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Towards Sustainable Fishery Management in Jamaica: Is New Zealand's ITQ Solution Feasible?

by

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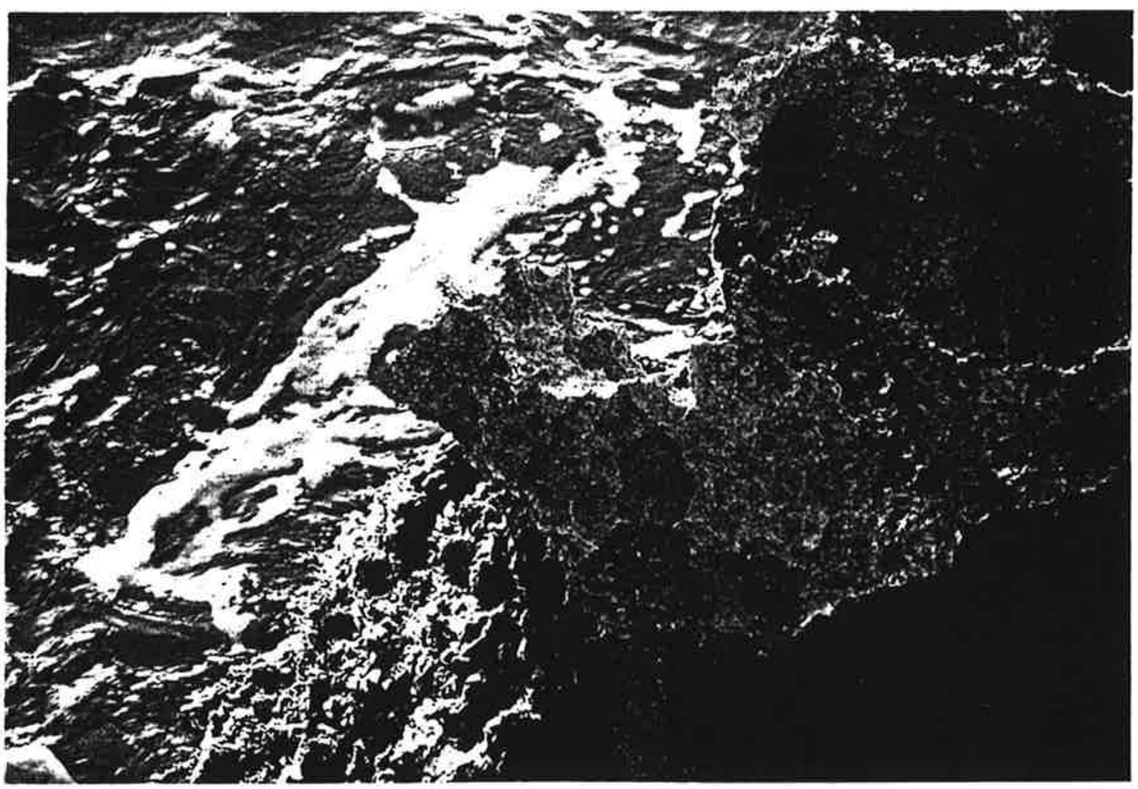
This article examines the pressing problem of overfishing in Jamaica and the subsequent degradation of the nation's coral reef. Open access to the ocean by many small fishermen results in over-exploitation of the Caribbean Sea. A common property model is used to further readers' understanding of the underlying economic problem. Plausible coastal management policies are listed, and the successful individual transferable quota (ITQ) program implemented in New Zealand is explored at length. Contrasting the economic and biological conditions of the two nations, the author concludes that ITQs are not the most relevant strategy in the Jamaican context. Instead, community-based management (i.e., territorial use rights) is offered as a plausible solution.



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I. Introduction

The purpose of this paper is twofold: to identify the difficulties with an open access resource such as the reefs off the north coast of Jamaica and to analyze feasible fishery management strategies for this small island in the Caribbean Sea. In recent years, it has come to the attention of the National Resource Conservation Authority (NRCA) of Jamaica that the coral reefs off the north coast are in a serious state of decline (NRCA 1999). In Jamaica, anthropogenic effects are driving the degradation: too many fishers chasing too few fish creates reefs that are overrun with algae. In healthy marine ecosystems, reef fish feed on algae, thus preventing total reef cover. However, when fish stocks are depleted, excess algae covers the living coral and blocks sunlight (Shannon 1996). Since light is required for the polyps inside coral to grow, increasing algal blooms smother coral reefs and stagnate growth. One possible scheme to reduce the level of over-harvesting, and thus, minimize reef degradation in Jamaica's waters is the New Zealand model of individual transferable quotas (ITQs).

Degradation of the reefs in Jamaica, as in many other fisheries, is the result of the lack of effective property rights. As described in Section III, the underlying problem with open-access resources (i.e., the ocean) is that externalities are present because of the lack of property rights (Clark 1974, Ostrom 1990). In most cases, externalities are present whenever the actions of an agent in the economy directly affect the well being of a consumer or the production possibilities of a producer (Clark 1985). Therefore, ineffective management strategies combined with a lack of ownership means that fishers have little incentive to conserve fish. Instead, fishers seek to maximize their individual profits (Section III, Copes 1986). In broad terms, this leads to a race for fish, crowding and over-harvesting. In the Jamaican context, the eventual result is the depletion of fish stocks and subsequently, the destruction of reef habitats.

Jamaican fisheries are currently managed through regulations that restrict access to the fishery (NRCA 1998). The controls in place do not overcome the incentive for overfishing that follows from lack of ownership in open access fisheries. At present, insubstantial fees are collected for licensing fishers and boats, and the penalties from violating the Fishing Industry Act are insignificant (NRCA 1999). Therefore, the degradation of these delicate ecosystems continues. Jamaican reefs are declared the most over-fished in the English-speaking Caribbean by the CARICOM Fisheries Resource Assessment and Management Programme (CFRAMP) (NRCA 1999). The marine environment is notoriously overfished; over the past 15 years, overall catch weight has fallen one-quarter, despite an expansion into new fishing grounds by fishers. One sleepy Jamaican fishing village can expect to harvest nearly 4 million pounds (half of which is trash fish) per year (NRCA 1999). Trash fish refers to species not normally purchased by consumers and therefore discarded before the point of sale. According to one US scientist, developing nations like Jamaica may harvest over 25 per cent of their fish catch directly from reefs (Weber 1993).

Overfishing is critically important in Jamaica because of the potential ecological ramifications and economic consequences. The biological consequences of overfishing are, in most cases, irreparable. Overfishing can cause extinction of slow-growing, long-lived reef species (Weber 1993). Long term studies show that the rate of species loss in Jamaica's coastal waters is undoubtedly higher than the statistical average (Wells 1990). Fish and crustacean populations fell, on average, 35% from 1975 to 1990 (Wells 1990). This loss critical in Jamaica, but also has worldwide importance; coral reefs are richer in species per unit area than are tropical forests (Dubinsky 1990). As well, reefs cover less than 0.2% of the oceans' surface, yet they may contain one-third of the ocean's fish in this limited area (Dubinsky 1990).

The status of Jamaica's coral reefs are commercially important for two reasons: most of Jamaica's small fishers use traps aimed at capturing reef fish; and reefs are the most important dive spots for tourist operators (NRCA 1999). The economic ramifications are astounding in the Caribbean; coastal tourism is worth over US$7 billion (Weber 1993). Now Jamaica's principal source of foreign exchange, tourism earnings reached US$965m in 1995 (Weber 1993). Therefore, revenue from tourism is three times that of fishing, agriculture and forestry; the three primary industries contribute a mere 8.1% to the island's GDP (NRCA 1999). The reefs surrounding Jamaica have been officially classified as in "critical" condition; they are destined for loss between ten and twenty years if drastic action is not taken (NRCA 1999, Weber 1993). The economic aspects of habitat loss can directly affect the nation's many small-scale fishers; dozens of families rely upon fishing income to support their humble lifestyles (see Box 1).

