Reflections of the way life used to be: Anthropology, History and the Decline of the Fish Stocks in Puerto Rico

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SEDAR91-RD-18

April 2025

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ABSTRACT

Arguments explaining the decline in fish stocks for Puerto Rico are straightforward: Overfishing is the main culprit for the steady decline in landings over the last three decades. The data is self-explanatory, and the graphs clearly show peaks and sharp and steady declines in catches. Accordingly, fisheries' management strategies focus on extractive activities and the seasonality of fishing to protect species through closures, Marine Protected Areas (MPA), and other regulations that reduce effort.

In this paper I propose a reverse approach: the examination of proximate human causes and driving forces that affect fish population dynamics and stocks. Not as a fundamental explanation for the decline, but to contextualize fishing, and overfishing, in a tropical-insular environment on a historical perspective. Ecosystem-based and adaptive management require innovative ways of looking at the data and the new forms of analysis. Understanding of the connectivity between the ecological, human, and managerial, systems on diverse spatiotemporal scales is a sine qua non condition. Here, I examine those connections by looking at a particular surface of processes and explanations: (1) Destruction of essential fish habitats, (2) Fish consumption and markets on a temporal (long duration) and global scale, (3) Policies to develop and retard fishing, (4) Coastal development and urban sprawl, and (5) The complex and fluid seascape of Caribbean fishing activities. If the argument holds water, then an adaptive and ecosystem-based management of fisheries must incorporate those processes in the management of the system.

KEY WORDS: ecosystem-based management, human dimensions, history

Reflexión sobre el Pasado: Antropología, Historia y el Colapso de los Abastos Pesqueros en Puerto Rico

El argumento principal para explicar el colapso de los abastos pesqueros es básicamente uno: La sobre-pesca es la actividad responsable por el proceso continuo de la merma en los desembarcos en las últimas décadas. Los datos se explican por sí solos, y las gráficas muestran claramente picos y descensos en las capturas. Por ende, las estrategias de manejo se concentran en las actividades extractivas y su temporalidad para proteger las especies por medio de cierre de áreas, áreas marinas protegidas y otras reglamentaciones que reducen el esfuerzo pesquero.

En éste trabajo propongo un enfoque contrario: el examen de las causas humanas próximas y las fuerzas motrices que impactan a las poblaciones de peces y los abastos. No como una explicación fundamental del desplome de los abastos, sino para contextualizar la pesca (y la sobre-pesca) en un entorno tropical-insular, y en una perspectiva histórica. El manejo adaptativo y el enfoque de los ecosistemas en el manejo requiere de formas innovadoras de mirar los datos y analizarlos. La comprensión de la conectividad entre los sistemas (ecológico, de manejo y humanos) en diversas escalas espacio-temporales es una condición sine qua non. Aquí examino esas conexiones auscultando un panorama de procesos: (1) Destrucción de hábitats esenciales para los peces, (2) Consumo y mercados de pescado en una escala temporal (de larga duración) y global, (3) Política pública desarrollista y retardataria de las pesquerías, (4) Desarrollo costero y desparramamiento urbano, y (5) El complejo y fluido paisaje pesquero del Caribe. Si el argumento es válido, entonces el manejo adaptativo y el enfoque de los ecosistemas debe incorporar esos procesos en el manejo del sistema total.

PALABRAS CLAVES: enfoque de ecosistemas en el manejo, dimensión humana, historia

INTRODUCTION

The Human Dimensions of Fisheries Management

A major change in the paradigm of fisheries biology and management is the incorporation of the human dimension in the analysis of the stocks and the design of management strategies. However, lip service is only paid in the majority of contexts where this possibility is discussed, or worst, it is mandated by law. Social sciences, broadly defined, have not made a good effort in matching our own peculiar interests with those of the managers and fisheries biologists, who are always interested in cohorts, recruits, spawning aggregations, stock biomass, and variations on the theme of the Gordon-Schaeffer Curve. To them, our discourse is foreign, and for us, those buzzwords remain a mystery, similar to quantum physics. Arguably, both fields are plagued by the principle of uncertainty.

Despite my qualms, it is fair to say that we both have traveled far into the process, and that we are now at light

years from the first tumbling steps after the Magnuson Act required the incorporation of the social sciences in fisheries management. Without abandoning our guiding principles and intellectual loyalties, both camps engaged in interdisciplinary and transdisciplinary efforts to tackle the hurdles imposed by the complex process of fisheries management.

Fisheries management remains a human and a biological endeavor that crisscrosses a diversity of facets of the human and ichthyologic experiences in ecosystems, entangled by food webs, markets, productive processes, habitats, niches, and policies. History is perhaps the common ground and the field of potential productive interactions. It is also a field that provides for the engagement of interdisciplinary and transdisciplinary efforts that look at fisheries in a truly holistic and appropriate manner.

Understanding of cultural processes located in the spatiotemporal context of nature is critical to the analysis of the fisheries; and thus, the role of anthropology in this paper. It is, to borrow a concept from geographer Carl Sauer, the *standorstproblem*, or the problem of location and processes in landscapes and that of the human footprint on nature. Nature is, thus, considered something constructed and modified by culture. That is precisely my view of fisheries: Stocks and the biology of fish are things that could, in the case of specific and particular physical and historical contexts, be understood only in the light of the human processes that shaped the form of nature, biomass, and resources.

The connection between historical process and the predicament of the fisheries became more obvious in recent years (Jackson 2001, Jackson et al 2001). As the fisheries management establishment moves towards an Ecosystem-based Approach and Adaptive Management, there is a need to develop innovative ways of looking at the data and new forms of analysis and explanation. Understanding the connectivity between the ecological, human, and managerial systems on diverse spatiotemporal scales is, in my view, a sine qua non condition of this new paradigm. Accordingly, history and culture provide data and theoretical models for the understanding of the status of the stocks and the future of fisheries. Recent schools and theoretical trends in the fields of history, anthropology, and geography contribute to the analysis of nature, always as a by-product of human actions. And by actions, I want to underscore the role of public policy decisions and actions, productive and market processes, labor practices, decisions of individuals and firms, consumption patterns across the board, ways of gazing and enjoying nature, location of settlements, global economic processes, and developmental strategies, among many others.

