Extending the Bajo de Sico, Puerto Rico, Seasonal Closure: An Examination of Small-scale Fishermen's Perceptions of Possible Socio-economic Impacts on Fishing Practices, Families, and Community

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ABSTRACT—Despite considerable conservation efforts, many reef fish fisheries around the world continue to be in peril. Many are vulnerable to overexploitation because they have predictable and highly aggregated spawning events. In U.S. Caribbean waters, fishery managers are increasingly interested in advancing the use of closed areas as a means for rebuilding reef fisheries, protecting coral reef habitats, and furthering ecosystem-based management while maintaining the sustained participation of local fishing communities. This study details small-scale fishermen's views on the Caribbean Fishery Management Council's proposals to lengthen the current Bajo de Sico seasonal closure off the west coast of Puerto Rico to afford additional protection to snapper-grouper spawning populations and associated coral reef habitats.

Drawing on snowball sampling techniques, we interviewed 65 small-scale fishermen who regularly operate in the Bajo de Sico area. Snowball sampling is a useful method to sample difficult-to-find populations. Our analysis revealed that the majority of the respondents opposed a longer seasonal closure in the Bajo de Sico area, believing that the existing 3-month closure afforded ample protection to reef fish spawning aggregations and that their gear did not impact deep-water corals in the area. Whilst fishermen's opposition to additional regulations was anticipated, the magnitude of the socio-economic consequences described was unexpected. Fishermen estimated that a year round closure would cause their gross household income to fall between 10% and 80%, with an average drop of 48%. Our findings suggest that policy analysts and decision-makers should strive to better understand the cumulative impacts of regulations given the magnitude of the reported socio-economic impacts; and, more importantly, they should strive to enhance the existing mechanisms by which fishermen can contribute their knowledge and perspectives into the management process.

Introduction

Worldwide reef fish fisheries are in peril. Newton et al. (2007), who studied reef fish fisheries in 49 island states, found that current landings exceed sustainable levels by 64%. Similarly, work by Sadovy de Mitcheson et al. (2008) suggests that 79% of the documented spawning aggregations around the world are undergoing substantial declines. In U.S. Caribbean waters, commercially valuable reef fish species such as Nassau grouper, *Epinephelus striatus*, and goliath grouper, *E. itajara*, remain overexploited despite commercial harvest bans since the early 1990's (Appeldoorn et al., 1992; Sadovy and Eklund, 1999). Reef fish species, especially groupers, are particularly vulnerable to overexploitation due to their life history characteristics, which include slow growth, delayed reproduction, sedentary behavior, and highly aggregated spawning events (Sadovy and Eklund, 1999).

Though reef fish fisheries only account for a small fraction of global landings (2–5%), they are an important source of sustenance, income, and employment for many coastal communities (Pauly et al., 2003; Sadovy, 2005; Newton et al., 2007). Hence, policy makers are interested in management tools that rebuild depleted fish stocks, protect the structure, function, and resilience of coral ecosystems, and maintain the well-being of coastal communities (Newton et al., 2007).

In the Commonwealth of Puerto Rico, local fishery management agencies have favored the use of seasonal closures to conserve and protect reef fish populations, particularly those that exhibit predictable and highly aggregated spawning behaviors. While seasonal closures provide for the sustained economic participation of small-scale fishermen, they afford limited conservation benefits. Hence, fishery managers are increasingly interested in novel management tools such as marine protected areas that provide greater protection for reef fish stocks. Unfortunately, despite a growing literature examining the biological performance of marine protected areas, there is a paucity of socio-economic evaluations (NRC, 2001; Christie et al., 2002; Christie, 2004).

This study investigates small-scale fishermen's views on the Caribbean Fishery Management Council's (CFMC) proposals to lengthen the current Bajo de Sico seasonal closure to afford additional protection to snapper-grouper spawning populations and associated coral reef habitats. The intent of this study is to provide decision-makers with a first-hand account of the reported socio-economic impacts of the various proposals as perceived by small-scale fishermen.

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Management Background

Following the collapse of Nassau grouper stocks in the late 1970's, Puerto Rican fishermen began targeting smaller, less frequently marketed groupers such as red hind, *E. guttatus*; and coney, *Cephalopholis fulva*, which then became the dominant commercial grouper species (CFMC, 1985; Matos-Caraballo, 1997; 2002). In 1996, concern about the declining condition of the red hind population resulted in a regulatory amendment to the Shallow Water Reef Fish Fishery Management Plan of Puerto Rico and the U.S. Virgin Islands (CFMC, 1996). This regulatory amendment established three seasonally closed areas: Bajo de Sico, Tourmaline, and Abrir la Sierra. These three areas were closed to all fishing activities (excluding coastal pelagic and highly migratory species) from 1 December through the last day of February (CFMC, 1996; Aguilar-Perera et al., 2006). The Bajo de Sico area was selected because several commercially important reef fish species, including red hind, form spawning aggregations in this site. After the adoption of the 1996 regulatory amendment, the Commonwealth of Puerto Rico implemented compatible regulations.

