# What the Fish is Going on Here? Are Regulations Being Followed at the Ver-O-Peso Market in Belém, Para?

Neil Thompson
The University of Vermont
Department of Biology
Advisor: Luciano Montag (UFPA/MPEG)

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## Abstract:

Since the commercialization of the amazonian fishery in the early 1970´s there have been major problems with enforcement of minimum capture length laws and regulations. It has been well documented with species such as tambaqui (*Collosum macroponum*) and mapara (*Hypopthalamus edentates*) that juveniles and pre-adults are being targeted by fishermen. This has led to a situation where most of the individuals present in fish markets are undersized and illegal according to IBAMA regulations. The majority of the research done on undersized illegal market fish has focused on markets in Manaus, Tefé and Santarem. This study seeks to find out if there are illegal fish being sold in the public Ver-O-Peso fish market in Belém, Para. Seven commercially important species were chosen, 4 from the siluriformes order and 3 from the sciaenidae family. The species were filhote (*Brachyplatystoma filamentosum*), dourada (*Brachyplatystoma flavicans*), piramutaba (*Brachyplatystoma vaillantii*), tamoata (*Hoplosternum littorale*), pescada amarela (*Cynioscion acoupa*), pescada branca (*Plagioscion squamosissimus*) and gó (*Macrodon anyclodon*). The Ver-O-Peso market was visited 5 times in the early morning and surveyed for all individuals of the 7 species. All individuals were measured by eye and placed in to 20 cm size categories. At the end of the 5 days all data were summed to compile one master table of total number of fish per size category for each species. IBAMA regulations were obtained from Luciano Montag at UFPA. This study found that 6 of the 7 species studied had illegal individuals being sold at Ver-O-Peso. In total there were 3,438 illegal fish present over the 5 days. The only species that did not have undersized individuals present was tamoata. The methodology used was not specific enough to determine if there were undersized tamoata. IBAMA had set forth sound regulations and laws governing what size fish were legal to take, however enforcement and monitoring of the markets was minimal at best. Overall this study supported the trend seen in the western Amazon, undersized fish are being sold at public markets in plain view of regulatory groups and this is still a major problem in the Amazonian fishery.

## Resumo:

Uma vez que a mercantilização da pesca amazônica no início dos anos 1970's tem grandes problemas com o cumprimento mínimos de captura comprimento leis e regulamentos. Tem sido bem documentado com espécies como o tambaqui (*Collosum macroponum*) e mapara (*Hypopthalamus edentates*) que juvenis e pré-adultos estão sendo orientados pelos pescadores. Isto levou a uma situação em que a maioria das pessoas presentes no peixe e de subdimensionados mercados são ilegais de acordo com regulamentos IBAMA. A maioria dos estudos sobre peixes subdimensionados mercado ilegal tem incidido sobre os mercados de Manaus, Tefé e Santarém. Este estudo visa descobrir se há ilícitos peixe a ser vendido ao público em Ver-O-Peso peixe mercado em Belém, Pará. Sete espécies comercialmente importantes foram escolhidos, 4 siluriformes e 3 em na família Sciaenidae. As espécies foram filhote (*Brachyplatystoma filamentosum*), dourada (*Brachyplatystoma flavicans*), piramutaba (*Brachyplatystoma vaillantii*), tamoata (*Hoplosternum littorale*), pescada amarela (*Cynoscion* acoupa), pescada branca (*Plagioscion squamosissimus*) e gó (*Macrodon anyclodon*). A Ver-O-Peso mercado foi visitado 5 vezes nas primeiras horas da manha e supervisionado para todos os indivíduos da 7 espécie. Todos os indivíduos foram medidos por olho e colocados a 20 cm no tamanho categorias. Ao final do dia 5 de todos os dados eram somadas para compilar um mestre tabela de número total de peixes por tamanho categoria para cada espécie. IBAMA regulamentos foram obtidos a partir de Luciano Montag na UFPA. Este estudo concluiu que 6 das 7 espécies estudadas tinham sido vendidas a indivíduos ilícito. No total, houve 3438 pesca ilegais presentes ao longo dos 5 dias. A única espécie que não tenham sido presentes Tamoata indivíduos subdimensionados. A metodologia utilizada não era específica o suficiente para determinar se houve Tamoata subdimensionado. IBAMA tinha som regulamentos e leis que regem o que foi legal para ter tamanho, porém execução e fiscalização dos mercados era mínima, na melhor das hipóteses. Em geral, este estudo confirmou a tendência na Amazônia Ocidental, peixes subdimensionados estão sendo vendidos em mercados públicos na planície de vista regulamentar grupos e ainda é um grande problema na pesca amazônica.

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## Introduction & History of Fishery:

The Amazon River harbors the largest number of freshwater fish species in the world and the commercialization of the fishery has had a significant detrimental impact to many species. The river and basin hold many world records, it´s the longest river in the world at 6,400 km. It ranges from the Atlantic Ocean to the Andes Mountains and contains many different types of water, brackish to freshwater. But, the rivers that feed in to the Amazon are not all created equal. Some are white water, others black water and some others clear water. Each type of water has its own unique characteristics and suites of species that do best in their respective water types. Because of this diversity the basin is estimated to have between 1,500 and 5,000 species of fish, this is more fish species than the entire continent of Europe has. An example of the diversity found here is in the order Siluriformes (catfish); there are 1000 described South American catfishes (Goulding 1980).