For the tropical-insular fisheries context of Puerto Rico, as well as for other Caribbean islands), those decisions, on a historical scale, shaped the dynamics of the stocks, under the vigilant eye of the management agencies at the Commonwealth (territorial) and Federal level. The argument does not eradicate overfishing as a cause. However, I argue that overfishing is perhaps the most abused concept in the tropical fisheries, and in the case of Puerto Rico, brandished as the sole culprit for the sad state of the stocks. And it is a safe alternative from engagement in the difficult process of weighting historical responsibilities. Now that the Ecosystem-based Approach to Management is almost mandated in the Federal realm of the United States and that the Commonwealth of Puerto Rico's Environmental Protection Act requires the measurement of the environmental / human processes shaping nature and resources, there is no escape in assessing those human factors other than overfishing that contribute to the status of the stocks.

I am not naïve; therefore, I do not think that the full incorporation of the human dimension will happen overnight. The process will require the test of time and the will of all those invested with the ministerial and ethical responsibility of protecting nature, ecosystems, stocks, and resources. I am an anthropologist, but I am not a fool. In my view, the understanding of this process will remain in the hands of fisheries biologists, and indeed, their knowledge is essential to solve the puzzle. Anthropologists and historians do not have the answer, but in their name, and for the specific case study presented here, I wish to ask other related questions and propose alternative ways of looking at the problem of the decline in the stocks. Perhaps we may be able to decode the token phrase "we do not manage fish, we manage people," which seems to be followed by the almost unspoken aphorism of "always based on fisheries biology data."

Eroding the Base: the Systematic Destruction of Essential Fish Habitats

In the eighteenth century the frail economy of the municipalities depended on the taxes imposed to the small-scale producers, and the permits for the use of land and certain resources. For coastal communities and municipalities, the leasing of the rights to use fishweirs became the most important source of revenue (Valdés Pizzini 1987). Fishweirs were placed in the estuaries, rivers, and coastal lagoons. The authorities strictly controlled the seasons, size of gear, and the carrying capacity of the areas (number of users and gears). Landholders and farmers leased the right to use weirs, and subleased them to field supervisors from the plantations. Thus, a source of fresh fish for the landowners and the workers was secured. The surplus was sold to the local communities, but in San Juan the fish had to be brought to the walled city in order to satisfy the constant demand for fish.

We know very little about marine fisheries during the Spanish colonial period, except for fishing incursions in the cays and offshore islands of the archipelago and the systematic extraction of sea turtles to ship their shells to Germany. Fishers using boats were forced to enroll in the Seamen's Guild (*Gremio de la Gente de Mar*), a brotherhood and a conscription system to coerce coastal free laborers to

contribute time and skills to the interests of the Spanish Navy in the harbors and on the vessels. What was their reward? Those in the guild could fish in the local waters using their own crafts. The seamen could not interfere with the operations of the weirs in the estuaries. But historically, the right of the leasers were always contested by the seamen-fishers, tax collectors, the Navy, and the Spanish colonial authorities.

Weirs caught a number of estuarine species, and also caught those reef fishes that ply into the mangrove areas and coastal lagoons, such as snappers and groupers. Fishweirs were banned in 1953 as a result of a long series of debates promoted by the new class of recreational fishermen, some of which also represented the public interest in the legislature. In my view the days of the fishweirs were about to end. Mangroves and coastal wetlands were the target of a public policy transforming them into productive agricultural land. Rivers and estuaries started to receive a large amount of sediments and contaminants as they became part of the urban drainage system and the depository of the materials removed from the soil in the expansion of the suburban areas in the 1960's. Mangroves, coastal lagoons, and a diversity of seasonal and permanent wetlands were heavily impacted by development and agricultural practices. During the Spanish period, mangroves and coastal lagoons were used by peasants and rural workers. Concessions to private owners were also provided in the late nineteenth century for salt and wood extraction (Martínez 1994:195).

In what it is now the San Juan Metropolitan Area, mangroves and wetlands were lost to the occupation of shantytowns and the construction of military bases and facilities. Early in the twentieth century, the United States health authorities initiated a program for the eradication of the malaria-ridden areas of San Juan, surrounded by the mangrove forests and swamps. In 1918, 72% of the existing mangroves became part of the territory's system of forests (Bosques Insulares). In 1927 the government authorized the sale of mangroves and wetlands under the condition that they had to be filled and dried to eradicate malaria and other diseases. What followed was a consistent policy of elimination and draining of wetlands and mangroves that reshaped the coastal landscape, and also added productive land to agriculture (Miranda Franco and Casta Vélez 1997:147). At the onset of World War II the process of eradication of malaria and of mangroves and wetlands, accelerated dramatically by the construction of military bases (Roosevelt Roads in the East, and Ramey Fields in the Northwest) and installment of the Malaria Control in War Areas program, aimed at the drainage of malaria prone areas. Construction of military bases also required the elimination of those wetlands that served as the foci for the malaria vectors and intense fumigation of those areas with DDT on an experimental basis (1997:148).

Harold Heatwole studied the rate of mangrove loss in Puerto Rico since the 1970's and concluded that between the mid 1960's and 1970's the destruction of mangroves was greater than in previous years (Heatwole 1985:87). According to Heatwole, between a quarter and a third of the mangroves disappeared by the mid 1960's, and the rate of destruction accelerated in the 1970's (1985:90). He documented the uneven depletion of mangroves estuarine areas, some of which lost all the mangroves.

