The Curse of the Dead Fish

It was a hot morning, and Manuel woke up early. He decided to take a stroll around the lake, a wonderful opportunity to cool down and visit his fish cages. He grabbed his favorite old salakot [i] and took off with a cheerful heart. It was May of 2016 and he was thinking to himself that in another three more weeks he will be able to harvest the fruits of his labor. . . By then he could buy his youngest girl her first birthday cake and a new pair of shoes.

After walking for a few minutes, an unusual odor began to permeate the air. As he got closer to the dozens of cages in the lake, he noticed the color of the water has turned brownish and the source of the odor became clear when he saw hundreds of dead fish floating on the water. He thought this was not a good sign and hoped this did not mean what he feared it meant.

Aquaculture in the Philippines

Fisheries and aquaculture remain important sources of food, income and livelihood for hundreds of millions of people around the world. In 2014, world per capita fish supply reached a new height due to impressive growth in aquaculture, which provided half of all fish for human consumption. Around the world, aquaculture production had expanded rapidly while capture fisheries had stagnated over the last decade (see Exhibit 1).

i Salakot is a traditional wide-brimmed hat from the Philippines designed to protect the head of the wearer from the heat of the sun, providing shade especially for farmers and fishermen working in the fields and also protecting from rain.

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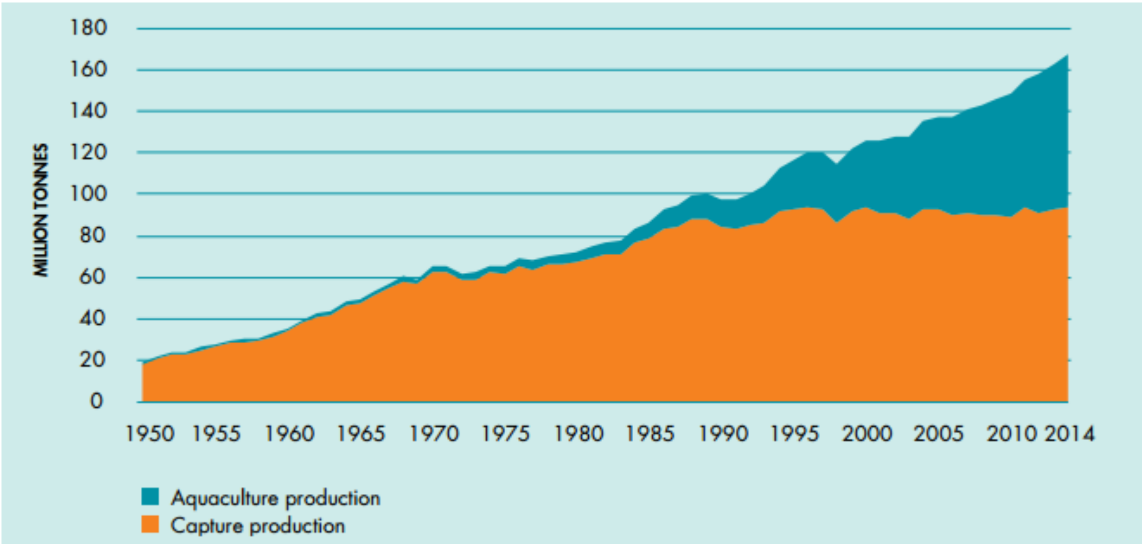
Exhibit 1
World capture fisheries and aquaculture production



Source: FAO. 2016. The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all. < http://www.fao.org/3/a-i5555e.pdf/>

The Philippines, as an archipelago, has vast fishery resources. However, due to anthropogenic impacts in the coastal areas, numerous fish species and marine organisms are experiencing overfishing and coastal habitats are showing signs of degradation. The Philippine fishing industry comprises marine capture fisheries, inland capture fisheries, and aquaculture. Aquaculture in the Philippines has a long history and involves many species and farming practices in diverse ecosystems. Most of the production comes from the farming of fish (i.e., milkfish, carp, and tilapia), shrimp, oyster and mussel (see Exhibit 2). Aquaculture contributes significantly to the country's food security, employment and foreign exchange earnings.