The river itself is 40-50 meters deep and 4-5 kilometers wide, it comprises approximately 20% of all the freshwater found in the world and it is the highest volume of freshwater in the world. Because the Amazon basin is incredibly flat, only 72 kilometers in elevation separate Manaus and Belem, the river´s current is extremely slow and this makes it easily navigable. There exist many different fishing strategies for the different areas of the river; the main canal and seasonally flooded forests. Fishing methods also depend on the height of the river; it can vary up to 15 meters between wet and dry seasons. Commercialization of the industry began recently, in the 1970´s. Before this there were primarily artisanal and subsistence fishermen. These two groups used simple canoes and fished with zagares, curraes, espinels and other similar, relatively non-destructive methods (Moss, 2008). However, once commercial markets became established, money came in to modernize boats and technology; the fishery took off.

It was officially declared in 1967 by the Brazilian government that an aim of the country was to augment and modernize the fishery and fleet (Barthem 1997). This turned a primarily small subsistence based industry in to a major economical force. Fishermen were able to finance and build boats with center-mounted diesel engines and fixed ice chests that allowed fishing trips to last for days or weeks. No longer did boats need to go to port to off-load their catch within the same or next day as catching the

fish. Fish could be put in the hold of the ship and frozen, allowing many more times the amount of fish to be caught and the time usually allotted for travelling to the market could now be used to fish. Some of these boats had cargo holding capacities of 70 tonnes, but the majority in and around the littoral fishery average 10 tonnes (Barthem 1997).

Another development from the process of modernization was the creation of ice boats (barcos geleiros). These vessels were strictly constructed as floating ice chests for buying fish from other fishermen on the river and then transporting them to the markets. The ice boats buy fish at a lower price than market value and usually exchange fuel and supplies to the fishing boat so it may extend its voyage (Barthem 1997). Exchanging supplies allowed fishing vessels longer, more profitable trips and the ice boats to simply act as middle men. Having no investment in fishing gear or large crews affords the ice boats a profit when they sell their stock at market for higher prices. The ice boats are especially keen to travel to the Ver-O-Peso market in Belem where the highest prices for many fish species in the catfish families are obtained (Barthem 1997).

Modernized boats allowed exploitation of new areas, previously unavailable to subsistence fishermen. Diesel engines provided power and speed not previously had so boats could travel farther from the market to fish better locations. Along with the new boats came new types of gear to catch fish with. The large diesel powered boats no longer used the artisanal forms of fishing. New nets, including purse seines and gill nets, are now used by the large commercialized fishing vessels. A purse seine is a net that is dispatched from the end of the boat and towed around a school of fish then returned to the rear of the main vessel. Once the two ends of the net are together a drawstring is pulled to enclose all fish and other animals in the net. This form of fishing is extremely effective, but comes with a large ecological cost. It catches all fish that were surrounded by the net; this includes non-target species, undersized individuals and juveniles. Nearly all of the non-target individuals caught are non-salvageable and subsequently destroyed. For this reason purse seines were outlawed in the lower Amazon, but have been documented to be still in use by Lang (1998). It is an attractive form of fishing to fishermen as using a purse seine results in a 32% higher catch per unit effort than gill nets (Almeida et al. 2003)

Gill nets are the other primary form of fishing gear used in the Amazon. These nets are made of nylon cord and are made with different size holes for fish to pass through or become entangled. Like purse-seines they are an extremely effective form of fishing. They are made of a floating headline and a sinking foot rope with the nylon cord interwoven in between the two main-lines. They can be free-floating or strung from fixed objects and are usually put in the water and fished for a minimum of 5-6 hours. They can also be weighted to sink to a specific depth. Because of this versatility they are very common and a preferred method of fishing. During the night, fish will swim in to the net, become entangled in the nylon and become trapped. Because the fish is trapped and not allowed to move around in the net all individuals usually succumb and die. Sciaenidae (drums) are particularly quick to die as they appear to be caught in the net when chasing prey; with their mouths gaping open and already being fatigued they quickly succumb to the lack of oxygen (Goulding 1980).

Just like the purse-seine there is a large by-catch associated with gill nets and the majority of individuals caught by the net are destroyed. The net does not discriminate between species, anything that gets entangled in the net is caught. Nets range in size dramatically depending on the location being fished, but some are as long as 1,000 meters. Only 2 men are needed to handle a gill net 1000 meters long and the 2 men can vary the depth of the net depending on the target species (Barthem 1997). The mesh size or space between the nylon lines also varies and depends on the species of interest. All of this development of technology and commercialization of markets has occurred in a relatively short period of time creating a prime opportunity for problems to arise.