In the present, there are several critical areas of mangroves identified by the Department of Natural and Environmental Resources that are also threatened by developments and are affecting the quality of the water in those estuaries, some of which are coastal reserves and marine managed areas. With the decline in the water quality, and the increase deposition of silt, there is an increase in the loss of coastal coral reefs and seagrasses in the neritic zone. It is appropriate to suggest that the process also alters the natural productivity of the systems, specially the available and potential budget of plankton in the coastal waters that contribute to the available amount of food for invertebrates, small fishes, and coral reefs.

Mangroves and the associated environs play a critical role in the developmental stages of a large number of tropical fishes in the Caribbean. Dubbed as "nursery areas," the ecological literature praises mangroves and their position in the food web. Providing shelter, areas for spawning, food, safe areas for growth, and protection, mangroves offer an invaluable service in the context of insular-tropical fisheries. In fact, mangrove connectivity with other ecosystems is a factor in the enhancement of fish biomass, and thus, their destruction has a deleterious effect in the trophic web (see Mumby et al 2004).

I am also not an ecologist, but I could argue that there is a major historical impact if the potential and capacity of the physical environment is reduced by 62% over a period of one hundred years, and that the quality of the water available has been reduced as well. Habitats for species in braquish waters have been lost, and their niche and contribution of those species to the food web is also lost. The dynamic of the system also altered the interaction with the waterfowl that I suspect is also dwindling as the amount of habitat is reduced and as hunting remains a major recreational activity in Puerto Rico. How do we incorporate habitat loss and the dramatic changes in the structure and function of ecosystems into our analysis of the stocks?

Although not as extensive and as documented as the condition of the mangroves, coral reefs are showing a pattern of reduction of coverage in those waters near the coast. Edwin Hernandez's dissertation is one of the key works on this topic, as he examined the population dynamics of reefs in the Eastern coast of Puerto Rico (Hernández Delgado 1999). His work shows hat there is a gradient of coral reef coverage that increases in distance from the shoreline in the Eastern portion of Puerto Rico as a result of an increase in water quality (1999).

A study based on expert opinion to gauge the variety of anthropogenic activities that impacted the coral reefs

and thee reefs (Valdés-Pizzini et al 2007). In synthesis, the study revealed that erosion and sedimentation is the key problem affecting the health of the coral reef ecosystem. This is an outcome of deforestation, construction in important watershed areas, and development and construction activities throughout the coast. The problem seems to be acute in the Southwest coast of the island where coastal construction has dramatically increased in the last decade. Development is a key factor in the transformation of the coast.

One of the most important documents on the impact of human activities on coral reefs was produced by the U.S. Geological Survey (Warne et al. 2005). The results of the study coincide with the report on anthropogenic activities. However, the USGS study actually measured the impact of those activities and identified quantitatively the areas where the problem is more acute. One important aspect of the report is the historical dimension. Although current activities are threatening the health of the coral reef ecosystem, the report argues that the major impact was produced by the agricultural practices of the nineteenth and twentieth centuries and development activities associated to the urban sprawl. In the watersheds of the North and Northeastern portion of the island the impact has been the greatest. For example, the Río Grande de Loíza "is estimated to have delivered more than 5,000 metric tones per square kilometer… of hillslope-derived sediment to river channels for decades" (2005:50). As a result, large amounts of sediment have been transported to the shoreline, and sediment has been stored in the alluvial valleys. The frightening consequences of those processes are summarized as follows: "The studies described above indicate that the island shelf, particularly seaward of river mouths, will be strongly influenced by the influx of agricultural-period-derived sediment for at least several decades to perhaps a century or more" (Warne et al. 2005:50).

The study also underscores a number of critical processes that are contributing to the decline of the coral cover: (i) conversion of upland areas from forest to agriculture and from agriculture to urban development increased sedimentation and turbidity in many areas; (ii) turbidity changed the landscape of corals, with a reduction of coral cover, reduced diversity of species, and a shift to slower growing corals; (iii) the impact of industrial effluents and the death of corals in the west coast; (iv) increased competition from sponges and algae for benthic space colonization; (iv) advantage of sponges and algae due to the high concentrations of phosphorous, nitrogen, and fecal material in the waters, due to river discharge; and (v) sewage effluents of untreated waters and the potential damage to coral reefs (Warne et al. 2005:50-51).

The document *The State of the Coral Reef Ecosystems of the United States and Pacific Freely Associated States: 2005* contains a summary of the predicament of the coral reefs in Puerto Rico (García-Saís et al 2005). A fascinating fact is that a key source of pollution in the coastal waters is the government, represented by the utilities companies, water and electricity, that contribute thermal pollution and sewage to the waters (2005:97-98). However, rivers "still represent the main pathway of sediment, bacteria and nutrient loading into Puerto Rico's coastal waters" (2005:108). The report also documents a number of activities affecting corals, such as: tourism and recreation, navigation, trade in ornamental fish and organisms, and fishing. The report is in agreement with Hernández Delgado's findings in that coral coverage and species diversity is higher in those areas far from the shoreline (such as the island of Mona, Desecheo, Vieques, and Culebra) and some reefs in the West coast (García-Saís et al 2005:127). The process of deterioration of the reefs, loss of cover, and the presence of cyanobacterial colonization of reef substrate is becoming pervasive in recent years.