The Bajo de Sico area encompasses both Federal waters and Puerto Rico territorial waters with a 60:40 split, respectively (Fig. 1). The 3,119-hectare site contains a submerged seamount with an extensive deep terrace reef formation. The reef lies across the entire northwest section of the seamount at depths between 45 and 90 m over a relatively flat, gently sloping, hard bottom terrace (García-Sais et al., 2008). Deep hermatypic coral formations[1] are found on the reef top and the upper slopes of the seamount (García-Sais et al., 2008). Rhodolith reefs occur along the gently sloping terraces at depths below 40 m (García-Sais et al., 2008). The reef top and walls serve as important residential habitats for commercially valuable grouper and snapper assemblages, including Nassau; yellowfin, *Mycteroperca venenosa;* yellowmouth, *M. interstitialis*; and red hind groupers and yellowtail, *Ocyurus chrysurus;* schoolmaster, *Lutjanus apodus*; dog, *L. jocu*; and cubera, *L. cyanopterus,* snappers. In addition, the seamount serves as a foraging area for large pelagic fishes such as wahoo, *Acanthocibium solanderi*; dolphin-fish, *Coryphaena hippurus*; tunas, *Thunnus spp.*; and marlins, *Makaira nigricans*. The reef system at Bajo de Sico also serves as an important foraging and residential habitat for the endangered hawksbill turtle, *Eretmochelys imbricata*.

In 2005, the Comprehensive Amendment to the Fishery Management Plans (FMP) of the U.S. Caribbean to Address Required Provisions of the Magnuson-Stevens Fishery Conservation and Management Act prohibited the use of bottom tending gears (i.e. traps, bottom longlines, gillnets, and trammel nets) in various seasonally closed areas, including Bajo de Sico, to enhance protection of essential fish habitats (CFMC, 2005). In addition, the CFMC prohibited the harvest of several snapper-grouper species during their spawning season. Current regulations ban the harvest of red, *E. morio*; black, *M. bonaci*; tiger, *E. fuscoguttatus;* yellowfin; and yellowedge, *E. flavolimbatus*; groupers between 1 February and 30 April and prohibit the harvest of black, *L. griseus*; blackfin, *L. bucanella*; vermilion, *Rhomboplites aurorubens;* and silk, *L. vivanu,* snappers between 1 October and 31 December. There is also a lane, *L. synagris,,* and mutton, *L. analis*, snapper closure that extends from 1 April though 30 June and a red hind harvest prohibition for the west coast of Puerto Rico that runs from 1 December through the last day of February.

Currently, the CFMC is contemplating management proposals that would afford additional protection to snapper-grouper spawning populations and local coral reef habitats in the Bajo de Sico area. The first management alternative would maintain the current closure for all fishing between 1 December and the last day of February. The second management option would extend the closure from 3 to 6 months. This extended closure would prohibit all fishing activities (excluding coastal pelagic and highly migratory species) for 6 months and retain the current year round gear restrictions.

Two potential 6-month closures have been suggested: one extending from 1 October until 30 March, and the other one extending from 1 December until 30 May. The third management proposal would close the area year round to provide full protection for spawning aggregations of large snappers and groupers as well as coral reef habitats. The closure would prohibit all fishing activities (excluding coastal pelagic and highly migratory species) for 12 months and retain current, year round gear restrictions.

Methodology

In the fall of 2008, 65 informal, voluntary conversations were held with small-scale fishermen from the municipalities of Aguadilla, Aguada, Rincón, Añasco, Mayaguez, and Cabo Rojo (Fig. 1). Snowball sampling techniques were used to identity those small-scale fishermen who regularly fished in the Bajo de Sico area since these would be most likely impacted by the proposed management alternatives. These in-person, open-ended exchanges elicited information on their opinions and beliefs about the performance of the Bajo de Sico closure following the 2005 bottom tending gear ban, and their views on the existing management proposals which could potentially lengthen the Bajo de Sico seasonal closure.

In snowball sampling, interviewees suggest other potential subjects from their social network (Bernard, 2002). This technique is frequently used to sample difficult-to-find populations. It was selected because Puerto Rican fishing trip reports do not collect information on the area fished. In addition, in recent years many fishermen had stopped reporting (or misreported) their landings following the implementation

[1]Hermatypic corals contain and depend upon zooxanthellae (algae) for nutrients.