## Problems created by rapid development and commercialization:

A classic example of the problems created with rapid development and detrimental forms of fishing have been documented with the tambaqui (*Collosum macroponum*). This fish is a specialist fruit and seed eater that inhabits fresh-water and is particularly important in the western Amazon near Manaus. There has been substantial research done on the species from biology, ecology and population demographics perspectives. Between 1980-1984 the average size of a tambaqui landed at the Tefé market was between 50-65 centimeters (Lima 1998). This range included the legal minimum length of 55 centimeters and therefore we can infer there were

undersized fish being sold in the early eighties. A study done more recently (1991-1992) at the Tefé market found 11% of fish being sold were of legal size and IBAMA should have confiscated 89% of the fish being sold (Barthem 1999). The fish that were being unloaded were predominantly juveniles that had not reached sexual maturity. Over the past two decades the species has experienced a 90% demographic reduction (Santos et al. 2007). This species is extremely easy to catch and exploit, in its juvenile stage it feeds in varzea forests underneath fruit trees. Fishermen are well aware of this and are able to take huge amounts of juvenile tambaqui with relative ease knowing their preferred location and feeding habits. Because of the ease of capture and high importance of the species as a food fish the tambaqui has been reduced in population tremendously. Fishermen were taking primarily juveniles and non-sexually mature individuals for years and years, now the fishery is dominated by undersized individuals. This is a classic example of how modern fishing methods, commercialized fleets and lack of regulation and enforcement have affected Amazonian fish species.

The tambaqui is not the only example found in the Amazon, the problem is also more widespread than just in the Manaus region. The mapara (*Hypophthalamus edentates*) was studied by Lang in the spring of 1998. She found fishermen were fishing during the closed season, the critical spawning period. Seventy percent of fishermen were using illegal types of nets and were capturing large numbers of juveniles who had not reached sexual maturity. The average fork length of a specimen captured was 4 centimeters short of the legal minimum fork length and a full 12 centimeters short of the spawning length. When all of this was combined her study concluded that the future looks bleak for the mapara.

The problems that have been created are to an extent species specific. Only ten taxa comprise 75% of the market catch in Brasil (Cerdeira et al. 2000 ). This puts an enormous focus on a very few species of interest. But, because of the current methods of fishing being used entire fisheries have declined and are now beginning to show indications of fisheries in distress. DeJesus said in 2004 that the commercial fishery of the Peruvian Amazon is showing classical signs of overfishing. Combining a high selective pressure for a small number of marketable species and the generalist methods of fishing the Amazon River fishery is heading for a crash. Fish lengths and weights at

markets have been decreasing over the past 10 years and there is no reason to not believe that this trend will continue (Luciano Montag, personal communication).

## Fishery regulation:

The Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renovaveis (IBAMA) is charged with regulating the fisheries and setting laws for the minimum length taken, closed seasons and types of gear allowed. IBAMA was created in February of 1989 by the federal government and was designed to monitor and manage the environment, license and permit extraction of natural resource and police and enact federal legislation pertaining to the natural resources of Brasil. Thus far the commercialization and modernization of the fishery has far outpaced the development of IBAMA. This has created a problem in that the fishery is moving at a much faster pace than IBAMA can keep up with.

IBAMA has published regulations limiting the shortest length a species can be taken at as well as closing periods of time to allow fish to perform annual migrations and spawn. All of these are steps in the right direction for the fishery and the legislation in place is in fact solid. The true problem lies within the enforcement of the regulations. IBAMA is known to be underfunded, understaffed and lacks equipment to enforce their laws (McGrath. 1999). Brasil can have laws and regulations in place that are top-notch, on par with other developed nations around the world, but without an infrastructure to police the fishery the current trends will continue.

Monitoring markets for illegal species or undersized individuals has been minimal in the past (McGrath 1999). Thus large numbers of undersized individuals have been taken and no penalty has been levied on the fishermen. The enforcement of the regulations has been so poor that McGrath found the fishery was regulated more by natural conditions than by the state (1999). With all these issues compounding: illegal nets being used, huge by catches from the illegal nets, minimal monitoring or enforcement of boats or markets and many juveniles being taken the future of the fishery in the Amazon is not bright. As the fishery expands and continues to grow eventually it will reach a critical point where too many individuals are harvested and then the populations will crash. The pinnacle of this problem is that IBAMA does not have the money, personnel or equipment to keep this from happening.

## Objectives:

The purpose of this study is to see if undersized, illegal fish are being sold at the Ver-O-Peso fish market in Belem, Para. It has been documented that undersized fish are common in the western areas of the Amazon (Tefé and Manaus in Amazonas), but no study has ever looked at Ver-O-Peso in Belém. We seek to find out if a major, metropolitan market in the coastal amazon has the same problems with undersized individuals being sold as is present in western Amazonia.

## Species Studied:

Our study will look at 7 species that are commercially important to the littoral fishery. Four species in the Siluriformes (catfish) order: dourada (*Brachyplatystoma flavicans*), piramutaba (*Brachyplatystoma vaillantii*), tamoata (*Hoplosternum littorale*) and filhote (*Brachyplatystoma filamentosum*). This order is highly prized in the Ver-O-Peso market as many of the species have high-quality flesh and are good market species living in the waters surrounding Belém.