It is plausible to argue that coral reefs have been used, abused, and threatened in recent years, but the human processes of the twentieth century, agriculture and urban sprawl, have taken a toll on the ecosystem. There are processes that we still do not understand well and that may also shed light to the historical uses of reefs in the Caribbean. In examining historical data on the use of resources in the island Culebra (Hernández-Delgado 2000), our team found a reference to the use of lime kilns in the coast and the use of dead coral to produce lime. The presence of these kilns in coastal areas of Puerto Rico and other islands suggests that planters and other people used to employ live and dead coral to produce the lime. Such use may have taken a toll on fringing coral reefs, such as those composed by *Acropora palmata*. We found a reference on the extraction of live coral to feed the kilns in St. Croix, US Virgin Islands that may shed light to the historical uses of corals:

There were no minerals on the island, but in most places there was abundant stone which was used for construction and it was easy to get coral with which to make white lime by packing the coral in a kiln with sticks or wood, coral, more wood, etc., and burning it. Coral stones or caliche stones were used to make white lime, but this produces lime of an inferior quality. However, government buildings, windmills, and [sugar] factories needed this white lime. Haagensen says "In my own estates, I used over 1,000 barrels of white lime and few times gave away some barrels to the poor people." Coral stones were found all around the island and you only had to go a few hundred feet to find all the coral you needed. When there were no stones (coral rock) near the coast you would go out to the reef with a big bateau and there you would have four, five or six slaves breaking the coral from the reef and loading it into the boats. While one boat carried it into shore, another boatload of coral would be broken loose (Lawaetz 1991:131).

More historical and archeological work needs to be done to assess the impact of live and dead coral extraction to feed the kilns that were distributed throughout the Puerto Rican coast.

The main question is: How can we incorporate the erosion of the environmental base of the fisheries, into the process of assessing the stocks and analyzing the predicament of the local fisheries?

It is evident to me that a number of human processes, on a historical scale, diminished the capacity of the ecosystems to produce fish regardless of the process of fishing mortality. Models in fisheries must take into consideration the transformations in the ecosystems and those changes that alter the structure of the trophic web, as well as the availability of species (in both diversity and biomass) and their potential for recruitment and reproduction. Dramatic changes in the environmental base also have the potential of altering ontogenetic processes of many species. The processes described here also have an impact on associated habitats, such as beaches, seagrasses, deepwater reefs of the shelf drop-off and pelagic waters. Again, if estuaries, mangroves, and coral reefs play a critical role in the life history, health condition biomass, and diversity of species, then their state is a factor in the current condition of fish populations and stocks.

The Successful Story of Our Ambiguous Decisions on Development

An esteemed colleague once shared with me an intriguing thought: fishermen in Puerto Rico harvest the resource in the most optimal way, and in that sense they are successful, for they have followed closely our advice and adopted the technology we transferred.

Developmental strategies are among the last things one may consider in the analysis of the stocks. However, stocks are extracted, and the rate of extraction is depleted as a function of the transfer of technology and investments in new boats and gears by the government and the private firms. The design of technology transfer programs is at the core of what we do in fisheries and fisheries related programs (Weber 2002.) In order to survive in the complex web of bureaucracy, we are forced to come up with better mousetraps and make people use them to increase their productivity and to raise their standard of living, all of which are reflected in small but important increments in the Gross Territorial (or National) Product.

The frightening conclusion is that overfishing of the stocks is a monument to our successful careers in technology transfer and development. The irony is, of course, that as we abandoned that paradigm in fisheries we became engaged in its antithesis: conservation, Marine Protected Areas, fleet reduction, and crew and fishermen downsizing. Those mixed signals permeate the perceptions of all those involved in the process. I will present three rather uneven examples of our "successful stories:"

(1) Sharks and underutilized species. The University of Puerto Rico Sea Grant College Program, as well as other government agencies may be responsible for starting a process of fishing down the marine food web (see Pauly and Palomares 2005).

In the mid 1980's Sea Grant started a program to entice fishers to catch and sell underutilized species such as sharks (I was the Extension Leader then, thus I bear responsibility of the ensuing effects of that program.). Homemakers and owners of restaurants were targeted with recipes to prepare shark meat. Sea Grant was successful; shark shish-kebab became a sought after morsel at the local festivals. We were basically copying great ideas from other Sea Grant programs and applying them to a local context in order to exploit an underutilized resource effectively.

From 1985 to 1990, UPR Sea Grant bragged about the potential success of the shark fishery in the proposals, stating that it had a potential for the extraction of half a million pounds per year or nearly a 12% increment in the total catch (University of Puerto Rico Sea Grant College Program 1985: A-24). However, for 1988 shark annual landings were around 21,000 pounds, with an estimated economic impact of $31,000 (University of Puerto Rico Sea Grant College Program 1988: MA-47). The program also promoted a number of elasmobranches, including apex predators and other species at the lower levels of the food web, such as parrotfishes (*Sparisoma spp.*). I joined the extension agents in workshops for the staff of supermarkets and for consumers that promoted the inclusion of parrotfishes in the shelves and in the diet. In other words, we made sure that the cascading effect of overfishing of a marine food web was well covered by enticing fishers to catch the top predator in the Caribbean food web, as well as species at the base of a tritrophic food chain (TFC), such as parrotfishes.

(2) One key historical process that shaped the future of fisheries' developmental policies in Puerto Rico was the extreme dependence on cheap codfish from Newfoundland in the twentieth century. Such market opportunity, Puerto Rican (and U.S.) interests in developing a strong sugar enclave from 1898 to 1940, and a modern industrialized territory after 1940 precluded the Island to pursue the dream of having a productive fishing fleet. Instead, fisheries development concentrated on the improvement of the small-scale fishing facilities (piers, lockers for equipment, fish houses), motorization of the fleet with outboard motors, mechanization of some on-board operations, provision of cheap building materials for gears, equipment, and refrigeration facilities (Valdés-Pizzini 1985, Griffith and Valdés-Pizzini 2002, Pérez 2005).

