From the Mid-West to the Middle East: A Fish Tale

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Fish supply 25% of the total animal protein in developing countries and are the principal source of animal protein for over one billion people. With this in mind, the WorldFish Center has dedicated its work to feeding the hungry and poor through research in aquaculture production. Formerly known as ICLARM, or International Center for Living Aquatic Resource Management, the WorldFish Center opened in Abbassa, Egypt in 1997 and became the regional headquarters for Africa and West Asia.

I was notified of my placement at the WorldFish Center in March of 2004 and I was ecstatic. I had heard the stories and read the papers from past interns and I knew I was in for a life changing experience. I wearily stepped off the plane in Cairo to find myself in an entirely different world. Where there was a two lane road- it was immediately made into four. The women carried their baskets of clothes on their heads and went to the river to wash them. The men rode their donkeys along the highway after harvesting their hay. The land was completely barren save for the trees that had been manually planted. My life in Iowa was a long ways away. The nerves were rattled and the panic had set in. What did I know about aquaculture? How could I, a high school graduate from Small Town, Iowa do anything to impact food security? What would they think of me, a young white American girl in a predominately Muslim nation? What would I think of them, the brilliant and dedicated scientists of the WorldFish Center?

The WorldFish Center is headquartered in Penang, Malaysia with several research centers located all over the world from the Solomon Islands, to the Caribbean Sea, to the African country of Malawi. The WorldFish Center has three overall objectives in which all research centers follow and strive to achieve:

¦ To identify systems of governance that enhance the contribution of riverine fisheries to food security and sustainable livelihoods, and distill reasons for their success.

¦ To acquire, interpret, and supply information on the value of fisheries in support of systems of governance that enhance the contribution of riverine fisheries to food security and sustainable livelihoods.

¦ Provide information of ways in which fish and fishers respond to natural and artificial changes in river systems as a basis for improved management and mitigation of losses cased by external intervention such as dams and water abstraction.

Because of the diverse locations of all the research centers, the WorldFish center has set objectives for each area of aquaculture in order to meet the need of a broad range of people. In the area of lake and reservoir fisheries there are four objectives:

¦ Identify systems of governance that enhance the contribution of lake fisheries to food security and sustainable livelihoods.

¦ Determine the status of the region's lake and reservoir fisheries and improve the availability of existing data on fisheries productivity (past, present, and potential) and management.

¦ Evaluate and identify approaches for conserving bio diversity in the region's natural lake systems.

¦ Identify options for improving fish production of lakes, reservoirs and SWBS (including pen and cage culture), in the face of competing demands for water.

As there are objectives for lake and reservoir fisheries, there are three objectives for coastal fisheries.

¦ To identify systems of governance that can foster sustainable use of coastal fisheries in the face of changing demographic, social and economic conditions, and can enhance the contribution of these resources to food security and sustainable livelihoods.

¦ To acquire, interpret, and supply information on the value of fisheries in support of systems of governance that enhance the contribution of coastal fisheries to food security and sustainable livelihoods.

¦ Provide information on the ways in which pressures upon the coastal zone impact coastal fisheries and identify ways to address these threats.

Despite the different locations and different objectives, the WorldFish Center in Malaysia has two main objectives which tie all the different centers together. The first objective is to enhance the capacity of national institutions to design and carry out research that will strengthen fisheries and aquaculture management in the region. The second objective is to enhance the capacity of national and regional institutions to disseminate and use the results of fisheries and aquaculture and research. Egypt plays a huge part in the world of aquaculture because it focuses on leading research for Africa and West Asia and research and training in aquaculture. In fact, a major focus in Sub-Saharan Africa is on integrating pond aquaculture into small holder farming systems, in North Africa it concentrates on integrating freshwater aquaculture, and in the coastal states of West Asia focus remains upon stock assessment and aquaculture.

The three objectives of the WorldFish Center in Abbassa are :

¦ Enhance the contribution of, and participation in, aquaculture through a better understanding of the adoption process.

¦ Enhance aquaculture productivity, including through efficient see production and genetic enhancement.

¦ Develop and implement methods to measure, monitor, and maintain environmental integrity as aquaculture expands in the region.

These objectives are important considering the area in which the research center is located. In Egypt alone, aquaculture production has grown from 60,000 t in 1990 to 340,000 t in 2000. However, the current regional supply of fish falls short of demand and is actually decreasing. This spells trouble for a country that is among the seven poorest in the region (Yemen, Iraq, Egypt, Syria, Algeria, Iran, and Jordan). Egypt's per capita GNP averages US $1,073 which is equivalent to US $2.90 per day.

The structure of the Abbassa Center takes into consideration the needs of the region and is broken up into four different departments: Genetics, Fish Health, Production, and Hatchery. Despite the different methods each department has for attaining sustainable aquaculture, they all focus on the same fish: tilapia. Although common carp and catfish are gaining momentum in becoming a main staple in the Egyptian diet, tilapia is of huge importance because of the Nile River. Nile Tilapia (oreochromis niloticus), once of great commercial importance, has now almost disappeared from lakes and rivers. Scientists have recognized that if we are to eradicate world hunger, tilapia will need to have a large role. Perhaps one of the biggest and most notable accomplishments of the WorldFish Center is the development of GIFT, Genetic Improvement of Farmed Tilapia. This improved genetic strain was developed in Malaysia and produces a 20% increase in body weight in tilapia. According to Dr. Mahmoud A. Rezk and Dr. Ebtehag A. Kamel, the transfer of improved strains from Asia have not been undertaken because of concern over the potential adverse impact on native germplasm in Africa and unknown effects of gene-environment interactions. Therefore, the approach being adopted by the Center in Abbassa, Egypt, is to implement the technology demonstrated in Asia for use in the genetic improvement of tilapia in Africa, test other approaches, and study the potential environmental consequences of genetically modified stocks.