There is a worldwide call to action- it is time to protect the world's fish and their habitats. The warning signs are clear; 11 of the world's 15 major fishing areas and 69 per cent of the world's major fish species are in serious state of decline (McGinn 1998). The first step towards regeneration of the Jamaica's coastal areas is the adoption of proper management strategies to eliminate externalities and establish property rights. New Zealand was one of the first nations to implement individual transferable quotas (ITQs) on a broad scale in a multi-species fishery as a method to limit fish harvest and preserve marine-life (Clark 1994). This paper examines ITQs as a solution to the common property resource and degradation issue in Jamaica. The paper is organized as follows: the specific problems unique to Jamaica's fishing industry are identified in Section II. A common property resource model and equilibrium are derived in Section III. Section IV examines the conditions under which the ITQ system operates in New Zealand. Finally, the feasibility of the implementation of the ITQ system in Jamaica is analyzed in Section V.

II. Overview of the problem in Jamaica

The origins of the current Jamaican situation must be understood before a feasible solution is considered. Jamaica's fisheries are dominated by many small fishers and characterized as a cottage-industry. For the most part, fishing is done with a lack of sophisticated equipment; men row out to sea in small wooden canoes and harvest using mesh bait traps and lines (Shannon 1996). Small-scale fishing is one reason for the destruction of coral reefs. As shown below, Jamaica's reefs are teeming with algae cover as a result of multiple other factors. Alleviating coral degradation is important to humans for three reasons described below.

Too many fishers chasing too few fish is a worldwide problem that is reducing reef productivity at this exact moment. As explained in the introduction, overfishing directly increases coral reef degradation. This phenomenon is marked in Jamaica; the small island takes its name from Xayamca, "the land of wood and water" and is situated in the northern Caribbean. Reefs form a crown over Jamaica's north coast and protect small bays all along the coastline. In contrast to some other parts of the Caribbean, few fishes are to be found in Jamaican coastal waters. The major cause of their depletion is believed to be overfishing (Koslow, *et al.*1986). The impact of fishing is especially pronounced along the north coast, where the submarine shelf is very narrow and fishing efforts are concentrated in a small area (Koslow, *et al.* 1986). The fishing methods used are selective and exert the greatest pressure on medium to large herbivores and predators. As a result, algal blooms are rapidly increasing and choking out the living coral on northern reefs (Weber 1993). A 1995 study shows that algae percent cover has increased from 7% in 1975 to almost 80% on one Jamaican bay in 1995 (Shannon 1996). Over the same period, coral cover fell from 60% to less than 20% (Shannon 1996). This damage has drastic effects on ecosystem balance and the island's economy. As a result of the damage, ecosystems are disrupted, fish are displaced, fishers are left with empty nets and deprived families, and tourists are denied snorkeling and SCUBA sites.

The above-mentioned damage matters because of the inherent and utilitarian values humans assign to ecological habitats such as reefs. Reefs are valued for their biological diversity, their ability to generate revenue and their intrinsic value. Most citizens know that Jamaica's exquisite coral reefs provide homes for thousands of species and the basis millions for dollars in tourism revenue (NRCA 1998). Scientists classify these categories as instrumental value and further delineate between goods (e.g. fish, lobster for human consumption), services (e.g. nutrient cycling), information (e.g. genetic data) and psycho-spiritual (e.g. aesthetic beauty) values (Meffe and Carroll 1997). Another, less popular facet of conservation is the idea that nature has value simply because it exists; this is termed intrinsic (or inherent) value (Meffe and Carroll 1997). For these reasons, it is necessary to protect species diversity and to regenerate fish populations for the long term.

However, in order to protect fish stocks and create sustainable management strategies, one must understand the underlying cause of destruction. In Jamaica, multiple factors affect the ocean's status: citizens point their fingers at regulatory failure, pollution, hurricanes and the lack of properly assigned property rights.

Regulatory Failure

As explained in Section I, the Jamaican government has some fishing policies in place to try and preserve fish stocks, however, they are largely ineffective. Fish populations are theoretically regulated by licenses, but regulatory failure (i.e. lack of monitoring of fish beaches) has created a system that closely resembles open access (refer to Section III). Harvests are not monitored by an effective central governing authority and as the government itself states, "[t]he laws in Jamaica which address fisheries management are deficient" (NRCA 1999). For example, two month moratoria are widely ignored for lobster, crab and shrimp (crustaceans). As well, conch and oysters are gaining popularity in export markets and are chronically overfished (NRCA 1999). Even more disturbing is that under the Fishing Industry Act (1975), no licenses are required for removal of invertebrates (e.g. mollusks). Thus, with an almost non-existent licensing and monitoring system, Jamaican waters are essentially an open access resource, free for exploitation by profit maximizing individual fishers. Current laws create little incentive for fishers to minimize and internalize costs or conserve the marine habitat (Clark 1985, Ostrom 1990).

Limited Alternatives for Human Capital

Another reason why fishers extract more fish and crustaceans than the reefs can sustain is a lack of viable employment options. There are limited alternative opportunities for human capital in Jamaica (NRCA 1999). As a result, depleting fish stocks have not caused traditional Jamaican fishers to exit the industry. Studies show a 7 million pound (per year) decrease in fish catch over the last 15 years despite a rising number of fishers and expansion into new fishing grounds (NRCA 1999). Jamaican fishers, for the most part, learn their trade from their forebearers and are not formally trained (Jackson-Miller 1998). Uneducated fishers have a difficult time retraining or finding other means of income; only 32 percent of a sampled group of fishermen had completed primary school, and only 6 per cent had a junior secondary education (Levitt and Witter 1983). Therefore, there are more fishers chasing fewer fish and the cycle of overharvesting continues as a result of few alternative sources of income.

Alternative Income Sources

To further exacerbate the reef degradation, as incomes from fishing fall, fishers seek other sources of income, some of which are destructive to reefs. For example, the spearing of fish, collection of aquarium fish or the capture of sea turtles are all options to earn necessary income (NRCA 1999). The elimination of species reduces biological diversity at reefs.

Increasing Competition

Another factor influencing fishers' decisions is increased competition from international fish harvesters (Levitt and Winter 1983). Jamaican fisheries produce a declining one-third of domestic fish consumption (Crystal 1997). Salted fish is a Jamaican staple food. It provides the basis for the national dish, ackee and saltfish. To compensate, much cod is imported from northern Europe. Fishers are forced to overharvest in an attempt to compete with the cheap imports (Levitt and Witter 1983).

Non-fishing related degradation

Disruption of reef ecosystems is also evident from non-fishing related sources. High population density and increasing industry creates sewage runoff, pollutants and industrial waste that end up in the oceans (NRCA 1998). The case of sewage treatment provides one example. In Jamaica, only 35% of households are served by sewerage and the rest rely on soak away pits (NRCA 1998). Due to inadequate treatment facilities, waste is generally left untreated and "soaks away" to watersheds and bays. As a result, high concentrations of nutrients (especially nitrates) are present in coastal waters, thus increasing stress on coral reefs (Shannon 1996, NRCA 1999). Another case in point was the drastic reshaping of marine landscapes by blasting ship channels in the 1950s and 1960s. Industries seeking to export goods abroad (e.g. bauxite) were forced to blast channels in coral reefs to let boats dock (Shannon 1996). This affected the biological integrity of Jamaica's naturally protected bays since reefs act as natural, permanent barriers from the open ocean to shallow bays.

Other, non-anthropogenic effects affect the health of Jamaica's coral reefs. For instance, algae growth increased drastically in the early 1980s after a viral disease almost annihilated Jamaica's sea urchin population (Shannon 1996, NRCA 1998). Sea urchins are major reef grazers and along with fish, they are relied upon to keep algae growth in check (Shannon 1996). As well, Hurricanes Gilbert (1988) and Allen (1980) caused major structural damage to slow growing reefs.