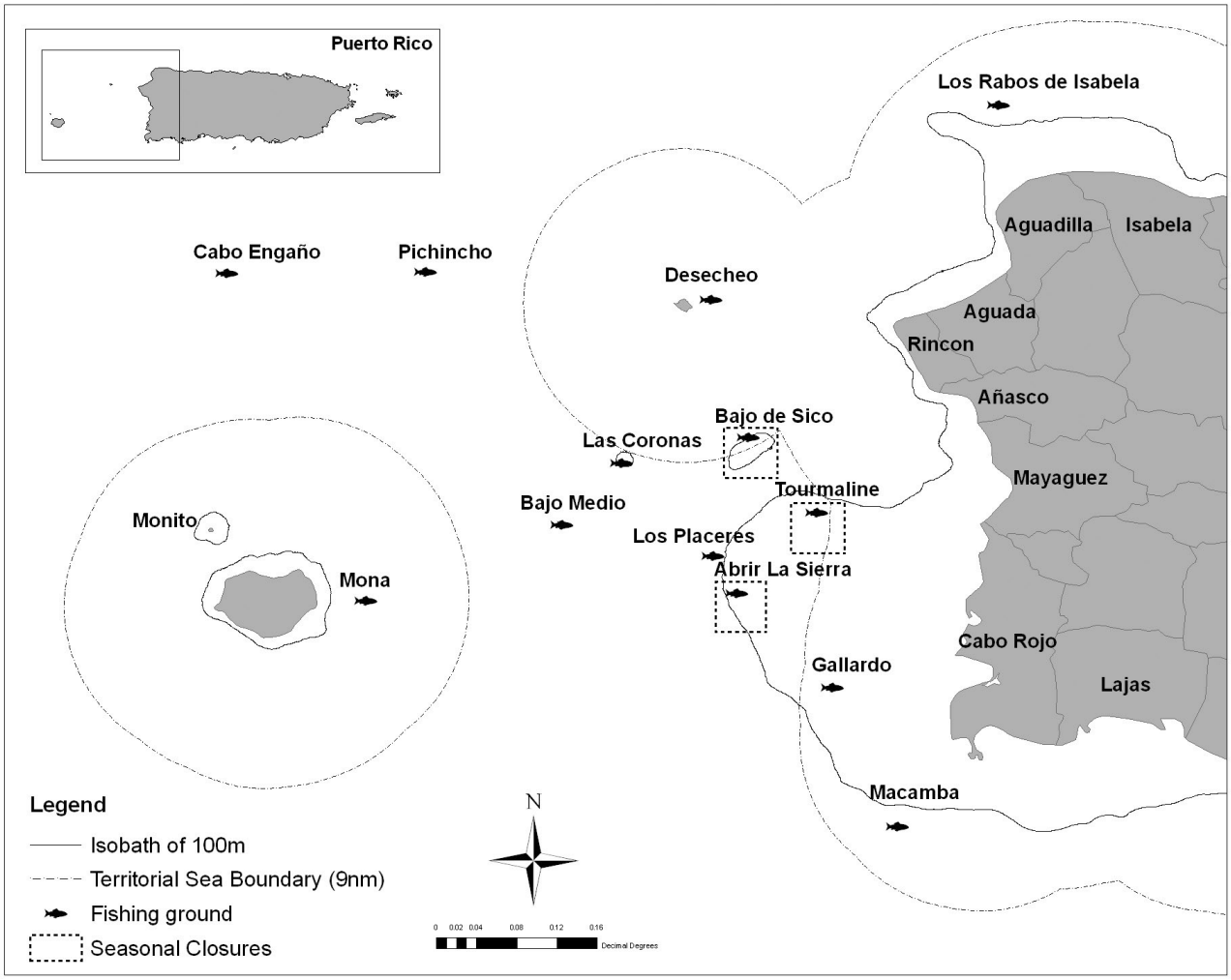

Figure 1.—Bajo de Sico area and surrounding fishing grounds.

of Puerto Rican Regulation No. 6768, which was adopted on 11 March 2004 (Matos-Caraballo[2,3]).

This regulation mandated that fishermen operating in Puerto Rican waters (0–9 nmi) had to report their landings and fishing related income. These new reporting requirements generated considerable angst since fishermen could potentially be forced to pay income taxes, and could lose public assistance and health care benefits. Under current regulations, full-time fishermen have a 90% tax exemption over their fishing related income whereas part-time fishermen have no tax exemptions.[4] Additionally, this regulation mandated the purchase of permits and licenses for several species such as queen conch, *Strombus gigas*; spiny lobster, *Panulirus argus*; land crab, *Cardisoma guanhumi*; and sirajo gobies, *Sicydium plumiere*. Fishermen were also upset about the increased minimum sizes of several commercially important species, especially silk snapper (Matos-Caraballo[2]). Local fisheries personnel from Puerto Rico's Department of Natural and Environmental Resources (PRDNER) and presidents of the local fish cooperatives ("villas pesqueras" as they are locally known) served as liaisons to local fishermen.