I knew I was in for a big change. I wasn't used to hearing the call for prayer five times a day, and I was scared out of my wits when I saw my first woman completely covered in black save for the thick gauze covering her eyes. Fortunately I wasn't alone as the compound is very international and I was soon making friends from Vietnam, to Kenya, to India. My first couple of days were spent trying to acclimate myself to my new surroundings. I settled into my apartment that I shared with my Kenyan roommate, Patricia, and I received a tour of the actual compound itself. The Center is located just north of Cairo in the Nile Delta region and neighbors three different villages with Abbassa being the closest. I was shocked at how the security guards kept a close vigil at the gates and made sure that no one was able to get across the canal which separated the Center's land from another villagers, but I came to understand how vital it was that the ponds remained untouched save for the doctors and workers as possible life-changing research was being conducted. Despite being intimidated at first site of all the guards, they actually became my first and some of my best friends. I am forever indebted to Ali, the head guard, as he came to my rescue my very first night as I was wandering around the compound in the middle of the night in tears searching for a phone that would work. Whenever someone asks me about the people of Egypt, I always think of Ali and how he took me under his wing and said, "Don't worry, you are safe. Welcome to Egypt- we are happy you are here." Thus began an amazing stay in an amazing county where the people were open and friendly, the food was delicious, and the sights and sounds were unforgettable.

My third day in Egypt I met with one of my supervisors, Dr. George John, and was introduced to several people that worked in the office area. I was then invited to go shopping with Patricia, Rose (a trainee from Uganda), and Heba (an Egyptian woman that worked as a computer supervisor) to the nearby town of Zagazig. The sights and sounds were almost overwhelming. It wasn't uncommon to see vans packed with people on the inside, and a few standing on the rear ledge holding on for dear life. There were several near-accidents and several near misses with pedestrians. Never before had I been to a city where cars had to stop for a man herding his goats across the street. People were everywhere and actually walked on the street because the sidewalks were extremely narrow and were covered with garbage. Children ran freely playing in the garbage or asking people for money. We made our way from store to store and I was in awe of the beautiful cottons, bedding, and figurines. It was obvious how much emphasis Egyptian's put on beauty and how hard working they are. At the restaurant I was shocked to find a full plate of food only cost $1.50 and a man (actually one of Heba's cousins) that wanted to marry me despite never having even talked to me. As honored as I was that someone

would want to marry me after having seen me for the first time, I was also a little nervous as to what other surprises and culture shocks were awaiting me.

After dinner we took Heba home and I was once again in for a new experience. I was surprised to learn that even though Heba is a grown woman with a good career, she still lives with her parents and has a curfew because she is not married. She had to ask special permission from her mother if she could go shopping and whether or not she could eat with us. As a young American girl that was preparing to head off for college and was getting my first taste of real independence from my parents, this surprised me quite a bit. We made our way up the dark, crumbling stairway to Heba's apartment. We immediately took off our shoes as we stepped across the prayer rug and then were greeted with kisses from her mother. The apartment was very small, but despite the American standards I had grown up with, the apartment felt like home. We sat down in what we would call the "family room" and despite our protests, were waited on hand and foot by Heba's mother. Not only were we served with water and Pepsi, but her mother made fresh mango juice just for us. We were also introduced to Heba's four year old cousin who when asked which of us was the prettiest, he pointed directly at me. Why? Because I am white. My skin color had never been an issue before, but I was surprised at the emphasis put on fairness. Where we sold bronzers and tanning lotions in our stores, they sold skin creams that contained bleach and would whiten their skin. I also learned that another form of beauty is a woman's hair which is why they cover it. The only men women show their hair to are relatives. It all goes back to Mohammed and the five pillars of Islam. However, women follow a sixth pillar which requires them to keep themselves covered and wear a veil or scarf. The only time I ever saw Heba's hair was that night when she removed her scarf because the only men present at the time were her father and young nephew. As we left that night, I realized I had already learned so many new things and yet there was so much I didn't know. I left with a new appreciation of what I had but also a desire to experience what else was out there. I had had my first taste of the real Egyptian culture and life, now was the time to start experiencing the work place.

It was decided that I would follow along with and help Patricia with her experiments, but because her experiments had not started yet, I would spend a week or two in each department and learn about the objectives and goals the department strives to achieve as it works to eradicate world hunger. Before I actually got involved in the field, however, I first had to learn about the specifics of each department and about the work of the WorldFish Center in general. I spent my first week reading and researching in the library and forming

realationships with the people in the office. When I had settled in and felt like I had a solid grasp on the overall intentions of the Center, I went to work with Dr. Waheed and Dr. Mohammed in the holding tanks. We observed the catfish fry and then transported tilapia to and from the hapa. A hapa is a stationary net in the water which makes fish collection much simpler and less time consuming. We first collected the fry from the hapa in the holding tanks. Using scoop nets and buckets of water, we counted the number of fry in each bucket until we had 500. We then put the fry into a bucket on a scale and found the total weight of all the fry. We then divided the weight by 500 to find the average weight of each fish. In this case, each fish came to .3 grams. We then took all the fish from the hapa and weighed them. Knowing the total weight and average weight per fish, we were able to determine how many fish were in each bucket. We placed the fish in big jugs that could be transported out to the ponds. We made sure there was an equal number of fish in each jug before we dumped the individual jugs into Dr. Mohammed's different ponds. He is conducting research on plankton and the best method of producing it. A couple ponds had bamboo shoots in them and others had plastic tubing. Dr. Mohammed is able to measure which produces better quality plankton by weighing and measuring the fish in each pond.