In essence, the Jamaican problem in characterized by a lack of assignment of property rights. Coastal waters are essentially an open-access resource because of the lack of enforcement of out-dated, tattered legislature. As a result, Jamaican marine environments are being overharvested. Compounding the problem even further are limited employment alternatives for traditional fishers, the use of destructive collection techniques, increasing international competition, pollution and non-anthropogenic effects.

Box 1: An Old Man and his Fading Sea

A human perspective on the declining fish stocks: a veteran Jamaican fisherman slowly becomes isolated from his livelihood. By Amanda Kennedy

Six days a week, Sullivan wakes up before the sun does. He slowly makes his way down to the water's edge from his aluminum-sheltered home half way up the mountain. He reaches the fisherman's co-operative by 3:30a.m., just as he has done for over fifty years. Declining the help of the younger men on the beach, he pulls his worn, wooden canoe out onto Discovery Bay. Reaching for his oar, he paddles his way out to sea; he sails past the protected bay, the coral reef, and is soon out in the open ocean, aptly locating the lures he placed yesterday morning. One by one he lifts his traps, and each time, he sighs with dismay; no lobster, no red snapper and definitely no crab today. His weather-worn face shines in the rising sun and he slowly makes his way back to shore.
Cottage owners are standing on their docks calling to Sully (as he known in the community). "Oye! Oy-eee! Y'have fish?" they call out to him. As he pulls alongside, he passes other fisherman, also unsuccessful in their efforts. "What do y'have today?" ask his regular customers. He shows them the one pound of sunfish and two pounds of goatfish he has to offer. "Oh," they say, "I'll take it, but what about the snapper you promised me? It's all right, why don't you have a Red Stripe?" As Sully sips a cold beer on the dock, his bare feet dangle in the clear ocean. Sully looks down at his reflection; his deeply lined eyes flash and he recalls the old days. His traps were full, the harvests were easy and there seemed to be no worries, he says. The old man and his faithful customer complete their transaction and Sullivan makes the last leg of the journey back to the fisherman's beach with $200 (approximately $9cad).
It's been the same, day after day, year after year. However, on the seventh day he breaks his weekly habit and attends a community mass. The room is filled with boys in neatly pressed suits, girls in brightly coloured dresses and women bedecked in their Sunday best. The men sit together in silence. Solemnly, unbeknownst to each other, they pray for the same thing: immediate recovery of the bay's glory and an opportunity to revive their livelihood. Who's going to make it happen?

III. Economic Theory of Fishery Management

Biologists and economists have developed models to explain overharvesting and overexploitation. A brief summary of the seminal articles and theories of common property resources and management of the commons are included below.

Common Property Resource Theory

Common property resource has varying definitions in economic literature, but most economists agree that it defines a natural or human-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use (Gordon 1954, Clark 1985, Ostrom 1990). As well, a single agent or authority does not control common property resources; therefore many users and unrestricted access can lead to exploitation (Rettig 1995, Garvie 1999).

H. Scott Gordon, a Canadian, is credited with providing the first, classic paper on fishery economics. His 1954 article, "The economic theory of a common property resource: the fishery," explained why, after an initially successful period, commercial fisheries would eventually find themselves chasing too few fish in too many vessels (Gordon 1954). His paper explained how economic overfishing would result in any unregulated fishery and biological overfishing would occur whenever price/cost rations were too high (Gordon 1954).

Garrett Hardin echoes the common property theory put forth by Gordon (1968). Applying Hardin's explanation of the tragedy of the commons to a fishing industry, one would reach a conclusion similar to this-- Each fisherman seeks to maximize his own catch. Fishing more produces positive utility and thus, a rational fisherman will extract another fish from the "common" ocean. But therein lies the tragedy. In a world of finite natural resources, each individual fisher wants to extract an infinite number of fish. Thus, over harvesting results in what Hardin terms, "ruin." (1968). Therefore, following his line of thinking, without proper management, Jamaican oceans could be left in a state of disarray at the hands of self-serving fishers. Today, however, very few fisheries are completely uncontrolled.

Open Access Resource Model: The Fishery

The following model shows how incentives determine the fishing level expended in an uncontrolled, open access fishery. (Parts of model adopted from Clark 1985, Gordon 1954, Anderson 1995 and Garvie 1999). Let us assume a fishery of a fixed size and let n represent the number of fishing boats used at the marine site. Although fishing requires multiple inputs (i.e., labour and equipment), we will consolidate all variable inputs into the term "boats." Therefore, the fish catch (y) measured in kg, is a function of the number of boats. The catch production function, y = f(n) is drawn below;

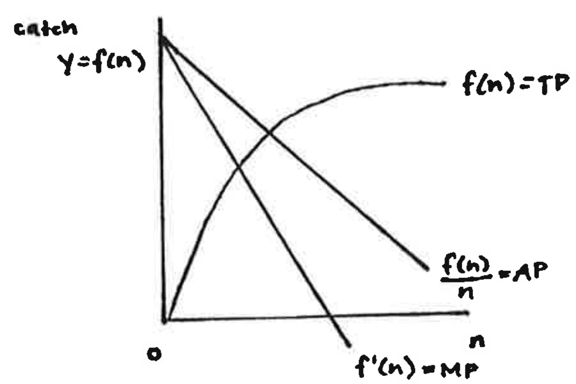

Figure 1. The catch production function in an open access fishery

Note that as the number of boats in the ocean increases, the fish catch increases, but at a decreasing rate. Thus, in a fixed marine area, the function illustrates diminishing returns to scale. Also note that boat crowding causes the average product (AP = f(n)/n) and the marginal product

(MP = f'(n)) to fall (Figure 1). In addition, as more boats (and hence, more fishers) enter the fishery, the average catch per person falls.

In order to approximate the equilibrium output level in this fishery, we can graphically integrate prices into the model. Assuming that the price per kg of fish is p and the marginal cost, MC, per boat is constant at level c, we can complete the model and derive the equilibrium. The total revenue generated from this fishery is TR(n) = pf(n) = py; total costs are simply TC(n) = cn (Figure 2). Average revenue is the value of catch per boat and is given by the equation AR(n) = pf(n)/n. Extrapolating information presented in Figure 1, we can derive the marginal revenue (the additional revenue generated by the introduction of one more boat), MR(n) and marginal cost, MC (Figure 2).