Results and Discussion

This section describes the main demographic characteristics of the fishermen interviewed and discusses fishermen's perceptions regarding the

[2]Matos-Caraballo, D. 2008. Lessons learned from the Puerto Rico's commercial fishery, 1988–2008. Paper submitted to Gulf and Caribbean Fisheries Institute, Gosier, Guadeloupe, French West Indies, Nov. 2008.

[3]Daniel Matos-Caraballo, of Puerto Rico's Program of Fisheries Statistics in Mayaguez, stated that the relatively high sample size likely accounted for most of the active fishermen who operated in the Bajo de Sico area. Personal commun., 28 Oct. 2008.

[4]Existing regulations require that full-time fishermen demonstrate that they derived 50% or more of their total income from fishing whereas part-time fishermen must show that they derive a minimum of 20% of their income from fishing.

socio-economic performance of the current seasonal closure and anticipated socio-economic impacts of the proposed alternatives. Throughout our conversations, fishermen stated that they were indifferent about the timing of the two 6-month proposals since they would have the same adverse impacts on their livelihoods. Hence, when discussing the impacts of the various alternatives, we simply discuss the 6-month and year-round alternatives.

Demographic Profile of the Respondents

The majority of the respondents were male captains whose fishing experience ranged from 1 to 53 years. About 50% of the respondents had less than 24 years of fishing experience. Fifty-two percent of the interviewees were full-time commercial fishermen, 40% were part-time commercial fishermen, 5% were charter operators and 3% were subsistence fishermen (Table 1).

Fishermen reported using a variety of gears such as hook and line, bottom line, and longline to target snapper-grouper species, including silk snappers, red hind, and queen snappers, *Etelis oculatus*.[5] Sixty percent of them stated that they fished with only one crew. About half of the fishermen reported taking 1–3 trips per week (Table 1). Many of them land their catch at local fish cooperatives (Fig. 2). Household sizes were relatively small, averaging 2–3 dependents per household. Income derived from fishing was found to play an important role in the household's economy. About 65% of the respondents derived more than 50% of their household income from fishing activities in 2008 (Table 1).

Figure 2.—Traditional fishing boats lying in front of a fish cooperative ("villa pesquera"), Aguadilla, Puerto Rico, October 2008.

Fishermen's Views on the Seasonal Closure

Impacts on Fishermen's Ability to Support Themselves and Their Household

Prior to discussing fishermen's perceptions about the anticipated economic and social impacts of the proposed management alternatives, it is useful to review earlier work to provide a backdrop to our findings. According to Griffith et al. (2007), who conducted a socio-economic assessment of the Bajo de Sico seasonal closure prior to the 2005 bottom tending gear ban, only 32% of the respondents believed that the seasonal closure adversely impacted their livelihoods. Their study also found that 51% of the fishermen did not believe that the seasonal closure negatively impacted their ability to support themselves or their families. Our study revealed that the 2005 bottom tending gear ban made it harder for fishermen to earn a living from fishing. Fishermen explained that the increasing number of burdensome regulations, higher fuel costs, and declining catches had forced them to become more reliant on non-fishing occupations.

When we asked about the likely impacts of the various management proposals on their ability to support themselves and their family, fishermen stated that the 6-month closure would likely reduce their gross household incomes between 10% and 80% with an average loss of 43%. In the case of the year round closure, they estimated that their gross household income would fall between 10% and 80%, with an average drop of 48%. When we parsed these results by income derived from fishing (0–49% vs. 50–100%), we obtained analogous results underscoring the importance of the area to local fishermen. We found that, on average, the more fishing dependent fishermen (i.e. 50–100% grouping) would lose 44% of their gross household income if the Bajo de Sico closure was extended for 6 months. This same group also reported that their gross household

Table 1.—Demographic characteristics of respondents.

Demographic characteristics	Frequency	Percentage
Type of fishermen		
Captain	55	84.6
Crew	10	15.4
Number of weekly trips		
0–3	29	47.5
>3	32	52.5
Status		
Full-time	34	52.3
Part-time	26	40.0
Charter	3	4.6
Subsistence	2	3.1
Number of dependents		
None	8	12.3
1	5	7.7
2	10	15.4
3	18	27.7
>3	24	36.9
Percentage of household income derived from fishing		
0–20	6	9.5
20–50	16	25.4
51–75	11	17.5
>75	30	47.6

[5]Hook and line and bottom line refer to vertical line gears. Generally, bottom lines have electric reels and a larger number of hooks than the regular hook and line gear.

income would drop by 49% if there was a year round closure. In contrast, the less fishing dependent group (i.e. 0–49%) stated that they would lose 41% of their gross household income if the seasonal closure was lengthen by an additional 3 months, and by 45% if there was a year round closure.

