



Analysis

Perverse incentives in fishery management: The case of the defeso in the Brazilian Amazon



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ABSTRACT

The policy of a closed season with compensation for fishers (called the defeso) was implemented in Amazonia in 2005, with the idea of protecting fishery stocks while maintaining the flow of income of fishers, most of whom are small scale and artisanal fishers. This paper examines the economic theory of this policy, and shows that such a policy could actually hurt fish stocks, even if rigorously enforced. It is then shown that in the absence of enforcement, the policy would definitely lead to an increase in the number of fishers and a decline in fish stocks. *In short, the current policy is worse than no policy.* This hypothesis is tested using data from the state of Amazonas (both statewide data and data from the county (município) of Coari) and we arrive at the following conclusions. First, the defeso is completely unenforced. Second, the number of fishers has increased dramatically. Finally, catch per unit effort (CPUE) has declined over the period from 2005 to 2010 and additional evidence (presented later in the paper) suggests that stocks have decreased as well. The paper concludes with the recommendation of spatially oriented fishery regulations (zoning and rotating closures) combined with a co-management regime with fishing communities.

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1. Introduction

Fishery policy is fraught with perverse incentives and unintended consequences. Post-World War II fishery policies were not capable of preventing the collapse of oceanic fisheries. Although Individual Transferable Quotas (ITQs) have been implemented in many fisheries and have the potential to deal well with the open-access problem, they do not address environmental externalities, such as by-catch and destruction of habitat from contact with fishing gear (Copes, 2000). The problem is compounded by subsidies that are implemented for economic development purposes. The United Nations Environmental Program (2004) illustrates the trade distorting and environmental impacts of various subsidies to commercial fishing. Fishery subsidies have generated unintended consequences in Brazil, as well, where Abdallah and Sumaila (2007) examined subsidy systems over the period 1960 to 1980 and found that they resulted in a substantial growth in the catch without appropriate consideration to the long-term sustainability of the fish stocks.

In the Brazilian Amazon, fisheries are critically important, but not well regulated. Fishery policy in the Amazon is based on direct controls

(restrictions on when fish can be caught, type of gear and size of fish) and is not even characterized by quotas. In other words, if a fisher stays within these restrictions, there is no limit on total catch. In terms of these restrictions, authorities rely on two primary policy instruments, a closed season (called the defeso) and size limits on select species. As shown in the body of the paper, neither of these policies are enforced. The purpose of this paper is to show that not only are the policies not working, but they create incentives that lead to higher quantities of catch (in the short run) and lower fish stocks (in the long run) than in the absence of the policy. In other words, the policy works against its stated goals of a sustainable fishery and healthy stocks of fish. Due to inability to enforce the closed season and size limits, we recommend the development of community-based management plans and a zoning system for fishing, which includes rotating fallow areas (rotating fishery reserves) to allow recovery of fishery stocks and amelioration of the impact of fishing on the ecosystem as a whole.

2. Amazonian Fisheries

Fisheries are important in Amazonia, as they constitute, with few exceptions, the only source of protein in rainforest communities. Even in the urban areas such as Manaus, with a population of approximately two million, culture is very oriented to the consumption of fish, as illustrated in Table 1. Even in the vicinity of Manaus, much of the fish sold commercially is produced by small scale fishers. As one moves away

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Table 1
Fish consumption in the Amazon River Basin.

Reference	Sub-basin	Social group	g/per capita · day	kg/per capita · year
Honda et al. (1975)	Rio Negro	Urban	53.95	19.69
Shrimpton and Giugliano (1979)	Rio Negro	Urban	121.7	44.42
Cerdeira et al. (1997)	Rio Amazonas	Rural	369	135
Batista et al. (1998)	Rio Solimões	Rural	510 to 600	186 to 219
Fabré and Alonso (1998)	Rio Solimões and Rio Japurá	Rural	509 to 805	186 to 294
Boischio and Henshel (2000)	Rio Madeira	Rural	243	88
Murrieta and Dufour (2004)	Rio Amazonas	Rural	511 to 643	187 to 235

from the Manaus, virtually all fishing is small scale. Commercial fishing enterprises will buy their catch from small scale fishers,¹ rather than employing labor. As one evaluates policy, it is important to remember that much of the catch of the small scale fisheries is not oriented towards supplying big cities, such as Manaus, but smaller cities and communities, as well as their families. Béné et al. (2010) stress the global importance of small scale fisheries as a source of protein, small cash incomes and employment buffers. This certainly is the case in traditional riverside (ribeirinho) communities in Amazonas, where fishing and small scale agriculture provide the preponderance of food.