Private firms in the Southwest also invested in larger vessels to ply the waters of the Mona Channel for groupers and snappers (Griffith and Valdés-Pizzini 2002). In the 1960's and 1970's a number of government programs bought large vessels (shrimp trawlers) to transfer the technology to the local fishermen. A thorough assessment of those programs needs to be done, but we know that most boats remained unused or were given back due to their high operational cost. Most fishers used traps in the insular shelf, and thus, large vessels were the most inappropriate and expensive technology to operate the traps in shallow

waters and nearby grounds. The vessels were also transferred to fish in distant waters, and only a few fishermen had already developed the cultural, financial, and social adaptations to engage in that fishery. The fishermen from Cabo Rojo, and the small successful firms in that area bought the vessels and expanded their operations into other areas of the Caribbean (Valdés-Pizzini 1985). Those firms and production units were responsible for an unseen increase in landings that reached its peak in the late 1970's. That effort was the result of the combination of governmental and private efforts that targeted the snapper and grouper fishery. *Lutjanids* are currently a genus of fishes considered overfished and threatened, and thus, heavily regulated by the Commonwealth of Puerto Rico and the Federal government. That is the result of some of our successful efforts in fisheries development.

(3) Finally, as soon as the fisheries management establishment realized that a number of species were overfished, it moved to protect those species through fishery management plans and regulations targeting exclusively the process of extraction. That is, of course, the traditional modus operandi of fisheries management (Berkes et al 2000). The Commonwealth of Puerto Rico developed and implemented the controversial, and much contested, Fisheries Law Number 247 to protect a wide range of species in order to reduce the detrimental effects of overfishing. Needless to say, the fishers saw it differently and started a campaign against the Law (Trumble et al 2004). Regardless of the potential criticism, I believe that the Fisheries Law was an act of good faith by the resource managers from the Department of Natural and Environmental Resources (DNER), as they attempted to regulate the rate of extraction. However, the Fisheries Law is part of a larger strategy for the protection of the fisheries that remains incomplete if the ecosystem is not factored into the equation. In contrast, fishers have a clear view of the importance of the ecosystem, natural, spatial, and historical entity that they constantly observe, as they are witness to its demise (see Martínez Reyes and Valdés Pizzini 1997).

Fish Consumption, Local and Global Markets and the Distortions in Conservation Ethics

Bacalao, Atlantic cod is the most important fish in Puerto Rican history. Puerto Rico has been one of the key markets of gadiforms from Maine, Newfoundland, and Europe in the nineteenth and twentieth centuries. It is as simple as that. A recent book on the historical trends in the cultural and nutritional diet of Puerto Ricans, *Puerto Rico en la olla* (Cruz-Cuadra 2006) devotes one full chapter, perhaps the most complete, to codfish and members of the gadiforms marketed in the island, such as hake, pollock, and haddock.

Puerto Rico's colonial connection with Spain explains the initial taste and patterns of consumption of cod, as that nation-empire became obsessed with codfish (Cubillo de la Puente 1998). The codfish connection is also part of the Mediterranean culture of religious observations and regulations promoted by the Catholic Church to avoid the consumption of meat during the days observed by the Church. Spain became addicted to *bacalao* since the times when the Basques fished the banks of what was later known as Newfoundland. The Canadian seas were part of the Spanish stronghold until the British seized the region and forced them, early in the eighteenth century, to relinquish their right to fish in that part of the world.

After 1713, Spain became dependent on codfish produced by the British in Newfoundland (1998:115), with a significant impact not only to national and imperial pride but also to the national budget as codfish increased in price (1998:126). The tense commercial relations between England and Spain, which centered on cod, were probably what sparked during the Enlightenment developmental policies for the diversification of the Spanish fleet (1998:128-133, passim). Galicia and the Basque Country became important commercial strongholds, trading codfish with England, to supply the Spanish market (1998:161-169, 285-288). Imported fish was scarce in Puerto Rico; however, the supply of salted codfish was always present (Ortíz Cuadra 2006). To sustain the market colonial authorities managed to establish in the nineteenth century a strong commercial relationship with England, one in which the salted codfish from Newfoundland played a critical role (Dávila-Cox 1996). Puerto Rico had a constant supply of salted fish from the U.S. mostly from Maine, but in the mid nineteenth century its preferences shifted to commerce with Great Britain and the salted fish from Newfoundland (Dávila-Cox 1996:108-109, Ortíz Cuadra 2006). The trade was linked to a complex exchange of money, monetary transfers from Spain, rice, manufactured goods, textiles, sugar, molasses, diplomats, silver, timber, and machinery. At the end of the century, the saltfish market in Puerto Rico was dominated by the British, via Canada.

Ortíz Cuadra offers a detailed description of the market, underscoring the apparent lack of a full supply of salted fish from 1898 to 1910, and a constant supply afterwards, but a reduced per capita consumption when compared to the nineteenth century levels and the role of codfish in the local diet (2006:155-160). However, in terms of the overall consumption and purchase of codfish, Puerto Rico became one of the major buyers of fish from Newfoundland (Alexander 1977). Our dependence increased to the extent that during the war time scarcity of the 1940's, our government implemented a short lived program of sailing to the Great Banks to fish for cod. A thorough examination of a number of documents at the archives in the United States and Canada provided information to clearly state that Puerto Rico, as a preferential market, became the major buyer of Newfoundland's cod from the 1920's to the late 1930's. In fact, Puerto Rico's market was made possible due to the economic exploitation of fishers, children, and women in the outports, and even the engagement of fishers in the winter hunting of harp seals in the ice sheets.

Markets play an essential role in the health of stocks and shape public policy and private investment leading to specific patterns and rates of resource extraction. Regardless of the history of big trawlers scooping groundfish from the Northern Sea, Puerto Rico had a big share of historical responsibility in the eventual collapse of *Gadus morhua* (to the speed of 22 to 32 million pounds of salted fish per year) as the availability of that fish created a dependence on that source of protein that retarded, contained, and structured the development of local fisheries.