Most of aquaculture production came from freshwater fishponds, and the remainder from freshwater fish cages, brackish water fishponds, freshwater fish pens, brackish water fish cages, brackish water fish pens and marine fish cages. Fish cages have several advantages over other methods of culture because they use existing water bodies. Cage culture offers the farmer a chance to utilize existing water resources, which in most cases have only limited use for other purposes. A relatively low initial investment is all that is required in an existing body of water. Moreover, cage culture of fish uses simple technology; hence, fish cages are popular with farmers. However, concern is growing about the environmental impact of these methods. Extensive cage farming has had a record of high initial promise, followed by decreasing production figures and intensive culture is believed to accelerate eutrophication.

Exhibit 2
Volume of Philippine Fisheries Production, 2008-2012

ITEM	2008	2009	2010	2011	2012
			('000 mt)		
TOTAL	**4,966.9**	**5,079.9**	**5,159.5**	**4,973.5**	**4,865.1**
Commercial	**1,226.2**	**1,253.9**	**1,242.1**	**1,032.8**	**1,042.3**
Municipal	**1,333.0**	**1,348.6**	**1,371.4**	**1,332.6**	**1,280.8**
Marine	1,151.3	1,159.9	1,184.1	1,138.9	1,083.4
Inland	181.7	188.7	187.3	193.7	197.4
Aquaculture	**2,407.7**	**2,477.4**	**2,546.0**	**2,608.1**	**2,542.0**
Brackishwater Fishpond 1/	303.2	308.4	304.3	311.1	320.2
Freshwater Fishcage/pen	167.4	163.6	165.1	164.0	165.4
Freshwater Fishpond 2/	143.7	144.9	143.2	142.9	144.7
Marine Fishcage/pen	83.6	80.6	88.7	105.4	114.3
Others	1,709.8	1,779.8	1,844.7	1,884.7	1,797.4
Oyster	20.2	19.9	22.5	21.5	20.6
Mussel	23.0	19.9	20.9	22.4	25.7
Seaweed	1,666.6	1,740.0	1,801.3	1,840.8	1,751.1

1/ Includes brackishwater pen/cage
2/ Includes small farm reservoir and rice fish
Source: Bureau of Agricultural Statistics. Selected Statistics on Agriculture 2013. Quezon City, Philippines.

Eutrophication: Causes and Consequences

Eutrophication, or cultural eutrophication, occurs when large quantities of nutrients enter an aquatic environment. While eutrophication occurs naturally, it is normally associated with anthropogenic sources of nutrients. It is the primary problem facing most surface waters today. Eutrophication has many undesirable consequences and major economic costs.

Both nitrogen and phosphorus contribute to eutrophication.[1] Sources of these nutrients include animal wastes, agricultural runoff, and municipal sewage. The ecosystem quickly experiences an increase in populations of photosynthetic algal species including diatoms, flagellates, chrysophytes and dinoflagellates that can thrive in the presence of added nutrients, cause nuisance blooms, and produce toxins that harm other organisms.

The most conspicuous effect of cultural eutrophication is the accumulation of algae into dense, visible patches near the surface of the water or shoreline that reduce water clarity. Algal blooms prohibit light from penetrating deeper areas of lakes or rivers, reducing growth and causing die-offs of plants in littoral zones. Some predatory fish species also depend on light availability to successfully pursue and catch their prey.[2] High rates of photosynthesis associated with eutrophication can also deplete dissolved inorganic carbon and raise pH to extreme levels during the day. An increase in pH can impair perception chemosensory abilities of some organisms that rely on dissolved chemical cues for their survival.[3]

Most of the oxygen available to fish comes from algae. Most dissolved oxygen (DO) is produced by aquatic plants through the process of photosynthesis, although some enters the water directly from the atmosphere through diffusion. At the same time, oxygen is used by fish, plants and other organisms through respiration. During nighttime and cloudy weather there is less available sunlight for photosynthesis, which causes algae to switch from photosynthesis to respiration, thereby consuming oxygen required by fish. Moreover, when these dense algal blooms eventually die, microbial decomposition severely depletes dissolved oxygen, creating a hypoxic or anoxic conditions. Fish become stressed during a low dissolved oxygen period and become susceptible to bacterial and viral infections. Too little oxygen in the water causes fish kills (see Exhibit 3). In addition, warm summer water cannot hold as much DO as cooler water can.

