules to restrain these influences, such as the local swarms must be used to propagate the river salmon, and for the river which yearly fishing amount exceeded 500, the fishing cage must be put out of the bayou for 15 km (Gowen R J, 1992, P.23-48).

### 2.1.4 The fishing intensity is further strengthened, which makes the inshore fishery resources further reduced

To renew the deteriorated coastal fishery resources, the seawater aquaculture is encouraged in China (Li, 2002, P.7-9). However, because most aquatic feeds are animal feeds, it will increase the fishing intensity on the contrary. First, the aquaculture needs large numerous of animal feeds, and except for part assorted feeds, some carnivorous fishes including *Micropterus salmoides* in fresh waters and the groupers in sea waters in China mainly eat captured natural mixed small fishes. The feed coefficient of fixed small fishes usually is 2~3, some times it will achieve 5~8. Second, though some fishes eat assorted feeds, but the animal albumens in assorted feeds mainly come from fishmeal, and the large demand of fishmeal would certainly increase the fishing amount (Yang, 2000, P.30-33).

## 2.2 Influences on the ecological environment

### 2.2.1 The influence on the physiochemical factor of aquatic waters

The main influence of aquaculture on water quality is to increase the suspended substances and the nutritional salts in waters (Luo, 2002, P.28-30 & Xu, 2003, P.204-206 & 235 & Zhang, 2003, P.54-59 & Zhao, 2003, P.362-364), and the cage aquaculture could reduce the dissolving oxygen in the aquaculture region (Tang, 2003, P.46-48). Liu Shunke et al (Liu, 1991, P.46-48) measured the water quality of cage carp culture in Shuimotan Reservoir, and found that the water color changing from cyan to black brown, and the transparency descended quickly, and the lowest was 54 cm. Chen Dechun's research result (Chen, 1993, P.23-26) showed that the total suspended substances, total P, total N, total C, BOD, COD were all higher than the control region, and the value of pH was a little lower than the non-aquaculture region, and the salinity and water temperature changed little, and the transparency and DO were obviously lower than the non-aquaculture region, which indicated that the wastes of cage aquaculture increased the total concentration of water nutrients and reduced the transparency of the waters. Therefore, red tides and water blooms occur frequently in Chinese water areas (Song, 1995, P.11-13).

The discharges of organic wastes and inorganic wastes produced by coastal fishery aquaculture would directly bring some phenomena such as the increase of organic loads and the eutrophication in some half-closed bays, for example, BOD increases, oxygen-poor and oxidation-reduction potential reduce, which will induce the reducing compounds (such as ammonia, sulfured hydrogen and firedamp) increased, thiobacillus bloomed, the biomass, abundant degree and kind amount of large zoobenthos reduced (Wang, 2003, P.60-62). Other influences also include the acidification of pond soils, the decrease of biologic diversity, the increase of pathogene, and the occurrence of water bloom. The ammonia, sulfured hydrogen and methane produced in settlings would also harm the aquatic animals (Shu, 2002, P.74-79). The pollution discharges of large aquatic farms (such as cage or pond) in the sea area that the water exchanges slowly would also induce red tides and threaten the safe production of fishes, shrimps and seashells (Folke C, 1989, P.234-243).

### 2.2.2 The influence on bottom matters

In the bottom mud of aquaculture, the contents of C, N and P are higher than the contents in other settlings, and the oxygen consumption is also higher, and the residual feeds are often seen in settlings (Luo, 2002, P.28-30 &

Shu, 2002, P.74-79). When the organic matters cumulated in the mud bottom are too more, the physiochemical index of the bottom will be changed, and the decomposing function of microbiology is bloom, and the dissolving oxygen in the bottom mud is deficient and becomes into the reducing status because of oxygen-poor or zero-oxygen, and large numerous of sulfates in sea waters generate  $H_2S$  in the reducing environment, and it can diffuse to the depth of a few centimeters in the bottom because of the absorption function of the settlings. Comparing relative factors of the surface settlings in the aquiculture region and the non-aquiculture region, it is obvious that the contents of high-sulfide, COD, inorganic nitrogen and inorganic phosphor in the aquiculture region are all higher (Zhang, 2003, P.54-59). Ji Rubao et al's research (Ji, 1998, P.21-27) about the bay ecological system of shell aquiculture indicated that in the denseness region of shell, the settling function of biology is very obvious. Hatcher et al (Hatcher A, 1994, P.219-235) measured the mussel aquiculture region in the Upper South Cove of Canady, and found that the settling amount of the aquiculture region is always two times than the non-aquiculture region.