Despite the anticipated sharp declines in income, most fishermen pledged to continue fishing, revealing a high degree of fidelity to their profession. They reported that they would attempt to compensate any loss of income by seeking part-time work outside the fishery. Most fishermen noted that non-fishing jobs were either not available or hard to secure, especially since many of them were already working part-time jobs.[6]

Bureau of Labor Statistics (2009), preliminary and not seasonally adjusted, unemployment statistics for 2008 validate their contention. These statistics show relatively high unemployment rates throughout the region (e.g. Aguadilla, 12%; Aguada, 12.8%; Rincón, 12.7%; Añasco, 12.2%; Mayaguez, 12.7%; and Cabo Rojo, 9.4%).[7] Construction was often cited as the most likely employment alternative. Few fishermen believed that the fishing sector could absorb additional workers.

We also inquired how the proposed alternatives may impact their annual round. Most fishermen remarked that they would not switch gears nor target different species if the seasonal closure was extended. They mentioned that they would continue using bottom line, longline, and hook and line gears to catch snappers and groupers. Fishermen's overall unwillingness to switch to other fishing gears and species was fairly consistent across municipalities. They remarked that it would be very onerous to switch to other fishing gears given the expense of purchasing new equipment and permits. Nevertheless, most fishermen suggested that lengthening the closed season would impact their fishing practices in a number of ways.

First, they would lose access to one of the most productive snapper-grouper and baitfish grounds in the area. They observed that foregoing access to this area by an additional 3 months would cause their average landings per trip to fall between 20% and 90%, with an average decline of 48%. In contrast, a year round closure would cause their average landings per trip to drop between 25% and 100%, with an average decline of 57%. When we disaggregated these results by income derived from fishing (0–49% vs. 50–100%), we obtained comparable results highlighting the importance of the area. We found that, on average, the more fishing dependent group (i.e. 50–100%) would have their landings per trip drop by 49% if the Bajo de Sico closure was extended for 6 months. This same group also reported that their landings per trip would fall by 55% if there was a year round closure. On the other hand, the less fishing dependent group (i.e. 0–49%) stated that they would lose 47% of their landings per trip if the seasonal closure was lengthen by an additional 3 months, and lose 57% if there was a year round closure.

During our exchanges, fishermen stressed that the Bajo de Sico area has a de facto 6-month closure since September and October are known months of poor weather[8] and strong currents, and there are overlapping seasonal bans for the harvest of various snappers, including silk snapper (Table 2). Fishermen who regularly operate in the Bajo de Sico area reported that silk snapper was their most important target species, followed by red hind and queen snapper. In addition, fishermen complained about the overlapping seasonal snapper-grouper harvesting bans, which last 9 months (Table 2). Fishermen claimed that the cumulative impacts of extending the seasonal closure by an additional 3 months (i.e. 6-month closure) coupled with the 2 months of traditional bad weather and rough seas, and the rolling snapper-grouper harvest bans, essentially felt "like a year round closure."[9]

Additionally, fishermen noted that extending the seasonal closure would increase travel time and associated fuel costs to other fishing grounds since they would have to circumnavigate the Bajo de Sico area and other seasonally closed areas to maintain their landing levels. Fishermen stated that if additional restrictions were placed on the Bajo de Sico area, then Abrir la Sierra and Tourmaline would become their preferred alternative fishing grounds. Other important fishing grounds mentioned were Pichincho, Corona del Sur, Desecheo, Mona, Gallardo, Macamba, Bajo Medio, Los Placeres, Cabo Engaño, and Los Rabos de Isabela (Fig. 1).

While current fishing regulations do not preclude fishermen from transiting through closed areas, most fishermen steer clear from them when fish are on board to avoid being stopped and possibly fined by the U.S. Coast Guard. The simultaneous closure of the Bajo de Sico, Tourmaline, and Abrir la Sierra areas and probability of being detected and fined by the U.S. Coast Guard provide fishermen with a strong incentive to avoid these areas altogether (Fig. 1). Hence, extended closures would force fishermen to travel farther in search for new aggregations—making fishing trips longer, less profitable, and more dangerous.