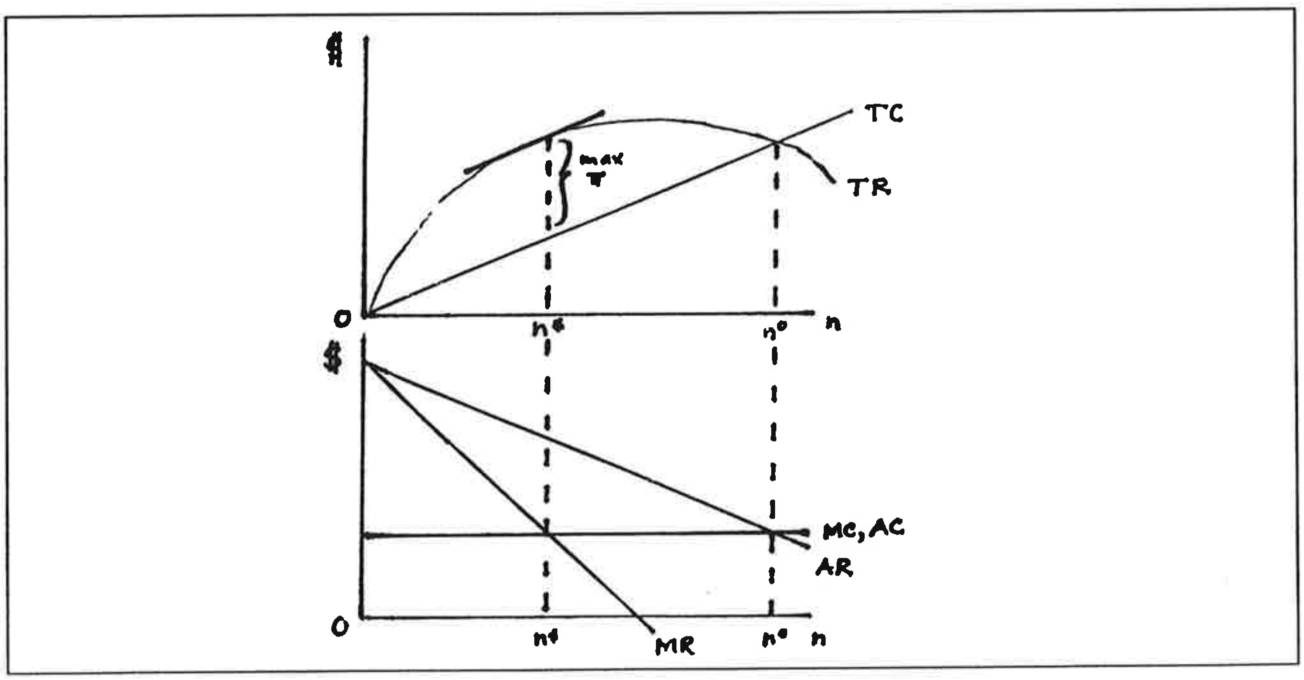

Figure 2. The open access equilibrium, n^o, rests at the point where average revenue is equal to average cost (AR(n) = AC). Private ownership results in fewer boats and an equilibrium point, n^*, where marginal revenue equals marginal cost.

The open access equilibrium point, n^o, can be derived mathematically: Since entry will continue until an individual fisher can cover his or her own costs,

$$A(n)/n = B(n) \geq 0$$

Therefore, fishers will extract fish until total revenue minus total costs are zero

$$n^o: \quad \Pi(n) = \quad TR(n) - TC(n) \quad = 0$$

$$\Pi(n)/n = \quad TR(n)/n - TC(n)/n \quad = 0$$

$$\pi(n) = \quad AR(n) - AC \quad = 0$$

$$= \quad pf(n) - c \quad = 0$$

$$\mathbf{AR = AC} \text{ at } n^o$$

The open-access equilibrium will rest at the point where average revenue equals average cost. In other words, individual fishers will enter the fishery as long as they cover their entrance costs. Essentially, a tragedy of the commons will occur when the catch rate from the equilibrium number of boats, n^o, with free access is greater than the rate at which a fish stock regenerates itself (Rettig 1995). Eventually, the fish stock will fall to a level beyond which it can regenerate itself (Radon *et al.* 1997). In simple terms, the lack of property rights creates externalities that lead to congestion and overfishing. Effective assignment of property rights would enable the extraction of the surplus resource rent and provide incentives to manage the resource more effectively (Ostrom 1990, Garvie 1999, Rettig 1995).

First Best Outcome: Private Ownership

In this second illustrated case, property rights have been assigned to one private owner. The owner is driven by a profit motive and seeks to maximize the difference between total revenue and total cost. Mathematically, it is:

$$\max = A(n) = py - cn \qquad = pf(n) - cn$$

$$= TR(n) - TC$$

The first order condition of the maximization problem is

$$n^*: \quad pf'(n) - c = 0$$
$$MR - MC = 0$$
$$\mathbf{MR = MC} \text{ at } n^*$$

The condition "marginal revenue equals marginal cost" is the definitive solution to the single ownership profit maximization problem (Clark 1985, Garvie 1999). This is noted graphically in Figure 2 as n^*. In this case, the resource is privately owned and the equilibrium fishing level (i.e., number of boats) varies considerably from the open-access scenario. Much less fishing effort is expended in the second case ($n^o > n^*$). This is because if private fishers overfish to boost immediate income, they do so at the expense of future income (Radon *et al.*1997). If a private owner reduces fishing effort to conserve the resource, they capture the future benefit. Likewise, they would have every incentive to invest in maintaining their fishery (Rettig 1995).

On the other hand, in an open access fishery, each additional entrant reduces the available resource rent (shaded area in Figure 2). Eventually, the resource rent is completely dissipated and the level of effort, n^o, is reached. In the open-access fishery, overfishing occurs because fishers cannot stop others from catching fish that they would otherwise leave in the sea. Sooner or later overfishing causes depletion of the marine resource far below the intention of any one fisher (Rettig 1995). The lack of ownership creates fisheries that are overused and abused (Radon, *et al.* 1997).

However, private ownership is not a feasible strategy in fisheries such as Jamaican fishing beaches. Therefore we must examine alternate, plausible solutions since open access marine environments historically result in over exploitation (Clark 1985, Hardin 1968, NRCA 1999). A leading academic noted that, "[l]eft to themselves, fishermen will go on fishing until the contents of the net are worth less than the cost of putting the net in the sea" (Jackson-Miller 1998). There is no blanket solution to lay over Jamaica's reefs. In other nations, many traditional strategies tried, but failed to address the economic aspects of the fisheries problem in a sustainable manner.

Management Strategies: Attempts to Close Open-Access

There is no consensus of opinion among economists with regards to management strategies for open access fisheries. Some prefer quantity based policies as a way to attain fishing effort n^* and others believe the answer lies in an incentive-based solution. In theory, with perfect information (a highly unrealistic assumption), it doesn't matter whether policies are price related (e.g., taxes) or quantity control measures (e.g., quotas), they should have equivalent effects (Clark 1985). However management strategies must be realistic. Therefore, Conrad notes two common interests that should transect all policies (1995). He states that policies should be able to withstand changes to the resource or the environment, and that they should remain effective over a long period of time (Conrad 1995). As well, policies should preserve biological integrity, internalize costs to fishers and be sustainable, least cost solutions (Copes 1986).

Closed seasons are one strategy to restrict access to fisheries. They were traditionally adopted to protect a fish stock during a critical stage in its life cycle (McGinn 1998). The overall aim of closed seasons is reduce the effectiveness of fishing effort and to maintain a maximum sustainable yield of the species in question. Moratoria have been used to manage crustaceans in Jamaica, but have met limited success because of the lack of consistent enforcement (NRCA 1999).

Another management device used to protect fish stocks is gear restrictions. Along with closed seasons, they attempt to protect juvenile fish from being harvested. They change fishers' incentives by increasing the cost of harvest to reduce fishing effort (McGinn 1998). For example, some countries have established a minimum mesh size for traps and seines in the hope that younger fish will escape harvest (Jackson-Miller 1997). Gear restrictions, in combination with other management strategies often lead to technological innovation (Rettig 1995). They are also meant to serve as a deterrent to overfishing, but are notoriously hard to enforce and for the most part ineffective without a strong regulating body (Rettig 1995).

Limited access theory argues that if the ocean were under some degree of local control, then fishers would have more of an incentive to preserve their share of the resource (McGinn 1998). Limited entry strategies attempt to limit the number of fishers in the region to reduce the total catch. Hopefully, those with rights to fish would get involved in stewardship and locally based-community management (McGinn 1998). If central governments are willing to relinquish control and communities have the resources and incentives to manage fisheries, this can be a sustainable management strategy as witnessed in the Philippines and Turkey (McGinn 1998).

Monetary measures are used in fishery management to create "equity". Current literature espouses that paying landing taxes on fish ensures that the fishers who reap the greatest value from the fishery pay the largest taxes (Retrig1995). They are commonly used, but according to Rettig, they rarely achieve efficiency goals (1995). As well, taxes are generally inflexible and cannot readily adjust to changing fish stocks.

The final method of inducing a certain level of fishing effort or number of fishers is to establish property rights. These are low cost and have historical success according to Rettig (1995). Property rights are allocated in one of three ways; they are available as long as participants obey the rules; only to qualified individuals; or, they are available in limited numbers to bidders or at auction (Rettig 1995). Territorial use rights aim to control parts of the water column and use a co-operative group to set goals at the local level. Instead of allocating fishing regions, quota allocations aim to allocate a share of the total allowable catch (TAC) to users. Individual transferable quotas (ITQ) are the last method under scrutiny. By definition, they are based on an annual quota or total allowable catch (TAC). Biological concerns for the fish stock are embedded in the TAC. An ITQ solution allocates shares of the TAC to individual participants. To increase flexibility, the quotas are transferable. (For further elaboration, refer to Section IV). In conclusion, the depletion of fish stocks is the result of, in economic terms, non-priced overharvesting (Radon, *et al.* 1997). Open access fisheries are no longer a practical option. The obvious solution is to create the missing market to eliminate the externality. This requires that property rights are well defined, enforceable and that a competitive market for permits exists (Anderson 1995, Ostrom 1990).