### 2.2.3 The influence on planktons and bottom dwellers

Generally, the input of outside-source materials and organics can increase the productivity of the planktons, and the high-density aquiculture would certainly influence the predominant swarms of planktons. Feeds make the nutrimental matters in waters to gradually increase, and the phytoplankton propagated largely at the beginning, but with the extension of time and the continual expansion of aquiculture scale, the nutrimental matters increase, the water quality deteriorates, the illumination reduces, so the amount of phytoplankton will begin to reduce (Chen, 2001, P.20-22).

Different alga kinds need different nutrimental elements, and in the continual deterioration of water quality, the dominant kind of alga always changes from diatom to blue alga. For example, seashell is a kind of filter feeder with strong filtering ability, and high-density aquiculture will impact the ecological system, and whether for the bottom seeding aquiculture (such as clam and oyster) or for the balsa aquiculture (such as mussel and scallop), seashells all can filter and incept phytoplankton and organic grains in waters, so they will obviously influence the swarm structure of phytoplankton, and increase the proportion of micro phytoplankton in the swarm (Ji, 1998, P.21-27).

The zoobenthos is good feeds for fishes, and the index to evaluate the water quality. The residual feeds in the aquiculture region and the dejections of fishes would change the nutrimental status of waters and the water quality, and correspondingly include the kind composing, amount and biology amount of zoobenthos. Lin Yongtai et al (Lin, 1995, P.6-10) surveyed the influence of cage fishing of Heilongtan Reservoir on the water environment, and found that the amount of zoobenthos in cage region was obviously less than the non-cage region, that was because that the nutriments were largely accumulated under the cages and around this region, and the DO in the settlings decreased, and the amount of zoobenthos significantly reduced, and the distance was far from the cage, and the influence was less. Behind the critical line, because of a little accumulation of organic matters, residual feeds and fishery dejections offered good nutrimental conditions for zoobenthos, which would increase the abundance of some kinds and reduce the others'. Kaspar et al (Kaspar H F, 1985, P.127-136) surveyed a mussel aquiculture region in New Zealand, and found that the multi-hair mussel occupied the dominant status in the aquatic region by comparing the swarm structures of zoobenthos, but its diversity was far lower than the non-aquiculture region.

### 2.2.4 The influence on the diversity of biology

The other influence of aquiculture on aquatic biology is that the escaping aquatic fishes would impact their neighboring biology. The escaping fishes in the aquiculture may diffuse diseases and change the inheritance composing of wild swarm (ICES, 1997, P.102-106), and infect local epidemics to wild swarms. The energy of escaping aquatic fishes was less than the energy of wild swarms. The escaping fishes would impact the amount change and spawning sites of wild swarms. Mills et al (Mills, 1983, P. 151-161) found that the influence of the fishes escaping from the cages or replanted intentionally on the wild fish swarm also would kill out local swarms by preying or feed competition. Especially once the cross-fertilized fishes and genetically engineered fishes generated by modern biological technology escape to the nature, the "gene pollution" may be induced, which will harm the inherit diversity of wild swarm in the nature (Chen, 2003, P.191-194).

### 2.2.5 The influence on the ecological environment

In the recent years, because of the development of aquiculture, the seductive profit of aquiculture has raised a aquatic tide in the world, most lakes, rivers, swamps, coastal lowlands and mudflats are changed into shrimp culture ponds and fish culture ponds (Paez-osuna F, 2001, P.229-231). These lowlands were mangroves, kaline soils and agricultural lands, and some of them were inhabiting, spawning and refuge places for many fishes and

shellfishes. And these places could also be important drainage passes when floods, storms and cyclones come. In addition, in the water exchange from mainland to coastal waters, these places are very important buffers. Especially, the mudflat and mangrove regions exert more significant function to maintain coastal ecological environment (Liu, 1997, P.101-106). However, many shadow seas and mudflats were developed without systematic planning and technical research, and blind ining or destroying exploitation still exist for quick success and instant benefits, for example, the shrimp culture of large-scale development has seriously destroyed the ecological balance of many mudflats. Unreasonable development will destroy the ecological environment of shells, and the natural resource of mudflat shells (especially the important economic kind) were destroyed to different extents (China Ministry of Science and Technology, 1999).