With the exception of tamoata, all 3 other catfish species being studied are very highly vulnerable to human harvest with a population doubling time of 4.5 – 14 years (fishbase.org). All three species can obtain large sizes with the smallest reaching a maximum total length of 105 centimeters. Catfish are incredibly important to not only the Ver-O-Peso market, but to the Brasilian economy as well. Two million dollars (USD) worth of piramutaba were exported from Brasil in 1990 and four years later the total catfish export from Brasil was 3 million dollars USD. Siluriformes are a major part of the littoral fishery and large importance to Brasil´s economy.

The estuary zone surrounding Belém is of special importance to Siluriformes and especially piramutaba and dourada. These two species are known to use the estuary as breeding grounds and migrate between the freshwater of the Amazon River and the brackish water of the estuary. Piramutaba are primarily exploited by gill nets and 95% of the individuals caught in the area surrounding Belém are pre-adult or adults around 36 centimeters (Barthem 1997). The species does not sexually mature until 42-64 centimeters and 3 years of age. The industrial commercialized fishery is exploiting

predominantly juvenile piramutaba, but this species is not heavily exploited in the estuary.

Dourada have a different tale to tell. They are in fact heavily exploited in the littoral zone or estuary of the Amazon River. Like the piramutaba, the dourada found near the coast are primarily juveniles and pre-adults and the favored method of capture is by gill net. They undergo a yearly migration beginning in August travelling upriver, thus bigger fish are found upriver and only return to spawn. The average size of a dourada captured in 1983 was 60.5 centimeters and 95 % of the fish caught were 50+ centimeters (Barthem 1997). However, the dourada does not reach sexual maturity until it is 90+ centimeters.

Filhote are also known to have spawning grounds in the estuary, but little is known about the species (Barthem 1980). There is no data on possible migrations and more study needs to be undertaken to elucidate the biology and ecology of the species. In general Siluriformes are hard to manage for because of their migrations between multiple types of water and different states. Barthem suggested that juveniles need to be protected first and foremost in order to keep the species from dwindling in the future (1997).

The other three species we will be studying are all in the Perciformes order. pescada amarela (*Cynioscion acoupa*), pescada branca (*Plagioscion squamosissimus*) and gó (*Macrodon ancylodon*). These three species are all a part of the sciaenidae family, but have different ranges of vulnerability to human exploit. P. amarela is highly vulnerable with a population doubling time of 1.4 - 4.4 years (fishbase.org). P. branca and Gó are both in the mid-range of vulnerability and have doubling times of 1.4 - 4.4 years as well (fishbase.org). All 3 species, can grow up to substantial lengths; the smallest growing to a maximum total length of 45 centimeters. The largest (P. amarela) can grow to 110 centimeters total length. All 3 species are carnivorous feeding on invertebrates and fish, some species from this family are able to produce a drumming noise heard underwater. The noise is produced from abdominal muscles pounding against the swim bladder of the fish. Sciaenidae are prized for sport-fishing as well as their high quality flesh making them a good market species.

# Methods:

In order to study the sizes of fish at a public market a method of measuring fish indirectly (without measuring tape) was needed. We used size categories and would place individuals in to their corresponding group. The size categories were 0-19, 20-39, 40-59, 60-79, 80-99, 100+ centimeters. The researcher, prior to surveying the market, calibrated his body to known distances. For example, from the tip of the pinky finger to thumb when the hand is stretched is 15 cm, from the finger tips to the elbow joint is 30 centimeters. The distance from the tips of the fingers to the arm-pit was 50 centimeters, 70 centimeters was the distance from the foot to mid-thigh and 90 centimeters was from foot to hip. One hundred centimeters was from the foot to top of the hip bone.

With the help of known distances the researcher would enter the Ver-O-Peso market and place every specimen seen of the 7 species in to one of the size categories in his field notebook. The market would be visited for approximately one hour from 7AM to 8AM. Every fish of the species researched was to be counted, measured and recorded. Only fish on the vendor's metal selling table in the front of the stall would be counted and only whole fish would be used for the study. The length measurement that was used was the total length of the fish. Total length is the distance from the anterior-most point of the mouth to the end of the tail, excluding tail filaments (pertinent to catfish).

The Ver-O-Peso fish market in Belem, Para was visited 5 times, one time per each day of the working week (Monday-Friday). At the end of each day the total number of individuals per size category was summed and placed in an excel spreadsheet. A table was made for each species and the total number of fish (all 5 days summed) in each one of the size categories was displayed.

Error is a major factor of our study and to control for this a system of measuring the error was created. Before the research began a total a 50 pieces of string were cut at random lengths. Five bags were labeled day 1 thru day 5 then taken and 10 pieces of string were placed in each bag (randomly). Every day the researcher would return from the field he would take the corresponding bag and measure by eye (with the aid of the known body measures) the lengths of the 10 pieces of string. Each string after it was measured by eye would be marked with tape and its corresponding number for the day

(numbers 1-10). All ten strings were measured and placed back in the bag corresponding to that day. One bag was measured per field day and this was done for all five field days. The true measurements of the string were not performed until the final field day was complete. This ensured the researcher was not biased by knowing his error during the research.