Fish consumption in Puerto Rico depended also on the availability of smoked herring and sardines, some of which were imported under the name of pilchards, a common name for a number of clupeids. Later in the twentieth century, fish sticks and a variety of frozen and canned fish (including the locally produced tuna) made their way into the tables of Puerto Ricans but not in the same numbers as cod. As the population increased in per capita income, as a function of industrialization, the taste for foodstuffs became more sophisticated, and the production and market of fish also had to accommodate the new tastes of the tourism market.

Fresh fish and shellfish became almost a delicacy as spiny lobster (*Panulirus argus*), once bait for traps and food for hogs, turned into a specialty item in restaurants in the 1950's. A similar history can be traced for conch (*Strombus gigas*) in the 1980's. Both were underutilized species, and the market turned them into central pieces of Fishery Management Plans, due to the rate of extraction and the threat of overfishing (Caribbean Fisheries Management Council 1981, 1985).

A fleet of U.S. based longliners operating in the nearby (Federal) waters, and often intruding in the waters of the Commonwealth of Puerto Rico (from the shoreline to 10.35 miles) targeted pelagic fishes, mostly swordfish for the restaurant market. The story is a long and convoluted one that could be summarized as follows: By-catch (wahoo, marlin, and dolphinfish) was dumped in Puerto Rico, and sportfishermen were successful in protecting tournament billfishes (mainly *Makaira nigricans*) as the local fishers lost their bid for a concession to continue with a traditional hand-line fishery for marlin.

The market is the name we give to those human actions and perceptions involved in the exchange of commodities, including money. Those human actions are embedded in cultural and historical contexts that shape the form, rate, and extent in which commodities exchange hands and are consumed, transformed, and exchanged once again. It is amazing to note that markets have little value or are of little interest to the management of fisheries. The omission must be reversed as markets:

(i) Shape the culture of consumption and develop needs for new food items and tastes (for example, sharks).

(ii) Replace local species, often prohibited, with species caught in other management regimes, allowing for the continuation of consumption and market transactions despite closures and regulations. In other words, conch is prohibited during the spawning season, but it is also available, imported from other countries.

(iii) Increase the demand for fishes that had a modest following. Red snapper or *chillo* (*Lutjanus vivanus*), and a number of deep water lutjanids is a case in point, as it slowly became a keystone species in the market food web of Puerto Rico, and an essential item in the restaurant market. Their critical role became evident when local fishing firms constantly imported snappers from the Caribbean basin to satisfy the demand, mixing imported with "locally" and "fresh" caught fish, yet another misconception, as I will explain later.

(iv) Distort conservation ethics as the main actors in the market exert pressure to the producers to have a constant supply of the commodities. In the tropical fisheries, it is in the market where the Tragedy of Open Access (formerly known as the Tragedy of the Commons) becomes evident, as fishers with all their Traditional Ecological Knowledge keep fishing and landing undersize fish and shellfish to supply the market and to keep in business, as we have witnessed (Martínez and Valdés Pizzini 1997).

Fishing in the Islands, or How Overfishing is Calculated without a Cultural Context

Arguably, lutjanids are the most managed family of fishes in Puerto Rico. The catch rates dropped in the last two decades and the stocks appear to be in dire straits. There are closures for *L. vivanus*, *L. analis,* and *L. bucanella*, key species in the snapper-grouper complex. Logically, the fishers exploited local resources at a rate that left the habitats and stocks in bad shape; thus, the regulations and the management steps taken to protect the species. However, a look at the history of the snapper-grouper fishery provides a richer context and a socio-cultural explanation for the changes in the fishery, including the stocks.

From 1979 to 1982 there was a huge bonanza in the Puerto Rican fisheries. Landings during that period increased dramatically, as the snapper-grouper fishery expanded its overall effort. In fact, 1980 and 1981 became landmarks in the history of the local fisheries, as production set a standard that was impossible to reach in years to come. In 1979, landings reached 7.2 million pounds, but the landings of fish and shellfish declined afterwards (Cummings and Matos 2003:3). That is a successful story in development, with an increase in economic effort, income, and profits. Technology played a critical role, as the vessels were rigged to explore the bottoms and plateaus of the region, equipped with echo-sound and electric reels; vessels powerful enough to travel for ten to fifteen days looking for the snapper-grouper banks.

This specific fishery was the result of local development, investments, risk taking into the waters of the Mona Passage, capital accumulation, and the opportunities provided by the government of Puerto Rico, with loans and other financial aids to purchase large boats (Valdés-Pizzini 1985). In the late 1970's the government made a dramatic

effort to improve the fleet by purchasing large boats (Thompson trawlers, for example) with the intention of increasing effort in the local fisheries, dominated by sailboats with adapted car motors, employing traps as the main gear (Pérez 2005). A number of fishers obtained the vessels to increase their effort with traps. That process coincided with the elimination of the prolific and traditional fishery of sea turtles.

Unfortunately, investment in those large vessels was hasty, as the trap fishery could not sustain an effort that could pay the loans for the vessels. A number of fishers went bankrupt, and vessels were returned to the government. Government officials auctioned the vessels and the small fishing firms of the Southwest, more specifically Puerto Real in the municipality of Cabo Rojo, benefited from the process. Figure 1 depicts the ups and downs of the landings in that community. The government also purchased smaller boats to be used in the trap fishery, but there was a major shift in the Southwest, from traps to hand lines and electric reels for deep water fishers.

The result: The small firms rigged the boats (*lanchas*) to explore and fish the banks of the Mona Passage, while those same firms and fishers throughout the region employed smaller crafts (*lanchas* and *yolas*) for trap fishing, and later for shorter trips fishing for groupers and snappers. Puerto Real became the epicenter of that development, which consisted of a mix of government strategies, availability of vessels, and entrepreneurs involved in the process of capital accumulation that made possible an infrastructure to manage the production process and the circulation of commodities. In fact, this is one of the few cases in Puerto Rico of a fishery in which most fishers were de facto wage laborers for the local fishing firms (Griffith and Valdés Pizzini 2002).