The stocking of fish was a popular task for me because experiments are continuous and fish are always needed. As time passed and the fish got larger, we would monitor their growth by sampling. In order to sample, a group of workers went out into the ponds with a one large net and made their way from one side of the pond to the other gathering fish in their net along the way. We would then take a sample of approximately twenty fish, weigh them, measure them, and then throw them back into the pond. Depending on their stage of growth, sampling would be conducted around two times a month.

Sampling is conducted as part of every aspect of research whether it was to monitor plankton production, fertilizer quality, or genetic strains. The most common sampling I witnessed was to test different types of fertilizers. My second day of work actually involved working with Dr. Ahmed and Dr. Mohammed observing the application of fertilizers to the ponds. There were twenty ponds with ten using green compost and the remaining ten using chicken manure. The bags of fertilizer were dumped into the ponds with the direction of the wind so it would blow across the pond. The total amount of fertilizer dumped in each pond was 125 kg. Depending on the fishes' stage of growth, more or less fertilizer was dumped accordingly. The purpose behind the two different types of fertilizer was to determine which one was more cost effective for the rural farmer. Does a more expensive fertilizer really produce bigger fish? Which fertilizer is more beneficial in the long run? Are there

any other fertilizers that would produce the same outcome as the ones previously tested? These are just a few of the questions Dr. Ahmed and Dr. Mohammed are trying to answer with their ongoing research.

Another aspect of production is the actual harvest. What is done with the fish once they are grown and the experiment has been conducted? During my two month stay in Abbassa I was fortunate to witness a harvesting and develop a greater understanding of how it is conducted. Because of the heat, amount of work, and time consumption involved, the harvest usually begins at 6:00 am. They assemble as many workers as possible to drain the pond and collect the fish. The workers scavage through the mud sweep the pond with a large net to collect as many fish as possible. The workers will also wade through the mud picking up the fish by hand and placing them in baskets. The fish are then brought to a large metal table with four different holes placed on the corners. The fish are then sorted into categories one through four (one for the biggest fish and 4 for the smallest fish) and are sold accordingly. The fish are already spoken for by the different employees at the Center and some are given to the workers as part of their compensation for working overtime. After all the fish have been "picked," the pond is remains empty for a couple days in order for the mud to dry. Before the pond is filled again, it needs to be disinfected as it is a breeding ground for bugs and bacteria. A worker carries a mixture of diluted chlorine on his back and spays the pond by hand. Water is then directed to the pond using their irrigation systems, fish are transferred to the pond, and the cycle begins all over again.

I was excited to be working outside on something new and interesting, but I soon learned that working out by the ponds was no easy task. It was not uncommon for the temperature to reach above 100 degrees Fahrenheit and acclimated as I had become to my surroundings at the center, the same was most definitely not true for the weather. I was always shocked to see the doctors in their long sleeved suits drinking their hot, strong tea and smoking their cigarettes. And what about the women? How did they stand to be completely covered in such extreme heat? However, the people I most sympathized were the workers as they were in their uniforms and doing most of the brunt work. They worked from 8:30 am to 4:00 pm with only a couple short breaks to pray. They did all the heavy lifting and carrying and were constantly

climbing in and out of the ponds doing work. Then there were the gardeners who didn't even have a chance to get wet but were in the sun all day long maintaining the long and working on the landscaping. I was always amazed as I made my way from the apartment to the office how beautiful and green everything was despite being in a desert of sand. It became very apparent very soon how much the Egyptians valued beauty and how hard they were willing to work to achieve it.

As much as I loved working at the compound, at times it felt like I was living in a bubble. Fortunately, a group of us traveled to Cairo every weekend to attend church and do our grocery shopping. I also got a chance to be a tourist and visit the pyramids, Alexandria, and even swim in the Red Sea. However, as magnificent as those sites are my favorite place to travel was through the village of Abbassa. As we would drive past the small shops, the herds of goats, and the rundown buildings, I became more and more appreciative of what I have in America. I learned to appreciate the small things and not take things for granted. My eyes were opened to an entirely different world and I began to realize that I could make a difference. I understood more and more how important the WorldFish Center was to the community whether it was employment or another food source. Just from driving through the village a person could see how the Center had impacted the town and the lives of the people living in it, and that is something that will stay with me forever.