Fishermen noted that as they take longer trips and travel farther out, their operating costs would increase too. When asked about the likely increases in their operating costs, fishermen stated that operating costs per trip (mainly fuel) would increase between 5% and 175%. Fishermen offered iden-

[6]Puerto Rican fishermen regularly engage in numerous temporary, low-skilled employment opportunities (i.e. odd jobs or "chiripas" as they are known locally) to supplement their household incomes (Griffith and Valdés-Pizzini, 2002; Perez, 2005; Griffith et al., 2007; Agar et al., 2008).

[7]Bureau of Labor Statistics. 2009. Unemployment Rate Statistics for the Commonwealth of Puerto Rico. Online at http://data.bls.gov/cgi-bin/dsrv, accessed 24 March 2009.

[8]Matos-Caraballo (2007) notes that fishing tends to slow down at the height of the Puerto Rican hurricane season, which encompasses the months of August and September. For example, hurricane Debbie and tropical storm Jeannie hit Puerto Rico on 22 August 2000 and 15 September 2004, respectively (Matos-Caraballo, 2007).

[9]In reality, the proposed 3-month extension (i.e. 6-month closure) essentially translates into a 10-month closure due to the overlapping snapper-grouper seasonal harvest bans (Table 2).

Table 2.—Cumulative impacts of snapper-grouper seasonal harvest bans and bad weather season on management proposals.

Current regulations and management proposals	January	February	March	April	May	June	July	August	September	October	November	December
Red hind fishery closure (W. Puerto Rico only)	r[1]	r										r
Black, blackfin, vermilion, and silk snapper fishery closure										s[2]	s	s
Red, black, tiger, yellowfin, and yellowedge grouper fishery closure		g[3]	g	g								
Lane and mutton snapper fishery closure				m[4]	m	m						
Traditional months of poor weather									w[5]	w		
Proposed Management Alternative # 1: (Status quo)	Closed	Closed	g	m, g	m	m			w	s, w	s	Closed
Proposed Management Alternative # 2 (a): 6-month closure (1 Oct–30 March)	Closed	Closed	Closed	m, g	m	m			w	Closed	Closed	Closed
Proposed Management Alternative # 2 (b): 6-month closure (1 Dec–30 May)	Closed	Closed	Closed	Closed	Closed	m			w	s, w	s	Closed
Proposed Management Alternative # 3: 12-month closure	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed	Closed

[1] The "r" refers to the months of the harvest ban of red hind.
[2] The "s" refers to the months of the harvest ban of black, blackfin, vermilion, and silk snappers.
[3] The "g" refers to the months of the harvest ban of red, black, tiger, yellowfin, or yellowedge groupers.
[4] The "m" refers to the months of the harvest ban of lane and mutton snapper.
[5] The "w" refers to the 2 months of traditional rough seas.

tical ranges for both the 6-month and the year round alternatives. On average, fishermen estimated that their operating costs would increase by 57% if the current 3-month closure was extended to 6 months and by 59% if the area was closed year round. The median percentage increase in operating costs for both the 6-month and year round closure proposals was around 50%. Fishermen also stated that lenthening the seasonal closure would curtail their access to baitfish. If the closed season was extended, then they would likely forgo this baitfish rich area, given its distance from the shore, requiring them to either fish for it elsewhere or purchase it. Both options would increase their operating costs.

When we queried them about the likely drop in gross revenues per trip, fishermen offered ranges between 20% and 80% for the 6-month closure and between 25% and 100% for the year round closure. On average, fishermen estimated that the 6-month closure would reduce their gross revenues by 47%, whereas the year-round closure would decrease their gross revenues by 55%. The relatively small difference in the estimates for the 6 and 12-month closures is consistent with the belief that the 6-month closures would feel "like a year round closure," as previously discussed. While most fishermen were concerned about the dire economic impacts of lengthening the closure, few said that they would exit the fishery since "fishing was all they knew." Many fishermen stated that the potential lengthening of the Bajo de Sico closure would force them to become even more reliant on part-time work as fishing regulations become more stringent.

Fishermen also complained that most marine reserves (e.g. Mona, Monito, and Desecheo) are being sited on the west coast of Puerto Rico. They observed that the increasing number of area and season closures creates confusion as to when, where, and which species they can harvest. Fishermen felt that extending the Bajo de Sico closure would be counterproductive since most of the fleet would shift its effort to the Abrir la Sierra and Tourmaline areas, which they believe show signs of overexploitation. Tourmaline has always been subject to higher exploitation levels due to its proximity to coastal communities and favorable habitat for red hind spawning activity (Marshak, 2007).

Despite fishermen's aversion to proposed management alternatives, they acknowledged that the existing Bajo de Sico seasonal closure had been effective in protecting spawning aggregations, particularly those for red hind and silk snapper. These results are consistent with Griffith et al.'s (2007) study, which found that 83% of their respondents believed that the Bajo de Sico effectively protected spawning aggregations. However, most of our respondents were quick to point out that the existing 3-month closure offered ample protection to the spawning aggregations.