IV. Possible Solutions: New Zealand's Individual Transferable Quotas

This section explores one of the six fishery management strategies outlined above. Individual transferable quotas (ITQs) are a quantity-based instrument used to regulate total harvest (Rettig 1995). In 1983, the New Zealand government introduced their management proposal (including ITQs) aimed at preventing the "Tragedy of the Commons" (Macgillivray 1990). The primary purpose of an ITQ program is to provide an incentive to manage capital (i.e., reduce or control overcapitalization) in commercial fisheries, and to improve the overall economic efficiency of the fishing industry (Radon, *et al.* 1997). ITQs provide an alternative to open-access fisheries and are one method of reducing fishing effort in an attempt to capture some resource rent and achieve the equilibrium n^*. Section IV presents an ITQ equilibrium model, a brief history of the success of ITQs in New Zealand, and concludes with the general advantages and disadvantages of ITQs as a fishery management tool.

Individual Transferable Quotas: A Model

ITQs essentially mean that each boat owner within a limited entry fishery is endowed with a certificate entitling them to harvest up to a specific fraction of the allowable catch per year (Macgillivray 1990). The onus is on fishers to decide when, where and how to fish their quota limit. We can think of an ITQ as a right to produce a unit of effort, or as in Section III's analysis, the right to send out a boat. Assume again a fishery with homogeneous boats and a fixed land area. Under open-access the fishery will achieve the equilibrium point n^{o} (Figure 3). When the government decides to adopt ITQs to decrease the number of boats at sea, it will sell permits on the open market. Each quota allows the firm (or fisher) to capture a set amount of fish from the sea. This, if a fishery wants to harvest a unit of fish, it must buy the labour, capital and a permit that will allow it to harvest. In this case, the government sells only the rights to n' number of boats. Therefore, the rent per unit of effort (i.e., boat) and the amount fishers will be willing to pay for ITQs will be p' (Figure 3). In essence, price is equated to marginal cost (MC) and user cost to induce the optimal harvest level of n'. (Parts of model from Anderson 1995 and Garvie 1999).

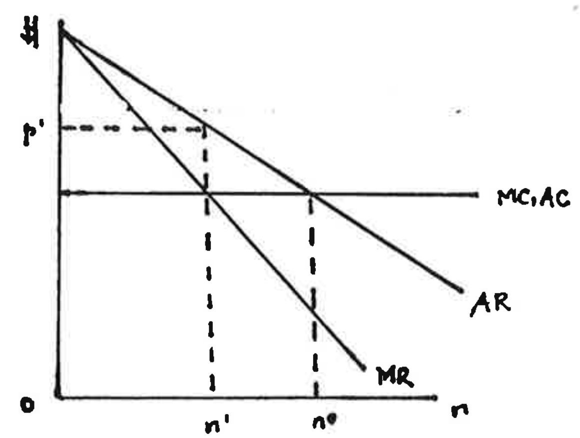

Figure 3. The open-access equilibrium, n^{o}, and the equilibrium reached under ITQ management, n'. (Note that $n' = n^{*}$)

The number of boats under an ITQ regime, n', is equivalent to n^*, the equilibrium under the first best outcome, private ownership. The equilibria differ markedly from the open access equilibrium, n^o. This is because of a change in incentives. Decision-making styles vary in the three cases. In an open access fishery, each individual fisher enters until his or her entry costs are covered (AR = AC). With private ownership, the sole decision maker maximizes total profit (MR = MC). And with an ITQ system, quota holders equate price to marginal cost and user cost (Anderson 1995).

Quota Prices

Quota prices emerge to reflect the current market prices of fish and the cost of fishing (Anderson 1995). Anderson notes that the price for acquisition of an ITQ reflects three things: 1) individual expectations about future prices, 2) harvest costs and 3) stock size and efficacy of fishery management (1995). Opportunity costs arise because quotas can be bought and sold; by adjusting the TAC, fishery managers are able to induce the price per quota to be set equal to the user cost (Macgillivray 1990).

Incentives

ITQs change the incentive structure under which fisheries are used and managed. As mentioned in previous sections, overfishing is now universally recognized as the result of fishers not having exclusive rights in their fisheries. To reiterate, the effects are twofold: open-access rules create an incentive for excessive effort, and the lack of ownership (and externality) quality of the resource is, in itself, the root cause of depletion of fish stocks (Copes 1986, Clark 1985, Ostrom 1990, Rettig 1995). Under the ITQ system, fishers and companies receive a specific allocation of fish per year. The quota is the property of a fisherman or a company who may keep it or sell it as they choose (Macgillivray 1990, Copes 1986). The theory behind this model is that if the fishers own the resource, they will take better care to protect it (Copes 1986).

Total Allowable Catch (TAC)

Another essential component of the model is the Total Allowable Catch (TAC). In an attempt to reduce fish harvest, regulatory agencies set a limit to the amount of fish that may be taken from the fishery in any one year (Macgillivray 1990, Rettig 1995, McGinn 1998). If the fishery were simply closed once the TAC was caught, fishermen would race against each other to get as large a share of the TAC as they could (as in open-access fisheries). To prevent this race, the TAC is allocated as individual catch quotas to fishers and fishing firms (Macgillivray 1990, Radon *et al.* 1997). The individual catch quota gives individual fishers and firms the right to a specified part of the TAC.

ITQs: Lessons from New Zealand

New Zealand is home to the fifth largest fishing zone in the world. With a fishing zone of 1.3 million square nautical miles, New Zealanders harvest fish from oceans fifteen times the country's landmass (Macgillivray 1990). However, the domain is not entirely productive because it is extremely deep. New Zealand produces about 0.5% of the global fish catch and just over 10,000 people are employed in the industry (Anderson 1995). Before the advent of ITQs, the system resembled an open-access fishery (as described in Section III). Thus, the externality created by an open-access solution was the underlying cause for over-exploitation (World Bank 1992).

History of ITQs in New Zealand

Individual transferable permits (ITQs) were first suggested as a fisheries management strategy in the mid-1970s. Individual Transferable Quotas (ITQ) were proposed for New Zealand fisheries in 1983 and finally introduced in 1986 (Macgillivray 1990). Before the advent of ITQs, a variety of input controls were employed; closed seasons, gear restrictions and fishing boat limitations were used to conserve fish stocks (Copes 1986). New Zealand's government had three main objectives while implementing ITQs; firstly, to achieve the optimal number and configuration of fishers, fishing gear and vessels to minimize the aggregate real cost of any given catch. Secondly, the government wishes to achieve a level of catch that maximizes the benefit to the nation while ensuring a sustainable fishery. Finally, they want to achieve their goals at lowest cost (from Macgillivray 1990).

Presently, in New Zealand, more than 90 per cent of total landings are managed by the Quota Management System (QMS). This means that 600, 000 of the 700,000 tonnes of landed fish are regulated under ITQs (Radon, *et al.* 1997). The where, when and how of fishing are left unregulated, only the amount collected is enforced. In New Zealand, the initial allocation of fish (and thus permits) was based on catch history; fishers were awarded them free of charge, and authorized fixed tonnage collection in specific areas (Copes 1986). The initial TACs were based on one of two methods of estimation: they were equated to landings in the most recent years for which information was available (Macgillivray 1990, Copes 1986), or they were calculated from a survey of biomass multiplied by a stock productivity value (Radon, *et al.* 1997).