As I was appreciating what I had at home more and more I was also accumulating more appreciation for the tedious work the researchers conduct. Two of my closest friends were PhD students. Yonas is from Eritrea and Harrison is from Kenya and both just happen to be working in the field of genetics. In order to conduct their research, hapas are placed in the ponds and fish are divided into groups so that there is one male and two females per hapa. The females lay their eggs at the bottom of the hapa and wait for the male to come and fertilize them. When they are fertilized, the female incubates them in her mouth but for different purposes at the Center the eggs are extracted from the female's mouth and placed in an incubation tank for 28 days. The fish that fertilizes her

eggs first is moved to a different hapa so the other female has a chance to fertilize her eggs. When the fish are of a big enough size (approximately three grams) they can then be tagged. The tags used are pieces of string with little plastic tags on one end and a needle on the other. The needles are disinfected and then "sewn" through the fish's muscle that is located just under the spinal cord and just above the lateral line. A small disk or sequin is placed through the needle to prevent the tag from slipping out of the fish. Approximately 1.5 to 2 inches of string is left after the disk and then a knot is tied. The goal is to have the string long enough so that the fish has room to grow, but short enough so that the tag doesn't become entangled with another

tag. Each tag has a number and letter written on it, as well as different colored tag and disk combinations. This distinguishes which family the fish came from. When the fish are full grown, the biggest are selected from each family and then paired together in order to breed. Thus the process starts all over and another generation is born. Note that no hormones are used- it is all natural selection. When this process is repeated for several generations, a strong genetic strain is formed (refer to GIFT mentioned in page three) and the fish are of better quality.

The fourth department of the WorldFish Center is Fish Health. Unfortunately, I didn't receive much experience in this area, but I was able to get a basic overview of the work the department does. The goals that this department strives to achieve are to understand the immune system of fish and develop different types of feed that can meet their needs. Sick fish are brought to the lab to be analyzed and new solutions are developed. Special feeds are made my grinding different ingredients in a blender until the mixture is so fine that it is almost a powder. The feed is given to the fish and progress is recorded in order to determine whether the feed increases the efficiency of their immune system. In order to determine whether the immune system has been strengthened, the fish are injected with bacteria of different kinds of diseases. Therefore, the fish that recover from their illness the fastest or never become sick in the first place have the stronger immune system. By addressing the diseases that often plague rural farmers' fish, new medicines and techniques can be developed, increase the survival rate of fish and therefore feed more people.

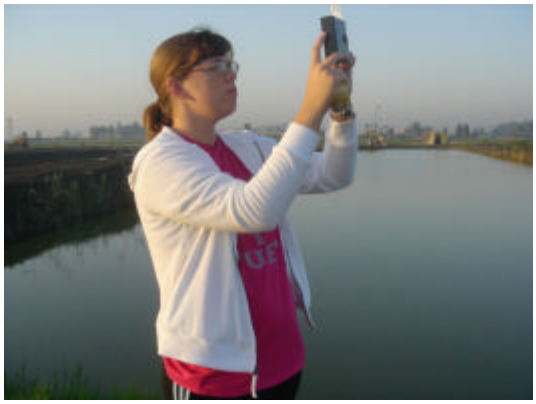
As poor as the people and surroundings were, I never actually saw someone that was starving. Hungry? Perhaps, but there was still food available and no signs of famine. It dawned on me when I returned from Egypt that my standards and perspectives had changed. I always knew that I was lucky- I never came home to empty cupboards and I was always able to eat lunch at school. However, I learned that we just don't have a supply of food, we have a surplus. Yes, people were poor in Egypt, but at least there was food to be eaten- it may not have been a lot, but it was still there. Fortunately the government is aware of the risk of famine that has affected so many of Egypt's neighbors and has subsidized the food supply which in turn makes it very cheap and affordable. A falafel only costs $0.35 (compared to $5.50 here in America) and a piece of flat bread is only $0.03. Food is actually a very important part of the Egyptian culture. One of my favorite and most educational memories from Egypt was when I was invited to the home of Abdallah, the Center's head worker. He actually lives in Abbassa in an apartment building that is occupied by his relatives, his two wives (men are allowed up to four in the Islam religion), and sons. I distinctly remember my excitement and anticipation as I

made my way up the stairs, took off my shoes, and then sat down on a pillow in the middle of the floor. There were cushions propped up against the wall and the walls were brightly covered with an intricately rug in the middle. I will never forget watching

Abdallah's wife walk up the stairs and through the doorway with a humongous tray of food balanced on her head. She placed the tray of stuffed chicken, bowls of rice, soup, cucumbers and tomatoes, and pasta down on the floor and then left immediately as she was not allowed to eat with us because other men besides her relatives were present. A jug of water was brought up along with one glass to be shared by everyone present. Normally, people don't drink anything until after the food is finished and then they drink mango juice or tea and coffee. The men will then bring out their shishas to smoke and socialize. It was at this time where I discovered my love for Egyptian food. It is very rich and flavorful with an amazing array of spices. Also, the quantity sizes are extremely large and despite being full after only half a bowl, they kept putting more food on my plate. Never before I have felt so privileged as when I sat down with my friends and ate a tray of food with them using only our fingers. There were no longer boundaries between us, it didn't matter that I spoke no Arabic and they spoke no English, we held a special bond sitting together eating from the same tray. I was treated like royalty as they prepared so much food for me and were willing to give me everything they had. I was humbled and honored and to this day I cannot think of a more memorable or meaningful meal as when I ate with a family that was willing to give a young, foreign, naïve girl everything they could possibly offer. I am forever indebted to them for welcoming me into their home and their hearts and teaching me about the importance of giving all that you have to give.

Out of the four different departments at the WorldFish Center, the department I worked the most in was production. Therefore, it became obvious that my project should also focus in this area. For my last two weeks in Egypt I was given four ponds that I would monitor and collect data from. Two of the ponds were fertilized using chicken manure and the other two were fertilized with green compost. From the data I collected I would then analyze it to determine which fertilizer provided the best results in terms of water quality and fish growth. Granted, two weeks is not enough time to determine a result, much less conduct the experiment, but for my sake I was able to get a taste of the process.