After the field days were complete the true lengths were determined for all 5 bags and 50 pieces of string. Each string in the bag had the piece of tape with a number on it that corresponded to the error data sheet for the bag. This ensured the researcher knew exactly which eye measurement the piece of string corresponded to. The average error for each day was determined. This allowed the research results to be put in to context and give some support to the method of measuring by eye. Our error system would either validate the eye measure and size categories or suggest a new measurement system should be used in the future.

Legislation and IBAMA laws pertaining to the 7 species studied were procured from Luciano Montag at UFPA and the Emilio Goeldi museum. He also served as the research advisor for the project and general aid during the research process.

# Results:

| | | **Size Classes** (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 - 59** | **60 - 79** | **80 - 99** | **100+** |
| **Species** | **Pesca branca** | 45 | 1032 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 39 | 87 | 181 | 71 | 40 |
| | **Gó** | 2127 | 352 | 0 | 0 | 0 | 0 |
| | **Filhote** | 0 | 272 | 200 | 70 | 2 | 11 |
| | **Dourada** | 0 | 522 | 270 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 154 | 1 | 0 | 0 | 0 |
| | **Tamoata** | 840 | 60 | 0 | 0 | 0 | 0 |

Figure 1: Number of fish observed per size category for each species

| Market Day # | Average Error ( +/- cm) |
|---|---|
| 1 | 7.3 |
| 2 | 4.2 |
| 3 | 6.8 |
| 4 | 4.1 |
| 5 | 3.5 |

Figure 2: Average error in centimeters per market day

| Species | Minimum Length (cm) |
|---|---|
| Pescada branca | 35 |
| Pescada amarela | 45 |
| Gó | 25 |
| Filhote | 100 |
| Dourada | 60 |
| Piramutaba | 65 |
| Tamoata | 15 |

Figure 3: Minimum size of capture. (Luciano Montag, personnel communication)

In total there were 6,376 whole fish of the 7 species studied observed and measured over the 5 market visits. From the sciaenidae family there were 3,974 individuals present; the majority of which were gó. The siluriformes order was represented by 2,402 individuals at the market with no clear cut species having the majority.

## Discussion:

At the Ver-O-Peso market in Belém, Para there are illegally undersized fish being sold. Six of the seven species studied in this experiment were found to have undersized individuals present at the market. The legal capture limit for the species tamoata is within the smallest size category and is therefore undeterminable from our data if undersized individuals are being sold. In total we observed 3,438 fish that were undersized according to IBAMA regulations. Gó was by far the species most affected with 2,127 individuals being undersized at Ver-O-Peso. This species was abundant at the market during all 5 market visits and when present at a vendor´s table was

represented in large numbers. Some examples of the huge numbers present on vendor´s tables are: 200, 100, 150, 72 & 125. The other 5 species found to be undersized did not have nearly as high a number of undersized individuals, but still had a significant number for only 5 visits to the market and a total of 5 hours of observation.

The other two species in the sciaenidae family we studied had the smallest number of undersized individuals. Pescada amarela had the smallest number, 39, and pescada branca had a relatively low number of 45 undersized fish. For the commercially important siluriformes a relatively high number of fish are being taken illegally. The dourada had a total of 522 illegal individuals, this was 66% of all the dourada present in Ver-O-Peso market over 5 days. Filhote had a similar story to tell; 544 fish were undersized according to IBAMA regulations and this represented 98% of the species present during the week. Piramutaba has the worst record at the market, all 155 specimens were undersized and not a single fish was of legal length. In total there were 1,221 illegal catfish that were present in the Ver-O-Peso market during the third and fourth week of November in 2008.

Interestingly, although not included in our study was the area surrounding the fish unloading area in Belém. This small area directly adjacent to Ver-O-Peso has many small vendors who set-up makeshift tables often from a few milk-crates or fish-boxes with only cardboard to create a table. These vendors had many more undersized individuals of the species we studied in this project. While we cannot comment on the number of undersized fish because it was not studied, the majority of the vendors had smaller fish than those vendors inside the Ver-O-Peso market. All of this was observed by the researcher at the same time as the Ver-O-Peso observations were being conducted. These make-shift vendors are only present for a short time, they were observed from 7 AM until approximately 9 AM and usually completely dismantled and gone by 9:15 AM.

Our method of indirectly measuring fish specimens at Ver-O-Peso was validated by the error measurement system and results. The error varied from day to day but was within tolerable limits and never exceeded 20 centimeters. If the error had been +/- 10 centimeters (to give a range of 20 centimeters) then our system of placing fish into 20 centimeter size categories would have been questioned and re-designed. The highest error was present on the first market visit, +/- 7.3 cm and the error got progressively

smaller as the experiment went on. The final market day had the smallest error of any day; only +/- 3.5 centimeters. Using our methodology of calibrating known distances to the researcher´s body, while not ideal, was an effective method of determining fish sizes and yielded solid results. We are confident in the measurements taken at the market and have no reason to believe that our study is any way compromised by the use of visual measurements.