Success of ITQs in New Zealand

The ITQ strategy is now a comprehensive scheme covering some 26 species including ground fish, pelagic species, and sedentary species (Radon, *et al.* 1997). There is general agreement that the management plan is working well overall. The value of fish production has increased from

US$290 million in 1984 to US$550 million in 1991 (Anderson 1995). New Zealand's fishery has moved from a "small domestic inshore industry" (Macgillivray 1990) to a huge export industry. They now export 80% of the harvest to Japan, Australia and the US. Another apparent example of the economic success is a fifty-fold increase in exports from 1970 and 1992, only ten years after the introduction of ITQs (Radon, *et al.* 1997).

However, New Zealand's system is not perfect; there was not full consultation with the Maori (Memon and Cullen 1992). The contention is that the 1840 Treaty of Waitangi, negotiated in 1840 between English and Maori tribal leaders, established exclusive Maori rights over fisheries. Today roughly nine percent of the New Zealand population are Maori; much different from the ratio of 70 Maori to one European at the signing of the Treaty (Memon and Cullen 1992). The native rights debate is ongoing in New Zealand. As well, the costs of administering and monitoring the system have proven greater than expected. Industry is now pushing for reforms that will ensure administration and monitoring at least cost (Radon *et al.* 1997). One major consideration is the biological implications of ITQs; however, these are not yet affirmatively determined since fish stocks take more than 15 years to regenerate.

The huge economic success of ITQs in New Zealand give rise to general questions about the efficacy of ITQs; some advantage of the system and disadvantages of ITQs follow:

Advantages and Benefits of ITQs

ITQ programs are intended to create a more stable and profitable market-based system for commercial fishing. Thus, market, safety, and social benefits are anticipated from controlling overcapitalization of fisheries by establishing property rights in the form of ITQs.

Ease of transfer

The ability to transfer permits means added flexibility; fishers are able to combine their efforts, rent, sell or lease their permits or hire someone to fish on their behalf. In New Zealand, ITQs can be sold to any person regardless of occupation (Macgillivray 1990). Quotas may be banked, and therefore, in a legal sense, they are rights to harvest (Anderson 1995). In New Zealand, there is a 20% limit on the percentage share any one participant can control. This is a deliberate effort to restrict hoarding of quotas by a monopolist (Radon, *et al.* 1997). Also, under an ITQ scheme, a quota is made tradable to avoid the locking in of quota owners, and the exclusion of non-quota owners. Trade allows fishers and firms to enter and exit the fishery freely by buying or selling quotas (Macgillivray 1990). As mentioned above, a quota has a value directly measured in its market price. Basically, the quotas, given the element of transferability reduce government intervention and create a matching of effort to available resources. This allows industries to develop while at the same time maximizing return to the nation through resource rents and increasing New Zealand's profitability base in international export markets

Individual Choice

Fishers are able to control their own costs because only the total catch is regulated. Therefore, fishers are able to determine when and where to fish throughout the season (Anderson 1995). ITQs shift a large part of the responsibility for fisheries management onto quota owners. This is as it should be. Quota owners are in the best position to know the health of their fishery and it is they who bear the costs of bad decisions or capture the gains of good management choices (Anderson 1995). The ITQ system allows fishers to enter and exit the industry when they see clear advantages.

Efficiency

Since permits are bought and sold on the market, it encourages inefficient users to leave by selling their rights to someone else (McGinn 1998). Market forces can determine the allocation of quotas in an ITQ management scheme. In theory, this can lead to economic efficiency and a low cost solution (Anderson 1995). ITQs are beneficial in enabling individuals to leave the industry without incurring a loss. The 20% limit on individual ownership in New Zealand allows for healthy competition. On the other hand, in countries other than New Zealand, an ITQ system can allow companies to buy control over the fishery. This merely rewards the group of people responsible for unsustainable fishing practices in the first place (Radon, *et al.* 1997). At the same time, ITQs can force smaller fishers out of the industry.

In addition to the clear advantages of transferability and individual choice, fleet efficiency can improve under an ITQ program. Fewer fishermen are able to catch the same amount of product that a larger fleet landed under open access (Macgillivray 1990). If need be, fishing vessel owners can liquidate their stake in the fishery by selling quota shares and taking boats off the water or moving to other fisheries (McGinn 1998). As well, fishermen often find it uneconomic to operate with small quantities of quota shares, and they may opt to sell their ITQs (McGinn 1998). This can be seen as return for their investment in the fishery, as opposed to receiving no return if they go out of business in an open-access fishery (McGinn 1998). Regardless of the approach taken, it is important to establish an equitable ownership allocation process.

Another advantage of the ITQ system is the low cost of enforcement. Since the management regime in New Zealand is no longer command and control (CAC), auditory measures have replaced the need for wardens and regulators on boats at sea (Macgillivray 1990). Now, procedures are followed and fish are tracked from landing to processing to consumption. Paper checks, weigh-ins at the docks and tracking sheets mark the flow of fish from the fishers to the retail outlets (Macgillivray 1990). This method of control also means that governments are easily able to change the quantity of permits on the market (Anderson1995). The central governing authority has the power to buy back quotas to reduce the TAC, or simply restrict supply to induce a drop in effort (Anderson 1995). Technological innovation is another added incentive. For example, a fisher in New Zealand is reported to produce fish oil as a by-product of trash fish (McGinn 1998). ITQs encourage increased responsibility and accountability by quota owners for management of the fishery (Rettig 1995). Along the same lines, fishers will extract the most out of each kg of fish counted towards their quota limit (Anderson 1995, Macgillivray 1990).

Disadvantages and Costs of ITQs

Along with the many, clear advantages of ITQs, there are a few drawbacks to this style of management. Lack of complete knowledge is a disadvantage in all natural resource management strategies. Policy makers do not have full information about industry specifics (Anderson 1995, Rettig 1995). In other words, the information necessary for fishery management is dispersed amongst many fishers. Everyday information that fishers, divers and others have about the state of the fishery is essential for sound management regimes. Since external managers are not privy to the day-to-day facts, errors in goal setting can occur.

Overestimation of the fish stock could lead to an inflated TAC

One such error is the overestimation of fish stocks. Some tout that fish stocks are constantly on the move, hard to see and are therefore difficult to analyze. Consultants are able to use this to their advantage and overestimate the size of a fish population and in turn, the TAC (Feldman 1998). Of course, one cannot exclude the lobbyists from an analysis of the fisheries industry; professional lobbyists are hired to influence ministers and legislation. Conservationists and recreational fishermen, although they outnumber the commercial fishers in New Zealand, simply do not have the financial resources and the organization to balance the process. So, often times, lobbying efforts result in a high, ecologically unstable TAC (Feldman 1998).

Squeezing out of small fishermen

Most small, marginal fishers have sold their quotas to the large fishing companies (Feldman 1998). This distribution equity issue continues to be a problem despite the fact that the ITQ system has apparently in general protected fish stocks. Small fishers are disadvantaged by the fact that banks will not consider quotas as collateral for lending (Radon, *et al.* 1997). A small-scale fisher without a large allotment of quotas or a large bank account finds it hard to acquire more quotas when the TAC is reduced. Small-scale fishers cannot borrow against other assets as larger companies are able to do. This makes it easier for large firms to buy many of the tradable quotas and try to monopolize the industry (Feldman 1998, Anderson 1995).

Mandated Waste and "High Grading"

When fishermen can only harvest a limited quantity of fish, they want to maximize their profits, so they discard fish that are too small, too big or are damaged (Weber 1993, McGinn 1998). The result is that more fish are killed than are harvested. In some New Zealand fisheries, waste (or trash fish) makes up more than half of the landed catch (Feldman 1998). Different recovery rates can also lead to dumping of fish; inefficient collection and harvesting methods can lead to excess collection of fish necessitating more dumping. Also, the discarding of low valued fish in order to increase profits is an issue ("high grading") (McGinn 1998). ITQ programs have been criticized for increasing the incentive for fishermen to file false catch reports and to "high-grade" their catch. This will continue as long as only retained catch is reported rather than total catch (Radon, *et al.* 1997) Under individual quotas, fishers seek to deliver the best quality of fish to maximize the price received. This situation is less problematic in open-access fisheries, because the race to fish usually provides a substantial incentive for fishermen to deliver as much as they can catch, as quickly as possible (Anderson 1995).