Three times a week I would wake up early to collect data at 5:30 am. I would start by taking the oxygen meter (a computer operated machine that has a sensor on the end that is placed in the water) to measure the temperature of the water and the amount of dissolved oxygen. It is important to take the temperature of the water into account because it affects the amount of dissolved oxygen in the water. Dissolved oxygen concentrations are greatest at 0° C and decrease with increases in temperature. The amount of dissolved oxygen in the pond is very important because fish will die if they are exposed for long periods of time to less than 0.3 mg/l of dissolved oxygen. The goal is to have a dissolved oxygen level of 5.0 mg/l and above in order to have healthy fish. A 1.0 mg/lt minimum concentration level is necessary to support fish at rest for long periods, but an overall level of less than 5.0 mg/l is undesirable in ponds. If dissolved oxygen levels are low, there is great risk for reduced fry survival, decreased weight gain and feeding, and bacterial infection.



The level of dissolved oxygen is actually tied to the amo unt of phytoplankton in the ponds. The abundance of plankton, which is normally composed primarily of phytoplankton, is the primary factor limiting light penetration and the rates of photosynthesis at different depths in ponds containing abundant nutrient supplies. The oxygen evolution by phytoplankton is greatest near the surface and decreases with depth because of self-shading. Ponds with high densities of phytoplankton have higher rates of oxygen production near the surface than do ponds with less phytoplankton, but oxygen is produced to greater depths in ponds with lower densities of phytoplankton.

The purpose for collecting my data at 5:30 am is due to diel fluctuations. During daylight hours, photosynthesis in the euphotic zone usually releases oxygen faster than it is used in respiration. Photosynthesis stops at night, but respiratory processes continue to use oxygen. This pattern of daytime production and continuous use of oxygen leads to diel fluctuation of dissolved oxygen concentrations in the euphotic zone. Maximum concentrations of dissolved oxygen occur during the afternoon and minimum concentrations at or just after sunrise. It was always apparent when the dissolved oxygen levels were dangerously low as I walked by the ponds because the fish

would swim to the surface and actually gulp for air because there wasn't enough oxygen in the water.

One might believe that in order to prevent dissolved oxygen levels from getting so low they need to grow more phytoplankton to produce more oxygen during daylight hours. In reality, though, this is a very difficult balance to achieve. Increasing phytoplankton abundance does lead to more organic production and greater respiration rates, however, increasing the phytoplankton abundance does not necessarily increase oxygen evolution by photosynthesis with resulting increases in oxygen supplies in ponds. Higher densities of phytoplankton restrict light so that synthetic oxygen production is restricted to shallower depths than before, restricting the depth of epilimnion. Although rates of photosynthesis may be greater near the surface, total oxygen production will be no greater, or even less, when the entire euphotic zone is considered.

Once the temperature and oxygen levels had been taken, I would also take a small water sample from each pond to analyze back in the lab. Not only is temperature and dissolved oxygen levels important to consider, but pH levels and ammonia levels also play a huge part in water quality and fish development. The pH scale ranges from zero to fourteen with seven being neutral. Anything below seven is acidic and anything above 7 is basic. Waters with a pH level of 6.5 to 9 at daybreak is most suitable for fish production. Not only does reproductions diminish at pH values below 6.5, but excessive mucus on the gills is formed which interferes with the exchange of respiratory gases across the gills. However, photosynthesis by aquatic plants removes carbon dioxide from the water during daylight hours and causes a rise in pH levels. Also, if the pH levels continue to be too low, lime may be added to the pond. Liming has the ability to raise pH levels but it also increases the availability of Carbon in the water for the process of photosynthesis. It also serves as a disinfectant and is a good source of soluble calcium for pond food organisms. (Please note my pH level results in graph two.)

Along with the pH level I also measured the levels of ammonia in the water. Unionized ammonia is toxic to fish but the ammonium ion is not. According to the European Inland Fisheries Advisory Commission it is stated that toxic levels of ammonia for short term exposure usually lie between 0.6 mg/l and 2.0 mg/l. Also, unionized ammonia is more toxic when dissolved oxygen concentrations are low. Too much ammonia results in an increase in oxygen consumption by the tissues, damages the gills, and reduces the availability of blood to transport oxygen throughout the body. Chronic exposure to high levels of ammonia increase a fish's susceptibility to disease and reduces their growth.