Our study is furthering the ideology that IBAMA has set forth solid, well-thought out and researched laws and legislation, but simply does not have the man-power, money or resources to enforce its own regulations. Major fish markets would be one of the easiest places to monitor for illegal activity. Not only undersized individuals or illegal species, but also for illegal types of gear being used or other forms of catching fish. There is a lot of action going on at the Ver-O-Peso market from the hours of 7-9 AM, but even if IBAMA officers were able to catch only a few infractions per day it would be a help to the fishery and more importantly send a message to the fishery fleet. If IBAMA is able to obtain the needed man-power and resources we believe they should first focus their efforts on major markets such as Ver-O-Peso. Fishing boats are docked 50 meters away from the market and regulation of not only the market and waterfront make-shift vendors would be possible, but also regulation of the fishing fleet could be performed. The methods of catching fish could be monitored relatively easily by simply surveying boats as they unload their catches to the market. If there are illegal nets present on board a vessel then IBAMA could quickly and efficiently levy fines or penalties on the boat. The way the fishery is heading needs to change. Enforcement of regulations needs to become more pronounced and more frequent. One of the best places to start would be the fish market at Ver-O-Peso.

For future studies in to the regulations of the littoral fishery and whether laws are being followed or not we have a few suggestions. First would be to study the make-shift vendors who set up tables of cardboard and fish boxes. What species are they selling, how big are the fish and are they of legal size limits? We expect this study to be highly contested by not only the vendors, but the fishermen that are passing by the cardboard tables on their way to sell their catch. Because of this we expect it to be difficult to obtain solid results, but suggest the methodology used in this paper could also be used as a preliminary study of the makeshift vendors.

Another question that this study has raised is what is exactly going on with IBAMA and their ability to enforce laws and regulations. Currently there are laws and regulations in place for the fishery that are excellent. They have scientific support and would be effective in keeping the fishery healthy and in a good equilibrium. However we seek to understand where the problem lies with the enforcement of these laws. Why is IBAMA having such a difficult time with enforcement?

The future of the littoral fishery surrounding Belém, Para is not bright. Six of the seven species in this study were found to have undersized individuals being taken and sold at one of the most famous and most important markets in the Amazon. If different methodology had been used that would have been able to determine if undersized tamoata were being sold we believe there would have been illegal fish in the market. The sciaenidae family while not doing too poorly are not doing well in Ver-O-Peso. With a total of 84 pescada branca and pescada amarela being undersized over 5 days the situation is not bad, but far from the desired situation of 0 undersized fish. Gó are another dilemma, they are moderately vulnerable to human exploitation and a huge number (2,127) of fish were undersized. This is not a good sign for the species and if this continues a significant population crash could be looming.

Siluriformes are in trouble. Just like the drum family the situation with dourada, filhote and piramutaba is far from the desired scenario. The estuary zone surrounding Belém is of high importance to the catfishes because they use it as breeding grounds. If serious regulation of the catfish fishery is not undertaken swiftly then the future looks bleak for os bagres. Piramutaba and dourada are particularly concerning. Only one piramutaba was sexually mature at the market and the remainder of the individuals were pre-adult and had not reached spawning length. The situation is even worse for the dourada, every specimen at Ver-O-Peso had not yet reached spawning length. If large numbers of these species are taken from the estuary, the nursery for these species then a decline is all but inevitable for these species.

All in all our study backs up previous studies that have found undersized individuals being sold at public markets. This is the first study to demonstrate this phenomena in the Belém area, but our study further confirms that regulation and enforcement of laws in Amazonia are problematic and need to be worked on. IBAMA needs to obtain whatever means necessary to effectively manage the fishery. Natural

conditions have been regulating the fishery since the 1970´s when the commercialization movement began. This has been going on too long and only time will tell how much more abuse the Amazon fishery can withstand. The question of whether fish stocks will crash is not a question of if, but when; unless the regulatory bodies of Brasil can get their act together and make a focused effort on regulating the fishery.

**Appendix I**: Field data from 5 market visits.

11/21/2008

| | | Size Classes (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 - 59** | **60 - 79** | **80 – 99** | **100+** |
| | **Pesca branca** | 35 | 37 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 7 | 43 | 56 | 0 | 0 |
| | **Gó** | 480 | 0 | 0 | 0 | 0 | 0 |
| **Species** | **Filhote** | 0 | 5 | 22 | 5 | 0 | 9 |
| | **Dourada** | 0 | 103 | 50 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 16 | 0 | 0 | 0 | 0 |
| | **Tamoata** | 480 | 0 | 0 | 0 | 0 | 0 |

11/24/2008

| | | Size Classes (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 - 59** | **60 - 79** | **80 – 99** | **100+** |
| | **Pesca branca** | 0 | 90 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 0 | 3 | 0 | 10 | 27 |
| | **Gó** | 30 | 143 | 0 | 0 | 0 | 0 |
| **Species** | **Filhote** | 0 | 0 | 19 | 0 | 0 | 0 |
| | **Dourada** | 0 | 58 | 13 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 12 | 1 | 0 | 0 | 0 |
| | **Tamoata** | 190 | 0 | 0 | 0 | 0 | 0 |