As well, ITQs could discourage new entrants into a fishery because of the additional capital investment required to purchase or lease quota shares (Macgillivray 1990). In addition, ITQ programs may become expensive for regulating agencies. If the TAC is set incorrectly, it may be a burden on the government to buy the quotas back. This is the reason why New Zealand's system was changed to a proportional system (Radon, *et al.* 1997). The cost of a change in effort is then borne by the permit holders (Rettig 1995). Finally, the equity of current approaches to the initial allocation of ITQ shares has been questioned. Some argue that the allocations created wealth and windfall profits and excluded processors and crew (McGinn 1998).

There are definite economic success stories, as well as stories of small fishers who have lost their livelihoods in New Zealand as a result of the ITQ system. The advantages and disadvantages of an ITQ system in New Zealand weigh heavily, but the drastic economic growth leads one to believe that they are on the right track. Let us now analyze the feasibility of a similar situation in Jamaica.

V. Transferable Quotas in a Jamaican Context

Improved management of small-scale fisheries is a mandate of a variety of international organizations (i.e., World Bank, WRI) as well as the Jamaican National Resource Conservation Authority (NRCA). Critical research is still necessary in order to formulate an applicable and sustainable solution for Jamaica's reefs. The lack of credible and conclusive studies on Caribbean fishery management leaves one baffled with the lack of progressive environmental planning. As mentioned above, one management alternative is the New Zealand-style individual transferable quotas (ITQs). What follows is a thorough examination of the advantages and disadvantages of the ITQ system in the Jamaican context.

Similarities and Differences between Jamaica and New Zealand's fishing industries

Jamaica and New Zealand are two small islands originally settled by the British. Although they are both independent, sovereign nations, they are still members of the Commonwealth (Crystal 1997). The population base is nearly the same; Jamaica is home to 2.5 million people and New Zealand hosts about 3 million citizens (Crystal 1997). Despite these general similarities, their economic environments and fishing industries are completely different. New Zealand is the world's shining model of successful ITQ implementation: Jamaica has yet to see a fortuitous fishing management strategy. Now, more than ever, as a result of drastic coral reef degradation, there is a need for a cost-effective and sustainable solution in Jamaica. Before applying a blanket solution to what seems to be a similar problem (i.e., over exploitation of marine resources because of an open access situation), one must examine specific components of both industries and economies. What follows is a discussion of considerations needed before a solution can be applied in a Jamaican context.

Scale of industry

New Zealand is characterized by overexploited resources (now under management plans) with relatively large catches taken by domestic large-scale fishing units. Jamaica is characterized by reef fisheries in which resources are overexploited by small-scale local fishing communities. Jamaica's industry is a cottage industry; only a small percentage of conchs and shrimp are exported (NRCA 1998). Fishers harvest for solely domestic consumption and markets are supplemented by foreign imports (NRCA 1999). New Zealand imports some seafood as well, but 93 percent of the seafood catch is exported (Feldman 1998). To further compare nations, only 8.1 percent of Jamaica's gross domestic product (GDP) comes from agriculture, forestry and fisheries; in New Zealand, agriculture and fishery revenue accounts for over 40 percent of the national income (United Nations 1999). In some ways, having small-scale fisheries is thought to be more efficient since the labour investment is high and the capital intensity is low. Therefore, fishers are less dependent upon imported goods and supplies. Yet, they are vulnerable to supply-shocks (World Bank 1991). In any case, even though the industry is small, effective management strategies must be implemented.

Juxtaposing New Zealand and Jamaican industries shows stark incongruencies. Large-scale, organized fishing trawlers are sent into the 200 mile zone around the Pacific island and they harvest, per year, more than 600 times what Jamaica does (NRCA 1999, Clark 1994). However, before the introduction of the 200 mile exclusive economic zone (EEZ) in 1978, New Zealand was also essentially an inshore, domestic fishery (Macgillivray 1990). Now however, their fishing market is export-oriented with about 80% of the output destined for Japan, the US and Australia (Clark 1994). To date, the fishing industry is developing export markets in Europe and Asia to avoid over-exposure to the Japanese market (Radon, *et al.* 1997). It's a shame that despite considerable off-shore resources, the fishing industry is still wholly underdeveloped in Jamaica;

fish is currently imported to meet domestic demand. Individual transferable quotas are a possible solution to close the gap, but Jamaica's small scale industry would not be able to create a viable market for permits. Small, marginal fishers would not compete for permits and pay for them. As the situation stands now, fishers refuse to buy licenses and continue to fish because of the lack of monitoring and enforcement.

Method of harvesting

Another important facet of this case is *how* the fish are collected. In Jamaica, small, one-man wooden canoes are used as the "fleets" for offshore fishing. Some mid-size trawlers venture into deeper waters, but they are mostly foreign poachers from the US, Mexico and Cuba (NRCA 1999). The technology used is far from sophisticated; mesh bait traps are left overnight to catch crustaceans and large snapper. Modern equipment such as motorization and SCUBA gear are recent additions to the industry (NRCA 1998). Faster boats and more sophisticated technology can only mean an increased fish harvest. Also of concern is net sizes: fishpots normally have holes of 1" or 1.25" which trap juvenile fish (NRCA 1998). This is largely unregulated and fishers can extract juvenile, immature fish without being reprimanded in Jamaica. The ecological consequences are severe; as young fish are harvested, it leaves little else in the oceans to regenerate stocks.

New Zealand, on the other hand relies upon large fishing trawlers, staffed by multiple employees (Radon, *et al.* 1997, Clark 1994, Rettig 1995). Competition for employment on the limited number of vessels is fierce (Clark 1994), therefore education and prior training are considered. Coming back to the Jamaican industry, it is easy to see that skill sets, except for expertise, do not matter quite as much as in New Zealand. It is also clear that New Zealand trawlers have more incentives to buy quotas than small Jamaican fishers. New Zealand's infrastructure allows for monitoring, evaluating and distribution of the ITQ system and boat owners are aware of this. However, the cost of resources required in Jamaica to assign quotas to small fishers and monitor their efficacy are much higher than any possible benefits accrued. Therefore, ITQs are not completely congruent with small, undeveloped fisheries as in Jamaica.

Biological Considerations

Biological considerations need to be taken into serious account when developing a management plan for Jamaica. There is a need to identify the species being lost, set priorities and make a management strategy. Jamaica needs to delineate between species management, population preservation and ecosystem conservation. New Zealand successfully focused on managing 32 species (Clark 1994). They developed 32 TACs and allocated quotas as described in Section IV. Unless Jamaica identifies clear biological goals, ITQs will be hard to implement.

Lack of Management Expertise in Jamaica

From the policy makers down, there needs to be a strong internal interest in preserving the reefs in order to effect a change. Jamaica's track record with fishery management (Section I and II) shows a lack of enforcement of outdated laws and a deficiency in central planning. The fisheries have been left in the hands of self-serving, individual fishers, and the damage is strikingly evident. Reefs are smothering and fish stocks are rapidly falling. There are a lack of well developed market institutions in place to create a market based solution. Market based solutions require strong central support, clear initiatives and a market for permits (Rettig 1995). The Jamaican fishing industry is too small to handle an ITQ solution as in New Zealand.