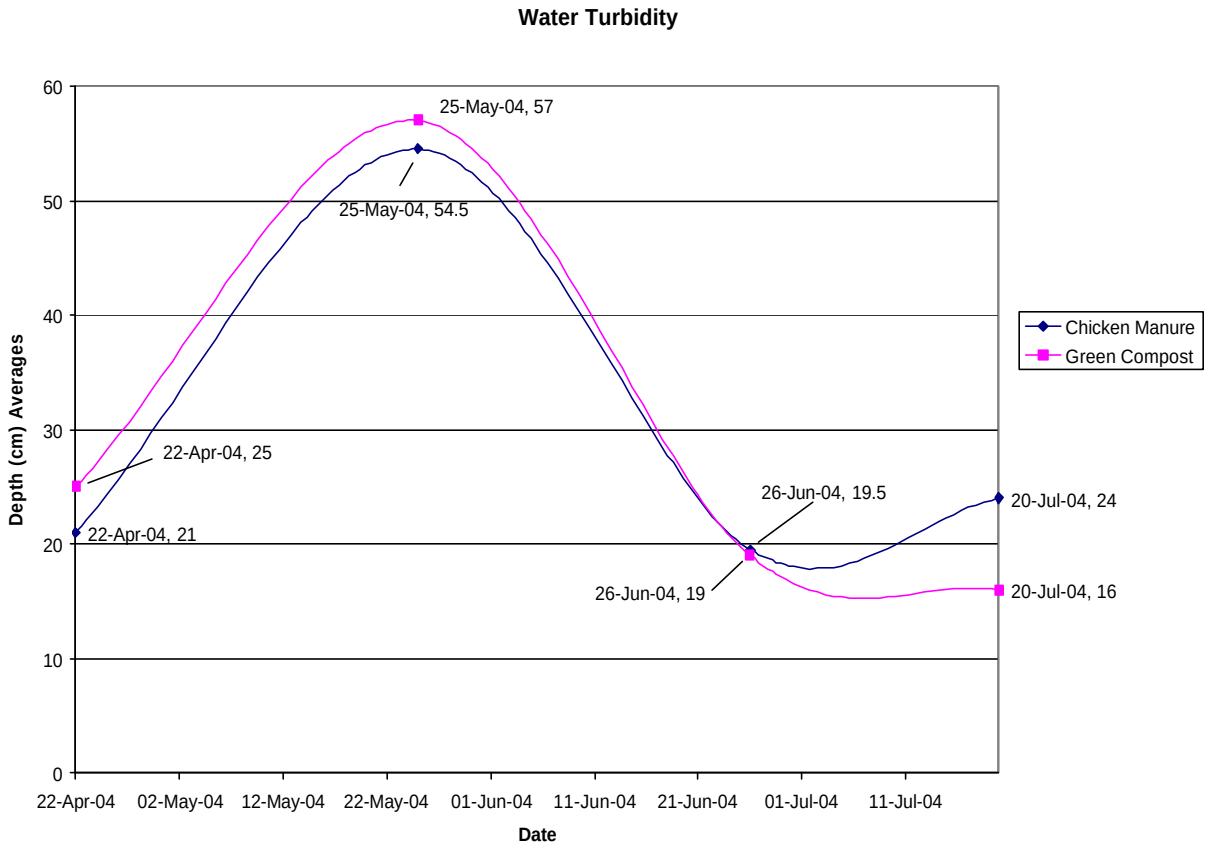
Therefore, it is important to regularly monitor the amount of ammonia present in the water. (Please refer to graph three.)

In addition to checking the dissolved oxygen levels, temperature, pH levels, and ammonia levels, in the afternoon I would also check the water turbidity. Water turbidity is the cloudiness of the water and is a good indicator of how much plankton is present. It is important that the water be a little cloudy (clear water can mean weed problems) but it is also important that it is not too dark (too much plankton). The desired measurement is somewhere between 20-30 cm in order for good fish production in aquaculture ponds. Water turbidity is tested using a secci disk. A secci disk is a long pole with centimeter markings on it and a flat circle on the bottom. The circle is divided into four sections, alternating between black and white (this makes it easier to see in the water). The pole is slowly lowered into the water and when the white on the circle disappears, the measurement is taken. The pole is then lowered even further, brought back up slowly, and measurements are again taken when the white appears. These two numbers are then averaged in order to determine the water turbidity. The lower the number, the more dense the plankton is which may foretell a low dissolved oxygen level. The higher the number, the less plankton there is which may result in an insufficient food base. (Please refer to graph one.)