Exhibit 3
Massive fish kills in fish cages

Source: PinoyGigs, Fish kills in Batangas and Pangasinan. http://www.pinoygigs.com/blog/news-and-updates/fish-kills-in-batangas-and-pangasinan/#!prettyPhotoFish cages Accessed 27 December 2016.

Fish cages can generate considerable amounts of effluents containing a variety of substances such as particulate material resulting from uneaten feed, fecal matter and excretory materials that increase biochemical oxygen demand and the concentration of dissolved nitrates and phosphates. These particulate and dissolved organic and organic materials are important because these compounds can directly affect both the water column and the sediment. Moreover, tidal regime, wave action, and the characteristics of aquaculture sites strongly influence the fate of waste released into the water column. For example, rivers and streams are high-energy environments and are usually less affected by the impacts of waste material because the bottom is consistently stirred by bottom currents. In contrast, lakes and ponds have weak water movements, which results to degradation of water quality.

Effluents from intensive production systems typically require large feed input and have greater negative impacts than effluents from semi-intensive or extensive systems with little or no feed addition. In cage culture, all excess nutrients are released to the environment, increasing the dissolved nutrient concentration in the waterbody and enriching the sediment beneath the cages. Feed can account for up to 60 percent of the total production costs in commercial aquaculture. Feed management regulates ration size, the spatial and temporal dispersal of feed, feed delivery rate and the frequency and duration of feeding events;[4] thus, it's important for farmers to understand how to feed their fish, considering their influence on the economic and environmental sustainability of their business. In addition, the growth rate and feed conversion ratio (FCR) influences feed quality. With high FCR, less of the nutrients are taken up by the fish and more are released into the environment.

The greatest determinant of the amount of excess nutrients entering the environment is the use of a poor feeding strategy by the farmer that leads to overfeeding. Poor feed quality and poor feeding strategy have major influences on environmental impact. Excess nutrients not utilized by the fish or shrimp are released into the environment and have to be assimilated or else they accumulate.

Fish Farming and Sustainability

Practices such as aquaculture create a perceived stability of food security, livelihood, and income, but unchecked growth in industrial food production can lead to unforeseen consequences in the future that could potentially undermine that security. This uncertainty stresses the need for an approach that aims to preserve the integrity of the ecosystem through more responsible treatment of the environment in a way that would justify the use of resources. In the case of cage culture, this means adopting more sustainable methods. For example, water and sediment monitoring protocols should always be followed to ensure early detection of excessive nutrient loads or anoxia, and implementation of adaptive management alternatives including follow-up monitoring. The use of modern feeds formulated to be efficiently digested by the cultured fish can also help decrease waste, as does careful monitoring of fish growth, survival, feed consumption, feeding times, and feed amounts. Polyculture,[5] the simultaneous cultivation or growth of two or more compatible organisms and especially crops or fish in a single area, offers an example of a more sustainable aquaculture industry. This method effectively promotes sustainability because “nutrient losses from one species are nutritional inputs for another.”[6] The resources do not get wasted but get recycled in an endless loop.

The Next Steps

Manuel talked to the local experts of the Bureau of Fisheries and Aquatic Resources, a government agency tasked to manage and regulate the country's fisheries sector and aquatic resources. From the information gathered, Manuel learned that in order to end the episodes of fish kills, he and other fish pen owners need to reduce their use of fish cages. Manuel is hesitant to heed the advice of the local government because his family’s income significantly relies on the harvest of these cages. Furthermore, he owns only a dozen of cages, which is a small fraction of the hundreds of cages in the lake.

Manuel went home with a heavy heart. He thought about things he could have done better and what he could do in the future.

Endnotes

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