### **3. Advices to reduce the influence of aquaculture on the ecological environment**

The pollution of fishery ecological environment has impacted the quality of aquatic products of China, and reduced the international competitive force of Chinese aquatic products, and induced large economic losses, and blocked the sustainable development of Chinese fishery industry. To solve the problem of environmental pollution of aquaculture, following aspects are advised.

#### *3.1 Enhancing the quality of artificial formulated feeds*

Because most aquatic wastes come from feeds, to reduce these wastes, the nutrimental components and feeding mode should be changed. Adding digestible carbohydrate in feeds can enhance the utilization of proteins. And selecting the optimal proportion of the energy content and the protein content in feeds can reduce the excretion of nitrogen in feed, and the excreted energy in unit biology quantity will also be reduced. For the feeding, the proper feeding quantity should be confirmed, which can reduce the amount of feeds and scattered feeds and the loss of feeds, so it is very important to control the feed inception (Funge-smith, 1998, P.117-133). From 1975 to 1989, the feed components of Northern European countries had been changed largely, and the fattiness in fishery feeds was enhanced for 27.5%, the albumen was reduced for 31%, and the energy was increased for 30%. From 1987 to 1991, the yearly output of fishes in Finland increased three times, but the discharge of P from fishery aquaculture only increased for 23%, and the causes include the enhancement of feed transformation rate, the decrease of P content, and the fishery output/ P discharge. From 1984 to 1991, the yearly output of aquatic fishes in Denmark increased four times, but the discharge of N only increased two times at the same term. The components of fishery feeds still can be improved further (ICES, 1992, P.32-35).

#### *3.2 Using fishery medicines correctly*

The prevention technology of aquatic fishery diseases is still lower. At present, most fishery medicines in aquaculture are human-animal sharing medicines, and the special fishery medicines are deficient, and the medicine using lacks in standards and pertinence in the aquaculture, and the confirmation of the dosage can not be based on scientific pharmacology, and the abuse of medicines still exist universally, even these medicines are entering into human bodies through the food chain. Therefore, the medicine dosage must be strictly controlled, and the performance and using method of fishery medicines must be known correctly, and the researches about the pharmacodynamics, the pharmacology, and the toxicology should be further strengthened, and the green fishery medicines with high efficiency and low poisons and without pollution and residuals should be studied to prevent the fishery diseases (Wang, 2004, P.21-26).

#### *3.3 Enhancing the management level of aquaculture*

In recent years, the main problem in the aquaculture is the management. At present, the reason that pollution of water environment and the destroying of coastal ecological environment by aquaculture in many places is the management of the aquaculture is not perfected and the development lacks in planning and control. Aiming at the problems existing in the aquaculture, the management should be urgently strengthened from macro and micro aspects. Following points should be emphasized, (1) constituting detailed aquatic development plan, (2) implementing rules about aquaculture resource development and management, and comprehensively utilizing the regulations of fishery resource management, (3) evaluating the aquatic capacity of various aquatic regions and the influence of aquaculture on ecological environment, (4) strictly managing the quality of aquatic seeds, feeds and medicines, (5) managing the safety of aquatic medicines and the aquatic products, (6) implementing aquatic science education and technical training for aquatic personnel, (7) enhancing aquatic personnel's environmental protection consciousness (Liu, 2003, P.24-25).

Only to develop the water resources and the aquatic biology resources by insisting the guidance of sustainable development, depending on science and technology, respecting the objective rules, protecting the ecological balance, and developing the fishery resources effectively and reasonably, the aquaculture of China in the 21st century must be full of more vital forces and energies.

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