When we inquired whether the closure had enhanced fish abundance within and outside the area, most fishermen disagreed. These findings contradict Griffith et al.'s (2007) results. Their study reported that 79% of the respondents believed that the Bajo de Sico seasonal closure increased the abundance of a variety of snapper-grouper species, including silk, queen, blackfin, lane, yellowtail, and mutton snappers and red hind. Griffith et al. (2007) also reported that 81% of the respondents stated having perceived greater fish abundance outside the seasonal closure, especially red hind and queen and silk snappers.

While we are uncertain as to the reasons for the discrepancy between our findings and Griffith's results, Marshak (2007) suggests that a spillover of female red hind into unprotected areas, and the discovery of previously

unknown concentrations of red hind may have contributed to a transient increase in catch per unit of effort (CPUE) following the implementation of the seasonal closure. However, over time, the CPUE declined in response to lower recruitment and higher fishing effort. This recent CPUE decline may explain fishermen's changing outlook on the closure's performance.

We also inquired about the need to protect corals in this area. Most fishermen questioned the need to protect them since they are found deep in the water column. Fishermen believed that their gears could not impact these deepwater corals. Fishermen also stated that they distrusted the CFMC because they feared that once the Bajo de Sico area is closed, Abrir la Sierra and Tourmaline areas would follow next, forcing them to take longer fishing trips and/or search for part-time jobs outside the fishery. An extended closure would force them to spend more time at sea to land the same amount of catch, which would weaken family cohesion, as they would have less time to spend with family and friends.

Socio-economic Impacts on Local Fishing Communities

Fishermen believed that the 2005 ban on bottom tending gears had adversely impacted their local communities, particularly fishing families, fish cooperatives, hotels, restaurants, and the support service firms. However, they struggled in articulating the severity of the impact. Griffith et al. (2007) report similar findings. Their study showed that 57% of the respondents felt that the Bajo de Sico seasonal closure created social or economic hardships for local communities.

When we probed about the likely community impacts of the CFMC's proposals, there was widespread consensus that they would severely impact local businesses that are directly and indirectly associated with the fishing industry. However, they had trouble quantifying the incremental impact of the various proposals. They observed that placing additional restrictions on the Bajo de Sico area would impact the entire local harvesting, wholesale, distribution, marketing, retail, and support service chain.

Fishermen stated that extending the closure would increase their operating expenses; however, because of the availability of inexpensive seafood imports, they would have to absorb most of these higher costs. Their inability to pass along these higher costs to the consumer means that the remuneration of both captain and crew would likely decrease since both receive a share of the trip's revenue after deducting operating expenses. Few fishermen stated that the proposed extensions would force them to reduce the number of crew employed since it would be unsafe to run the boat single-handed.

Additionally, fishermen stated that longer closures could potentially weaken kinship relationships.[10] Traditionally, crew members, who receive a share of the boat's income, have provided non-remunerated assistance to the boat owner (e.g. help repairing the vessel and gear) as part of an understood system of obligations (Agar et al., 2008). Since longer closures would reduce the wages available to crew members, they too would be forced to seek additional employment outside the fishery. Thus, crew would have to either reduce or eliminate the time they can dedicate to these non-remunerated activities. Many crew members reported that they were working part-time jobs and for different captains on other boats. These added economic strains could weaken traditional kinship relations and community cohesion, which are based on a set of cultural values of mutual help (Agar et al., 2008).

In addition to lowering crew's income, a longer closure would depress fishing-related expenditures at support businesses such as suppliers of boating and fishing equipment, boat mechanics, ice shops, and fuel stations. Griffith et al. (2007) reported that the commercial sector contributes significantly to local economies through fishing related expenditures. On an island basis, their study found that 71% of vessel construction, 98% of the vessel maintenance, and 94% of the engine maintenance were conducted locally. They also reported that 71% of the fishing gears and 43% of the electronic equipment were purchased locally.

When probed about the likely impacts of longer closures on fish cooperatives, called "villas pesqueras," the majority of the fishermen explained that lower catches would result in fewer employment opportunities, less income, and, more importantly, the potential loss of market share. Fishermen feared that lengthening the closed season would make it harder for them to compete in the marketplace since many restaurants and hotels would be enticed to substitute lower-cost, readily available seafood imports for locally-caught seafood.

Griffith et al. (2007) observed that the number of commercial fishing families has remained stable because they have been able to make a living by providing high quality, fresh fish and shellfish to local seafood markets, restaurants, and hotels. Fishermen often like to state that they "defend themselves with fresh fish (or lobster)" (Griffith et al., 2007). Fishermen believe that their comparative advantage lies in their ability to supply year round fresh seafood since most of the imported seafood is frozen, canned, dried, or otherwise preserved. Table 3 shows the relationship between com-

Table 3.—Annual commercial landings and seafood imports for Puerto Rico.