It is not surprising, as Puerto Real was the main harbor of the Spanish Crown in the West of the Island, for most part of the nineteenth century. A hub for commerce, navigation, piracy, smuggling, and privateers, Puerto Real had its share of seamen from the Cabo Rojo coast, and some of them were immigrants from Catalonia, Italy, and the Balkans. In the mid-nineteenth century, Puerto Real was an active harbor with connections throughout the Caribbean and evidence of fishing in the Mona Passage, as well as commerce and smuggling with the Dominican Republic. In the 1970's and 1980's, the fishers' surnames were similar to those who were listed as part of the Spanish Seamen's Guild.

By design, failure, serendipity, and the historical process, Puerto Real and the Southwest coast of Puerto Rico became a story of success when the fishers landed record amounts of fish in the 1980's decadal transition. However, shortly afterwards, those numbers dwindled as the snapper-grouper fishery started a downward spiral that moved resource managers to intervene. There are currently two sets of regulations (Federal and Commonwealth) based on seasons and sizes for the capture of a number of deepwater snappers in the region. Regulations are based on the decline in catches and a decrease in the sizes of sexually mature individuals that are caught over the years (Cummings and Matos-Caraballo 2003). Scientists and fishery managers could not help themselves in arguing that the decline was evidence of the collapse in the fishery. I will outline

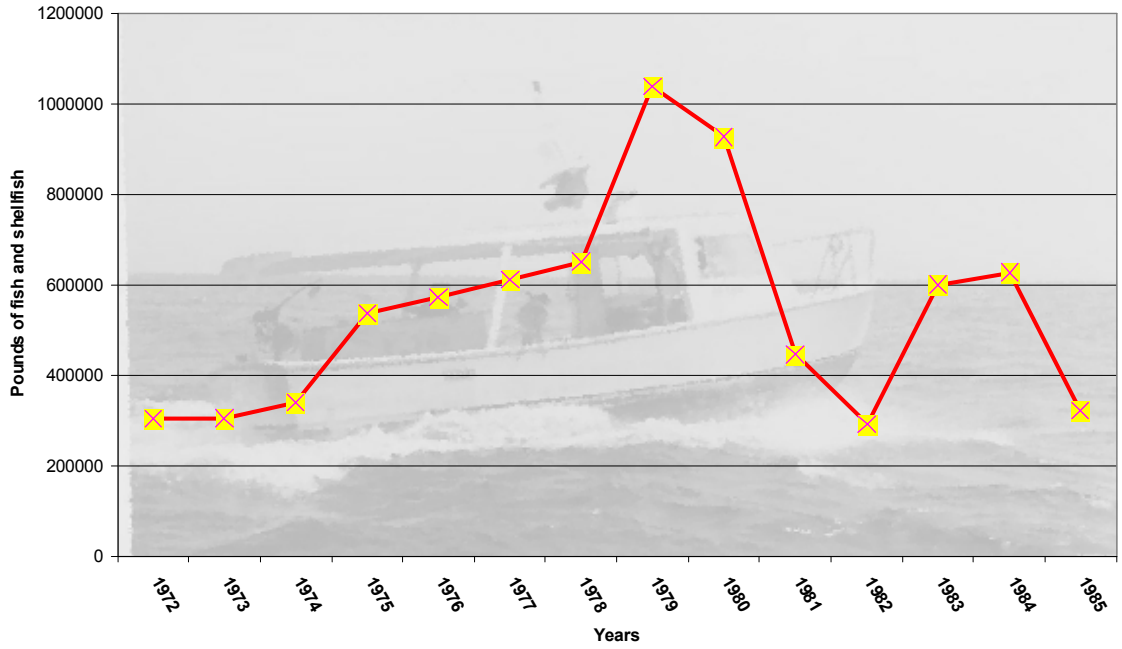

Figure 1. Fishing production in Puerto Real, Cabo Rojo. Source: CODREMAR Fisheries Laboratory Data DNER

the fascinating historical landmarks of the collapse of the stocks:

(i) The fishing firms of Puerto Real and the Southwest coast of Puerto Rico targeted the snapper-grouper banks of the Mona Passage (Pichincho, El Guineo, El Tostón, El Banco del Medio), Grapplers Bank (to the Southeast), and a number of sites in Dominican Republic (to the West of the country) and Navidad (to the North). Those trips lasted 5 to 10 days. Lack of enforcement and bribes, according to local lore, made it possible to fish in the Dominican Republic.

(ii) Fishing effort expanded to the Lesser Antilles, specifically Saba, Nevis, and St. Bartholomew. From 1979 to 1981 most of the catches of snappers came from Dominican Republic or from the Lesser Antilles. Those trips lasted 10 to 15 days and were responsible for large earnings and a derby behavior to exact large amounts of fish in those banks (20 to 30 quintals per trip). Demand in the restaurant market was at a historical high as snappers became the most sought after fish for their tables. In fact, the owners of the small firms satisfied the demand with imports of "fresh" snappers from Venezuela and Costa Rica, and frozen fish from Florida (Valdés Pizzini 1985). Reports indicate that the West coast was responsible for most of the landings of snappers, but failed to notice that most of the fish were caught in the waters of other island nations.

(iii) In 1981 an unspecified amount of fish caught in Saba was sold in St. Thomas by a skipper from the Puerto Real fleet. At their return home, the catch was seized as the fish had large amounts of ciguatera that intoxicated the buyers. The Food and Drug Administration of the United States intervened and ordered the involved agencies to prohibit those illegal fishing incursions into the waters of other island nations of the Caribbean. Although the prohibition was not made public, skippers and owners of the firms were advised on the consequences of their furtive activities. During that period, fishing pressure increased in the Mona Passage. My field notes on the period reflect the anxiety of the skippers that could barely make it with smaller amounts of fish caught per trip (4 to 5 quintals). Cummings and Matos reported that "large declines in silk snapper landings occurred in 1983" (2003:3).