11/25/2008

| | | Size Classes (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 - 59** | **60 - 79** | **80 – 99** | **100+** |
| | **Pesca branca** | 0 | 246 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 2 | 7 | 43 | 20 | 2 |
| | **Gó** | 210 | 189 | 0 | 0 | 0 | 0 |
| **Species** | **Filhote** | 0 | 54 | 71 | 53 | 2 | 2 |
| | **Dourada** | 0 | 54 | 134 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 55 | 0 | 0 | 0 | 0 |
| | **Tamoata** | 145 | 0 | 0 | 0 | 0 | 0 |

11/26/2008

| | | Size Classes (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 - 59** | **60 - 79** | **80 – 99** | **100+** |
| | **Pesca branca** | 0 | 324 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 0 | 12 | 61 | 22 | 9 |
| | **Gó** | 1010 | 20 | 0 | 0 | 0 | 0 |
| **Species** | **Filhote** | 0 | 98 | 57 | 9 | 0 | 0 |
| | **Dourada** | 0 | 88 | 43 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 45 | 0 | 0 | 0 | 0 |
| | **Tamoata** | 110 | 0 | 0 | 0 | 0 | 0 |

11/27/2008

| | | Size Classes (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 - 59** | **60 - 79** | **80 – 99** | **100+** |
| | **Pesca branca** | 10 | 335 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 30 | 18 | 21 | 19 | 2 |
| | **Gó** | 397 | 0 | 0 | 0 | 0 | 0 |
| **Species** | **Filhote** | 0 | 115 | 31 | 3 | 0 | 0 |
| | **Dourada** | 0 | 219 | 30 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 26 | 0 | 0 | 0 | 0 |
| | **Tamoata** | 195 | 0 | 0 | 0 | 0 | 0 |

**Appendix 2**: Daily error data. **All measures in centimeters**.

11/21/2008

| **String #** | **Eye Measure** | **Actual Measure** | **Difference** |
|---|---|---|---|
| 1 | 43 | 44 | 1 |
| 2 | 120 | 138 | 18 |
| 3 | 87 | 94 | 7 |
| 4 | 45 | 44 | 1 |
| 5 | 31 | 34 | 3 |
| 6 | 36 | 36 | 0 |
| 7 | 64 | 96 | 32 |
| 8 | 54 | 59 | 5 |
| 9 | 76 | 77 | 1 |
| 10 | 33 | 38 | 5 |

11/24/2008

| String # | Eye Measure | Actual Measure | Difference |
|---|---|---|---|
| 1 | 47 | 48 | 1 |
| 2 | 50 | 55 | 5 |
| 3 | 72 | 80 | 8 |
| 4 | 41 | 50 | 9 |
| 5 | 60 | 58 | 2 |
| 6 | 63 | 62 | 1 |
| 7 | 70 | 68 | 2 |
| 8 | 51 | 53 | 2 |
| 9 | 45 | 50 | 5 |
| 10 | 78 | 71 | 7 |

11/25/2008

| String # | Eye Measure | Actual Measure | Difference |
|---|---|---|---|
| 1 | 104 | 112 | 8 |
| 2 | 86 | 97 | 11 |
| 3 | 74 | 89 | 15 |
| 4 | 41 | 44 | 3 |
| 5 | 30 | 33 | 3 |
| 6 | 64 | 63 | 1 |
| 7 | 75 | 70 | 5 |
| 8 | 31 | 37 | 6 |
| 9 | 71 | 82 | 11 |
| 10 | 40 | 45 | 5 |

11/26/2008

| String # | Eye Measure | Actual Measure | Difference |
|---|---|---|---|
| 1 | 82 | 77 | 5 |
| 2 | 39 | 43 | 4 |
| 3 | 20 | 21 | 1 |
| 4 | 53 | 57 | 4 |
| 5 | 60 | 57 | 3 |
| 6 | 38 | 43 | 5 |
| 7 | 106 | 104 | 2 |
| 8 | 34 | 32 | 2 |
| 9 | 78 | 69 | 9 |
| 10 | 90 | 96 | 6 |

11/27/2008

| String # | Eye Measure | Actual Measure | Difference |
|---|---|---|---|
| 1 | 37 | 45 | 8 |
| 2 | 41 | 44 | 3 |
| 3 | 79 | 79 | 0 |
| 4 | 53 | 59 | 6 |
| 5 | 38 | 42 | 4 |
| 6 | 49 | 54 | 5 |
| 7 | 47 | 50 | 3 |
| 8 | 29 | 30 | 1 |
| 9 | 23 | 23 | 0 |
| 10 | 44 | 49 | 5 |

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# ISP Commentary

Your finally here. It´s ISP time and you don´t have a plan, but want to work with fish or do something aquatic. I´m going to save you from how to write the paper and how to do the project. We are all in college and have written enough term papers and done enough lab projects or research projects to know what we are doing.