Year	Reported landings[1] (lbs)	Adjusted landings[2] (lbs)	Imports[3] (lbs)
2000	3,362,722	6,276,077	195,659,105
2001	3,389,010	5,301,956	130,482,152
2002	3,272,812	4,048,506	83,425,022
2003	2,388,761	3,364,452	89,686,776
2004	1,864,680	2,626,310	77,047,313
2005	1,569,035	2,209,908	79,018,305
2006	1,338,924	1,761,742	79,773,368
2007	1,242,002	1,971,432	78,597,926

[1] Cummings, N., and S. Turner, Southeast Fisheries Science Center, NMFS, NOAA. Personal commun.

[2] These figures have been adjusted for nonreporting and misreporting. Cummings, N., and S. Turner, Southeast Fisheries Science Center, NMFS, NOAA. Personal commun.

[3] San Juan, Puerto Rico Custom District (text footnote 11).

[10] According to Griffith et al. (2007) about 50% of the crew is made up of friends and 31% family members, confirming that kinship relationships play an important role in the supply of labor in these small-scale fisheries.

mercial landings and seafood imports for 2000–07. While these figures show that most of the seafood available is imported, readers are cautioned that both domestic consumption and transshipments to other U.S. ports are included in this import statistic.[11] Unfortunately, the government does not break down domestic consumption and transshipment figures. Given that the current population of Puerto Rico is around 4 million people and tourism accounts for another 5 million visitors[12], it is likely that a high (yet unknown) percentage of these seafood imports are transshipped to other ports on the mainland. Griffith et al. (2007) also note that the availability of seafood imports enables small, family-owned restaurants and hotels to cater to tourists when the supply of fresh local seafood is limited.

Last, the issue of user conflicts was raised during our conversations. The likely crowding of inshore and offshore fishing grounds and the concomitant user conflicts were another source of uneasiness. Fishermen stated that the existing Bajo de Sico seasonal closure had already created crowding on other fishing grounds. Thus, extending the seasonal closure would simply reduce the amount of fishable grounds, increase competition in the remaining open areas, and exacerbate crowding. Fishermen also suggested that conflicts with the recreational sector may arise since they object to recreational fishermen selling their catches at lower prices, especially when they do not have a commercial fishing license. Furthermore, they noted that unlike recreational fishermen, commercial fishermen "do need to catch fish in order to make a living."

Conclusion

Balancing the need to rebuild overexploited reef fisheries, protect coral reef habitats, and provide for the sustained participation of local fishing communities is at the core of difficult management decisions. Our rapid socio-economic assessment showed that fishermen believe that the Bajo de Sico seasonal closure has effectively protected spawning aggregations, particularly for red hind and silk snapper. The study also found that fishermen were vehemently opposed to management proposals that would extend the seasonal closure. Most fishermen believed that the existing 3-month closure afforded ample protection to spawning aggregations and questioned the need for longer closures. Fishermen complained about the lack of biological assessments of the performance of the closure.

While fishermen's opposition to further regulations was anticipated, the magnitude of the socio-economic consequences described was unexpected. Fishermen reported that the overlapping seasonal snapper-grouper harvest bans and the 2 months of rough seas effectively transform a 6-month seasonal closure into a 10-month de facto seasonal closure. They also reported that the socio-economic impacts of a year round closure were marginally higher than those of a 6-month closure. Fishermen estimated that a 6-month closure would reduce their average landings per trip between 20% and 90%, with an average decline of 48%, whereas a year round closure would decrease their average landings per trip between 25% and 100%, with an average decline of 57%.

Taken together, our results suggest that policy analysts and decision-makers should strive to better understand the cumulative socio-economic impacts of regulations given the magnitude of the reported incremental effects. More importantly, given the sharp differences of opinion regarding the efficacy and need for additional protection measures, fishery managers should strive to progressively integrate fishermen's knowledge and perspectives into the scientific and management discourse. Greater public involvement and communication, information dissemination and compromise may be required to address fishery agencies' conservation goals and fishermen's concerns.

[11]NMFS. 2009. Import statistics by U.S. Import Custom District. Online at http://www.st.nmfs.noaa.gov/st1/trade/annual_data/TradeDataAnnualDistrictAllProducts.html, accessed 24 March 2009.

[12]CIA. 2009. The World Factbook: Puerto Rico. Online at https://www.cia.gov/library/publications/the-world-factbook/geos/rq.html#People, accessed on 2 April 2009.

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