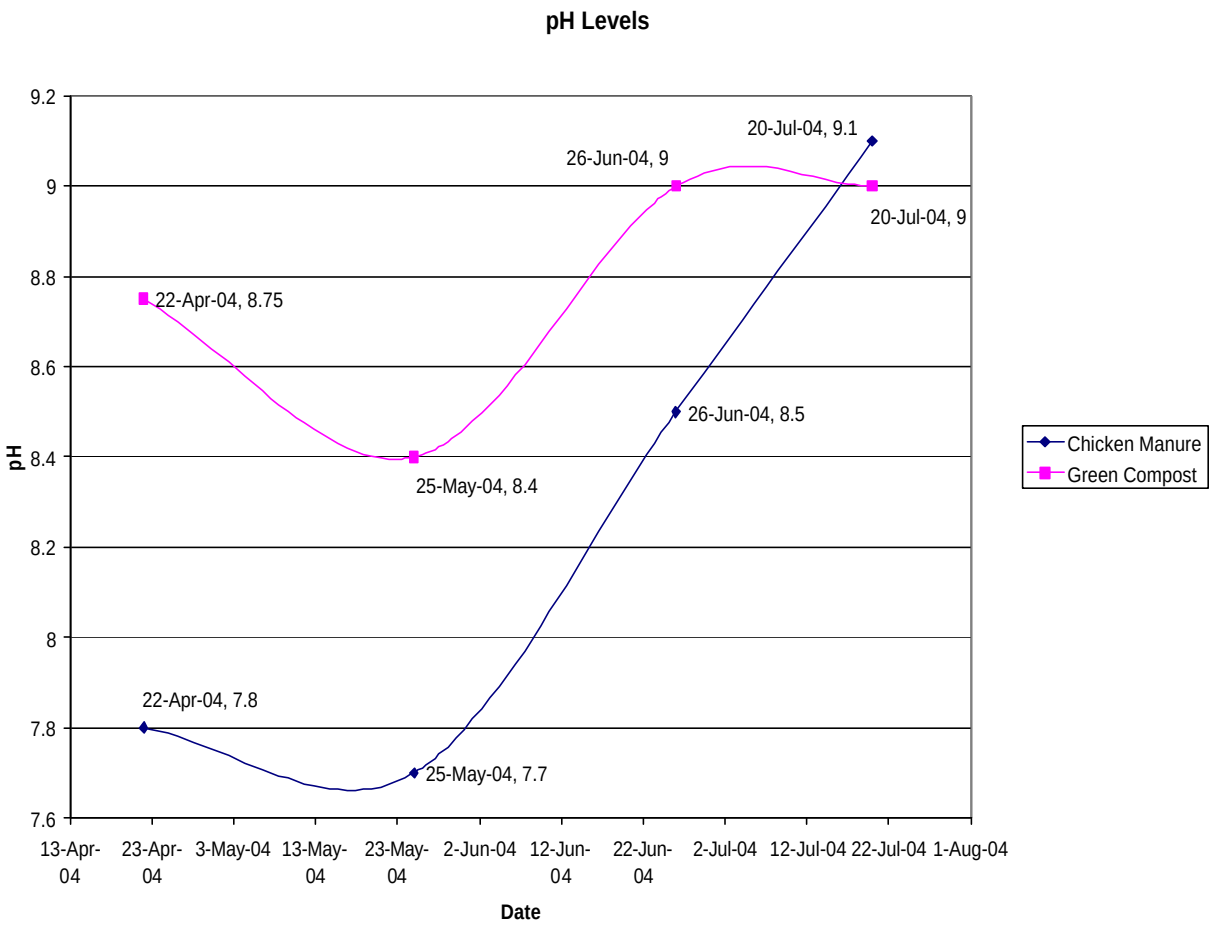
At the end of my eight weeks, I found myself missing my family, but dreading the day I would have to leave. I had found my place amongst the blowing sand, the crystal clear waters of the Mediterranean and Red Seas, the pyramids and the palm trees. I met some amazing people from all over the world- friends to last a lifetime. I learned a lot about the Islamic culture and the people of Egypt, but I also learned a lot about myself. It was as if I was born with a new set of eyes, and I find myself to this day looking at things in an entirely different perspective. I appreciate what I have so much more, and yet I find myself yearning to be back in Egypt where my life seemed so simple. I am more worldly and aware of other cultures, and yet I am more patriotic and proud of my own country. I am so happy to have had this opportunity, and yet so sad that it is over. Egypt gave me so much, now it is my turn to go back into the world and give back what I can.

I am so grateful for what I have learned and I am honored to have been part of the WorldFish Center. It is amazing to be amongst people that are striving each and everyday to eradicate world hunger and make a difference in the world. I am reminded of my senior quote that I put in the yearbook, and I am so fortunate to have experienced it first hand. I believe Margaret Meade sums up the most important thing I have taken

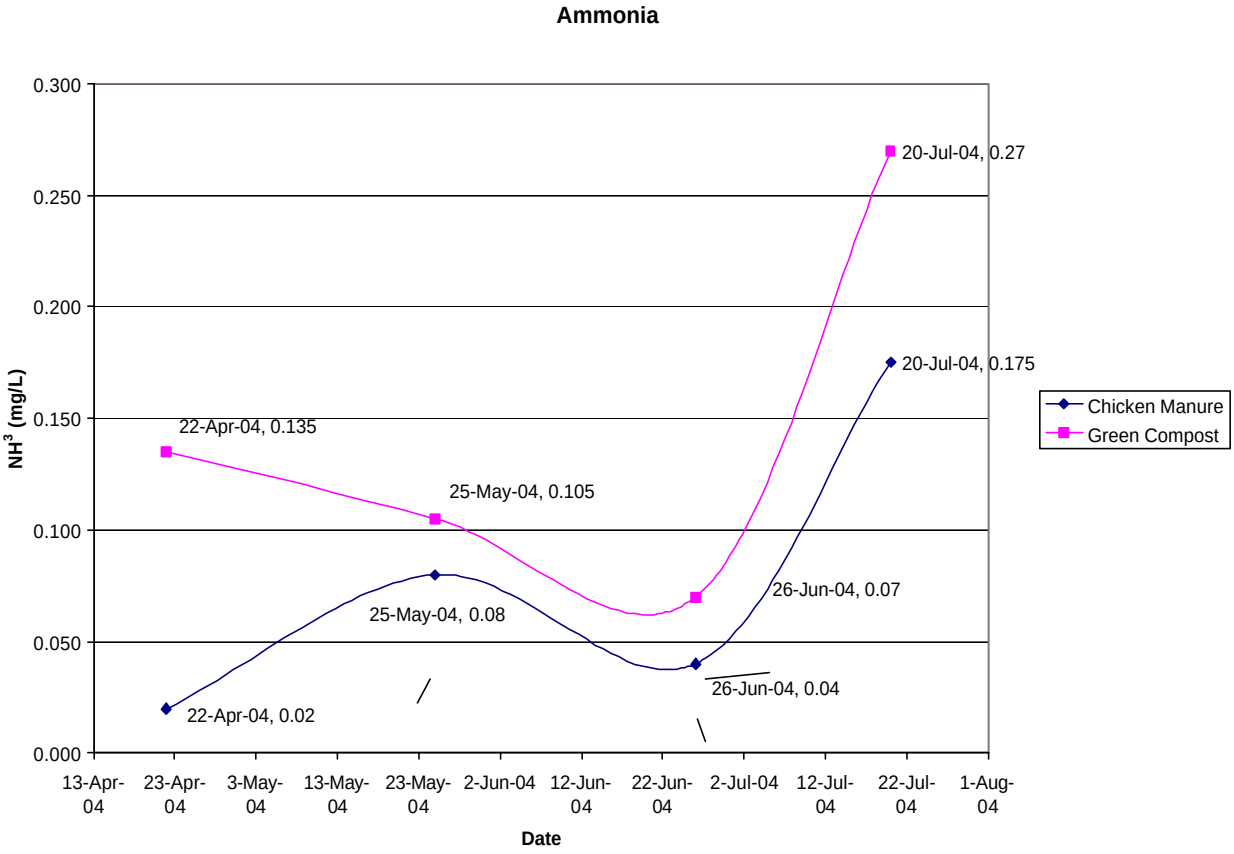
away from my experience in Egypt, "Never doubt that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."