My advice starts with my advisor. GO TO Luciano Montag at UFPA\MPEG! He is an awesome guy and will help you out tremendously. One word of warning, Luciano is about as hard to catch as a watermelon greased up with Crisco. Make contact early and meet with him as soon as possible, he´s very easy to talk to. I didn´t know a word of Portuguese before I came down here and I had a pretty easy time communicating with him. Not much got lost in translation and if it did it wasn´t much.

Older ISP commentaries have said Luciano has more or less come up with an ISP on the spot for them and altered their ideas. This did not happen to me, he only tweaked my methods and said lets do it. If you have an idea bring it to him and work it out with him. He is more than willing to help and will offer the use of his laboratory to you.

Another person worthy of note is his graduate student Tiago Freitas. A very cool guy who is much easier to meet with in Belém. He is also very knowledgeable about fish and the area so talking to him can never hurt. I got to accompany him to the Emilio Goeldi research station to help him with his P.h.D. project for 10 days. It was a great experience and I had a blast with him. One last word of advice…GET OUT OF BELÉM. Go somewhere, do something fun. It´s Brasil for Christ sakes and this may be your last opportunity to live it up….and don´t fret about the paper…it will get done….eventually.

Neil F. Thompson

ISP Title: What the Fish is Going on Here? Are Regulations Being Followed at the Ver-O-Peso Market in Belém, Para?

Advisor: Luciano Montag P.h.D. UFPA/MPEG

In 1967 it was decreed by the federal government of Brasil that an aim of the country was to modernize and commercialize the Amazon fishery and fleet. With this decree an influx of money came in to fishermen enabling them to finance and build modern fishing vessels with ice holds and diesel engines. Because of the drive to modernize and commercialize with an incredible influx of money the fishery took off and developed almost completely unchecked.

This fast paced modernization with a lack of regulation has led to many problems being created over the past 3+ decades. Fishermen have been taking undersized and juvenile individuals without fines or penalties being levied upon them. Because this has been going on for three decades the fishery now is dominated by juveniles and pre-adults being sold in fish markets. This has been documented in the western Amazon in the markets at Tefé, Manaus and Santarem, but no study has ever looked at the littoral fishery in Belém, Para. Our study seeks to find out if undersized individuals are being sold in the Ver-O-Peso fish market in downtown Belém.

To perform this study an indirect method of measuring fish by eye was used in the Ver-O-Peso market in Belém. Seven commercially important species were studied; 4 in the siluriformes order and 3 in the sciaenidae family. Filhote (*Brachyplatystoma filamentosum*), dourada (*Brachyplatystoma flavicans*), piramutaba (*Brachyplatystoma vaillantii*), tamoata (*Hoplosternum littorale*), pescada branca (*Plagioscion squamosissimus*), pescada amarela (*Cynoscion acoupa*) and gó (*Macrodon ancylodon*) were all surveyed. Individuals on vendor´s tables were measured by eye and placed in to size categories. The market was visited for 5 days and surveyed from 7-8AM. At the end of the survey on the 5$^{th}$ day for each species the number of individuals per size class was totaled. It was compiled in to a table seen below. IBAMA regulations for minimum size of capture were obtained from Luciano Montag at UFPA and are represented below.

| | | Size Classes (cm) | | | | | |
|---|---|---|---|---|---|---|---|
| | | **0 - 19** | **20 - 39** | **40 – 59** | **60 - 79** | **80 - 99** | **100+** |
| | **Pesca branca** | 45 | 1032 | 0 | 0 | 0 | 0 |
| | **Pesca amarela** | 0 | 39 | 87 | 181 | 71 | 40 |
| | **Gó** | 2127 | 352 | 0 | 0 | 0 | 0 |
| **Species** | **Filhote** | 0 | 272 | 200 | 70 | 2 | 11 |
| | **Dourada** | 0 | 522 | 270 | 0 | 0 | 0 |
| | **Piramutaba** | 0 | 154 | 1 | 0 | 0 | 0 |
| | **Tamoata** | 840 | 60 | 0 | 0 | 0 | 0 |

Figure 1: Number of fish observed per size category for each species

| **Species** | **Minimum Length (cm)** |
|---|---|
| Pescada branca | 35 |
| Pescada amarela | 45 |
| Gó | 25 |
| Filhote | 100 |
| Dourada | 60 |
| Piramutaba | 65 |
| Tamoata | 15 |

Figure 2: Minimum size of capture. (Luciano Montag, personnel communication)

In total there were 3,438 undersized illegal fish observed at Ver-O-Peso over the course of the 5 days of research. Six out of the seven species studied had undersized individuals. The legal capture length for tamoata is within the smallest size category and therefore cannot be determined if there were illegal undersized individuals present. The siluriformes were particulary hard hit with the 3 large catfish species having large numbers of undersized individuals. This is of special concern because the estuary is known to be used for spawning and if the primary catch is juvenile fish then there may be very few adults left returning to spawn. If this trend continues the catfish of the Amazon may be facing a demographic crash in the future.

Our study continues with the trend of reporting public markets selling undersized individuals. It is the first to report on Ver-O-Peso in Belém, but is in a long line of other papers studying markets in western Amazonia.