(iv) After 1983, the fleet of the Western coast moved clandestinely into other waters and other activities. Turks and Caicos and the Bahamas became the main targets of their operations. Fishing for snappers and groupers and fishing for conch (using divers from Dominican Republic) were probably the two most important activities in the region. However, the fleet was besieged by increased surveillance and enforcement and the seizing of their boats. The local fishery and firms never recuperated from those blows as the fleets ended the operations in the 1990's. Most owners sold their operations and left the fishery.

With the end of the Puerto Real fleet and the period of large boats plying the waters of the island nations of the Caribbean, a restructure of the fishery was in place. The market was, and still is, firm and demand was supplied with imports, with fish caught in the Mona Passage banks, or in the shelf drop-off of the island with smaller boats (*yolas*) rigged with electric and manual reels involved in daily trips. Pressure on those resources resulted in landings of undersized deep water lujanids.

I am not arguing that overfishing is not to blame. But a cultural, socioeconomic, and historical perspective must be in place to understand the fishery and to do justice to the process. The deepwater ecosystems of the Caribbean were exploited by these fishers and firms, in a true moment of pride that coincided with the establishment of government developmental projects to increase efforts, such as the formation of the CODREMAR (Corporación para el Desarrollo de los Recursos Marinos, Lacustres y Riverinos) agency (see Pérez 2005:64-66). Again, this is a story of success, for both government officials and entrepreneurs. In a world stigmatized by a lack of effort, immediate gratification, lack of investments, low productivity, and lack of navigational skills, the fishers of the West coast appeared as a different and strange breed, product of an ill understood historical process.

How do we calculate the fact that a large portion of the snappers and groupers caught in that period lived and reproduced in distant waters? How are we to incorporate social, political, and regional processes into the assessment of the stocks and the design and implementation of just and appropriate policies for fish and fishers?

Final Notes: Expanding the Horizons and Substituting Fishermen in the Coast

In the fishing community of Puerto Real, in the Southwestern municipality of Cabo Rojo, the term *pichichero* is given to those born in the community. It was also used to distinguish those fishermen devoted to catch small fish and baitfish in the waters of the Puerto Real bay. A rich source of protein, sardines became one of the key staples after the Depression and during the food scarcity of the World War II period, some of which came in cans with the unoriginal English label of pilchards, thus, the origin of the Spanish term *pichichero*. Clupeids and other baitfish appear to be declining in Puerto Rico, although the information is scant. Fishermen interviewed in a recent Sea Grant study indicated that "there is a decline in the number of baitfish due to poor water quality and habitat degradation" (Chaparro et al. 2006:3). Fishers are catching scad and sardines with cast nets to use them as bait for snappers, tuna, and mackerel. But perhaps more important, those fishes are being caught by artisanal fishers to supply the market demand of the sport and recreational fishers of the islands, who also engage in the process. Recreational fishermen, until now, operated without a license (although the new regulations are changing that), and fisheries' management still does not fully incorporate the unknown, and grossly estimated, figures of fish and shellfish caught by the recreational fishermen.

Leisure seems to have substituted the productive spaces and the traditional inhabitants of the coast, most of which were fishers (see Griffith and Valdés Pizzini 2002). A recent study of fishing communities shows the widespread and deleterious impact of gentrification, which is displacing original dwellers and substituting traditional coastal communities with condos, marinas, second homes, and malls (Griffith et al 2007). Fishermen are fully aware of the process, as they are of the long history of destruction of essential fish habitats due to economic development (Martínez and Valdés Pizzini 1996). They are not naïve, nor unaware of their role in the fisheries, as they are prone to admit the impact of increased effort over the stocks.

From our side, that is, those who work in the diverse aspects of resource management, we make a great effort to design and devise new technologies for the understanding and conservation of the stocks. To paraphrase publicist Seth Godin, for many of us the system is broken: It is not working; it is not effective. Historically, management systems thought about fish as a resource, and not of fishers as part of the ecosystem. These systems did not even think about other humans as part of the complex process. Removed from the productive and extractive act of fishing, other humans, their actions, culture, and markets remain afar. The Ecosystem Approach to Management requires that we incorporate the vast connection of habitats, ecosystems, and processes that produce the conditions of a fishery in order to develop and implement appropriate actions for the protection of the stocks, populations and ecosystems. However, I am afraid that the process will remain as an abstraction and as a complicated process that would be easily solved with our traditional methods of assessing the stocks and making decisions based on landings and sizes. We designed conservation systems thinking as fishes (and scientists) and not thinking as fishers, resource users, and humans inserted in ecosystems in a historical scale. Our challenge is great, our reward unfathomable.

ACKNOWLEDGEMENTS

The information used in this paper is from a number of research projects funded by the University of Puerto Rico Sea Grant College Program (Grant SE/D-20-1 and R/FA-20-1-94), the National Marine Fisheries Service, UPR-Mayagüez College of Arts and Sciences (Seed Money Program on Fishweirs 1994-1995, and on Codfish 1996-1997), and the National Oceanic and Atmospheric Administration's Coral Reef Ecosystem Studies program. The statements, findings, conclusions, and recommendations are those of the author and do not necessarily reflect the views of the NOAA-CRES, NOAA or the U.S. Department of Commerce. The ideas in this paper come from my own reflections on the topic and lengthy and productive conversations with colleagues and friends who deserve all my gratitude: Miguel A. Rolón, Juan Agar, Richard Appeldoorn, David C. Griffith, and Ruperto Chaparro. My gratitude also goes to Ana Krystalliá Valdés-Calderón for her editorial work and guidance.

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