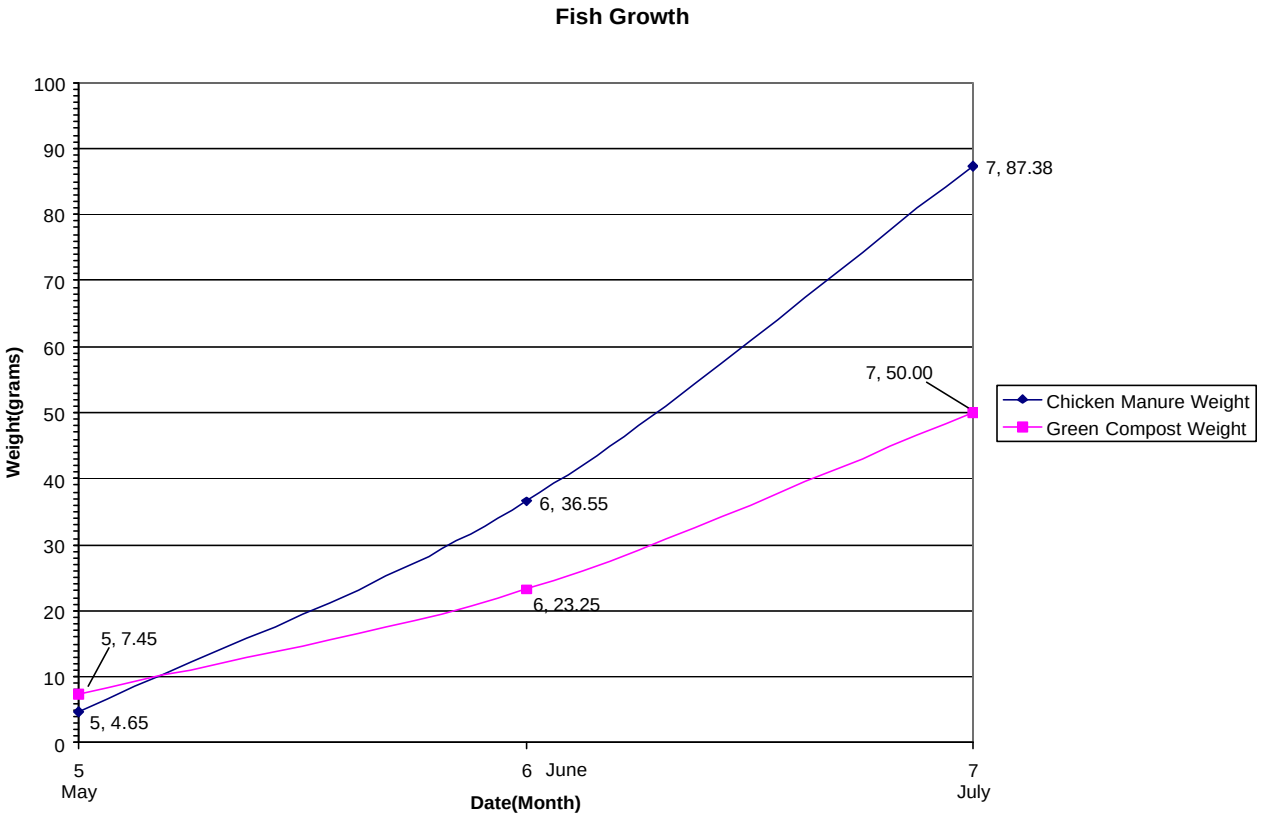
The goal measurement for water turbidity is in the range of 20-30 cm. According to the data obtained, the chicken manure appears to yield better results. However, it is important to keep in mind that this is over four months- not enough time to draw any actual conclusions.



It is difficult to draw any conclusions as to which fertilizer is better because they are both in the acceptable pH level range (6.5-9). However, the green compost remains more on the high side, while the chicken manure is quite a bit lower on the scale. Once again, more data is needed in order to draw any real conclusions.



According to this graph, both fertilizers on average are within a reasonable range for ammonia levels. However, the chicken manure is still has a lower level of ammonia on average over the four months.



Over a three month period, the fish that were fertilized using chicken manure grew much faster than the fish that were fertilized using green compost. Based on this data, chicken manure is more beneficial to fish in all areas of production and water quality. Once again, however, please keep in mind that this is not enough data to make an official conclusion, but it is a good start.

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