With the current Jamaican political scene, it may be hard to garner support for any new fishery regime. Some of the PNP (People's National Party) government priorities are debt payment, crime and reducing inflation.; coral reefs are not a *top* priority, not even within the NRCA. The difference is that New Zealand's initiatives had the support of key industry leaders (Clark 1994). Before the implementation of ITQs in 1983, the merits were discussed with industry and political leaders (Macgillivray 1990). The involvement of government and industry leaders helped to bolster public support of ITQs. In Jamaica, there are no large, dominating fishing industry leaders; instead the government would have to reach out to many small villages to spread the word about effective change. As well, New Zealand's final management strategy is fairly centralized, but fishers hold most decision making power (United Nation 1999). Again, there were few problems with administrative feasibility and political acceptance of ITQs in New Zealand (Clark 1994). In Jamaica, enforcement and regulation would be a large problem because there are so many small players. Since management capabilities are limited, the underlying open access fishery problem will resurface (as in Section III).

Socio-economic factors

Political feasibility is one of many indicators for the effective implementation of ITQs; other gauges include the employment context and social and cultural history of the proposed locale. In this case, we will explore Jamaica's socio-economic standpoint and evaluate the relevance of ITQs. Economic literature shows that ITQs traditionally lead to a smaller fishing workforce, and potentially increase unemployment (Anderson 1995). Some displaced fishers are unable to find employment elsewhere, and some economists argue that those who do find jobs may earn less than they did fishing (Feldman 1998). In Jamaica, fishers have little education and limited opportunities for alternative livelihoods (NRCA 1998, Section II). This is partly reflected in Jamaica's adult literacy rate of 85 percent (United Nations 1999). In comparison, New Zealand boasts an astounding 99 percent adult literacy rate (United Nations 1999).

The loss of fishery jobs after the implementation of ITQs in New Zealand is not entirely evident in the statistics. The initial loss of fishing jobs was offset by an increase of 3000 processing industry jobs in the early 1990s (Clark 1994). In 1995, the overall unemployment rate in New Zealand was 6.9 percent (fishery statistics were unavailable at print time) (United Nations 1999). Jamaicans face much bleaker employment prospects; the unemployment rate was 16 percent in 1996 and estimates show that at least 8 percent of adults are underemployed (Tradeport 1999). Implementing ITQs in Jamaica might encourage large firms or international fishers to vie for quotas and small, marginal fishers would be displaced. From an efficiency standpoint, this is a desirable outcome; however, with lack of education and limited alternative income sources, unemployed fishers wold place a large burden on society. The lack of infrastructure in Jamaica and history of small scale industry render it almost impossible for ITQs to work.

In addition, the social equity and cultural heritage of the two nations need to be carefully thought about. The Maori issue discussed above is one example of where cultural sensitivities need to be integrated into a strategy. In New Zealand, the Treaty of Waitangi guaranteed Maori ownership of New Zealand fisheries that could only be transferred through willingly selling the rights. According to the Treaty, the government's only function should be to protect tribal fishing rights. In today's politically climate, however, the government is unwilling to grant these rights. A long legal battle has left the Maori with only ten percent ownership of their original fishery rights (Memon and Cullen 1992). In Jamaica, a conclusive stakeholder analysis must be completed. Different user groups have varying interests and these need to be brought together. In the final analysis, policy makers must take into account the uniquely laid-back Jamaican work ethic and the developing nation status that the island holds. Local participants need to be involved for any management strategy to be effective. Since independence in 1962 from Britain, the Jamaican economy has diversified from being primarily an agrarian and mining (bauxite/alumina) economy to a more service-oriented (especially tourism) economy (Tradeport 1999). Thus, the tourist industry and tourists must be accounted for; tourism is the largest revenue earner on the island.

Although ITQs are transferable, efficient and allow for personal choice in New Zealand, they are not a cost-effective, realistic strategy for Jamaica. The current Jamaican infrastructure cannot simply integrate an ITQ management regime. The costs of enforcing it will exceed any small success it may bring the island's oceans. ITQs will not change fishers' incentives because the regulating bodies do not have the financial or human resources to monitor and enforce fishing grounds. The desired result of ITQs is to create a market for permits; in Jamaica this is an unrealistic goal since it is a small, cottage industry. Societal constructs are also mitigating factors in management decisions. Now that we have discarded ITQs as a solution for Jamaica, we need to discuss what the salient features of a successful, alternative strategy are.

Alternative Strategies

As noted in section III, the major cause of environmental degradation of coral reefs is the condition of free and open access to the resources. Although access can be closed by a variety of techniques, the technique most relevant to the Jamaican situation of many small scale fishers is not ITQs. Another consideration is that management of fisheries can be expensive at the national level; monitoring, control and surveillance of a national limit scheme would be hard to implement with the current Jamaican infrastructure (NRCA 1999). Computer systems and man power for monitoring and enforcement would be hard to finance. Also, national policies may not be locally relevant because of the slight regional variations in stock and it may be hard for administrators to relinquish authority.

Some have suggested that exclusive rights to certain parts of the sea seems like a more feasible solution (World Bank 1991, Rettig 1995). With territorial use right in fisheries, user groups are able to determine how they wish to allocate the resources within the area. In addition, there is an incentive and the means for self-regulation if the fishers are so inclined (World Bank 1991). As in any other management strategy, penalties for non-compliance need to be established, rigorously enforced and severe enough to encourage compliance. In Jamaica, policy makers would have to work closely with numerous communities and create small co-operatives. Scientists already have a prototype of this management strategy in Negril, a western- Jamaican tourist town (NCRCS 1999).

A local community group calling themselves "The Negril Coral Reef Preservation Society" work with youth to train "beach rangers," as well they are educating fishers about mesh size and the potential environmental ramifications of overharvesting. They are also working closely with tourist operators to realign incentives (NCRPS 1999). This is labour, not capital, intensive solution and it has trickle down effects. Instead of pushing against fishers, policies are created along *with* them as part of the decision-making process.

Community based management met acclaimed success in the Philippines and parts of Turkey (Clark 1994, World Bank 1991). In Jamaica, a start towards this lofty goal is to establish co-operatives like the NCRPS to increase education and begin to transfer authority to fishers. By focusing on providing supplemental income; credit, lending and diversifying income sources. Jamaica will not just manage fisheries and restrict people, but effectively manage people. Various sources suggest that we must look at short and long term solutions and account for the biological integrity of the resource (World Bank 1991, Macgillivray 1990).

At the expense of sounding like a waffling scientist, I will reiterate that all that is know for sure in the Jamaican context is that more research is needed. Techniques for management of large scale fisheries are well known and documented. Although they are difficult to implement, there is growing experience with ITQs all over the world and they are a slight consideration. However, a quota-based system will generally not be applicable in a small-scale fishery such as Jamaica.

VI. Conclusion

Jamaica's reefs and coastal waters are edging towards complete annihilation. The Natural Resource Conservation Authority predicts complete choking of the coral reefs within twenty years if immediate action is not taken (NRCA 1999). Many factors contribute to the degradation of coastal waters. The lingering effects of hurricanes in 1980 and 1988, sewage run-off, industrial waste and cruise ship traffic are all contributors. Yet, the single largest threat is overfishing.

Jamaica needs a sustainable, applicable and cost-effective management strategy. Since there is no perfect fisheries management tool to apply to all of the world's fisheries, we must strive for a local solution that most closely matches Jamaica's stated management objectives. In doing so, we have examined the feasibility of one successful strategy in the New Zealand context, the individual transferable quota (ITQ). The analysis evaluated the strategy based upon its ability to be adopted, implemented and enforced, as well as its inherent weaknesses.

The ITQ solution did not seem feasible for Jamaica's fisheries because of the lack of mature infrastructure and the inability to create incentives in a such small Caribbean fishery. ITQs do however address the common problem of over-exploitation of open-access resources in New Zealand and Jamaica.

Many things about Jamaica's natural resources are uncertain, but one certainty is that there is a dire need for more direct research. To successfully manage Jamaica's coral reefs, more research needs to be directed in the following areas: alternative income sources, alternative capital opportunities, how to strengthen communities and ensure equitable income distribution.

Hopefully, one day, communities, fishers, business people and government officials will come together, stand at the edge of a bay and marvel at the successful regeneration of Jamaica's coastal waters. When that day will be is yet to be determined, but I hope that I will be there, smiling up at a flying fish leaping over the blue waves.

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