As is the case in many locations throughout the world, commercial fishing is in conflict with subsistence fisheries, the closer to the urban areas the greater the conflict. This is particularly true in the state of Amazonas, where the Manaus, the rapidly growing city of two million, had a per capita GDP of roughly US\$11,000 in 2010 (Cidades, <http://revistacidades.com.br/site.do?idArtigoRevista=1276>). The combination of the growth in income and the growth in population has led to fishery depletion within several hundred kilometers of the city. This is shown by a comparison of studies by Petrere (1978) and Batista and Petrere (2007), which show a dramatic expansion of the area exploited by the commercial fishing fleet. In addition to the subsistence fisheries and commercial fisheries, two other types of fisheries are important in Amazonas, ornamental fish (aquarium fish) and sport fishing. Principal species of ornamental fish include cardinal (*Paracheirodon axelrodi*) and acarã-disco (*Symphysodon sp*) (Chao, 2001). Sport fishing is focused on peacock bass (*Cichla sp*), locally called tucunaré.

Ornamental fishing has been declining due to a variety of factors. These include reduced demand for these types of fish and competition from other regions and aquaculture of other aquarium species that are substitutes for the fish captured in Amazonia. It should be noted that the income received by these traditional communities has never been substantial. In August of 2010, the price was less than one US cent per fish. The paper will proceed without more discussion of ornamental fish species.

Sport fishing has a great income potential, as the remote areas of the state constitute one of the premier freshwater fishing areas of the world. However, the income flowing to communities is limited, as most of the value goes to the sport fishing firms from Manaus or the United States. Sport fishing has tremendous potential for sustainable development of rainforest communities. It should be noted that since peacock bass are not migrating fish, they are not regulated by the federal government with the exception of a minimum legal size of 25 cm.² Sport fishing in general has catch limited to a daily take of 10 kg plus one more fish. This regulation is not enforced in Amazonas, nor is the requirement to have a sport fishing license.

Sport fishing will not be furthered discussed in this paper, except to the extent that the new types of regulations suggested in the paper would affect the various species of peacock bass as well.

Although there is an industrial fishery in the mouth of the Amazon River serving Belém (the capital of Pará state) and export markets, the vast majority of the fishery in the State of Amazonas (1.5 million km², approximately 2.5 times the size of Texas) consists of small scale fishers based in small communities or smaller cities. Even in the vicinity of the industrial city of Manaus, the majority of the fishers have these characteristics. Typically, they fish with gill nets from open boats of 6 to 8 m, with 5 to 15 horse power motors with a direct drive, shallow water shaft (called a rabeta) (Batista and Petrere (2007), Cardoso and Freitas (2012)). There has been little technological innovation in the fishery, although since the defeso it is likely that more subsistence fishers have rabetas. Fishers who live in proximity to big cities or smaller towns, sell their catch directly in the fish markets of these cities. Those who live more distant sell their catch to larger boats with freezers or large Styrofoam ice chests, and these intermediaries sell the fish to the markets. The intermediaries have disproportionate economic power and the fishers receive a low price for their catch.

Although they may be primarily fishers, they also engage in agricultural activities, extraction of non-timber forest products, and limited extraction of timber. Most of the rural inhabitants in the state are either these small scale fishers or subsistence farmers. Because of the absence of a significant road system, rural life begins fairly close to city boundaries. Entry and exit in the fishery consists primarily of movement from subsistence fisheries to commercial fisheries.

3. The Ecosystem

There are two major types of rivers in the Amazon watershed, white water rivers and black water rivers (there are also green and clear, but these are less common) (Sioli, 1990). White water rivers are actually the color of *café au lait* due to the sediment they carry from their headwaters in the eastern slopes of the Andes Mountains. Black water rivers are cola-colored, primarily due to the presence of fulvic and humic acids and do not have high sediment loads.

Both types of rivers are characterized by a pulse, where the waters rise and fall according to the rains and the blocking effect of the larger rivers into which they flow (Sioli, 1990). There are four distinct stages of the pulse of the rivers, rising water (January through mid-April), high water (mid-May through July), falling water (July through mid-September) and low water (mid-September through December) (Bittencourt and Amadio, 2007). Junk et al. (1989) stated that this flood pulse is the main driver that regulates these systems of large rivers and adjacent floodplains, regulating the flow of nutrients and structuring the biota. Lakes which are connected to the rivers at high water are often isolated during low water, and fish move back and forth between the rivers and lakes, using both environments in different parts of their life history (Lowe-McConnell, 1999). The difference between high water and low water is typically 12 to 15 m, with the rivers flowing through the canopies of trees at the highest water levels. In the high water season, many species of fish are difficult to catch as they are deep in the flooded rainforest. Fish are easier to catch in the rising

¹ A large commercial fishery (Fredou, et al., 2009), industrial in nature, exists in the mouth and lowest stretches of the Amazon River. The areas of the Amazon examined in this paper (principally Amazonas State) are more than a week voyage by boat from the mouth of the Amazon River.

² IBAMA-AM, Portaria No. 01, January 3, 2001.

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