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Puerto Rican Commercial Fishermen Perceptions of Marine Protective Measures and Management Strategies: Final Report

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Introduction

Notwithstanding considerable fishery conservation and management efforts, many reef fish fisheries around the world continue to decline. Many of these species are vulnerable to overexploitation because they are long-lived, slow growing, late maturing, and have protogynous sexual strategies and predictable and highly aggregated spawning events (Sadovy de Mitcheson and Erisman, 2012; Russell, Luckhurst, and Lindeman, 2012).

In U.S. Caribbean waters, fishery managers are increasingly interested in advancing the use of closed areas and seasons as a means for rebuilding reef fisheries, protecting coral reef habitats, and furthering ecosystem-based management while providing for the sustained participation of local fishing communities (Tonioli and Agar, 2009;). Fishing is an important economic activity, which provides sustenance, income, and employment to many coastal communities.

Despite the growing call to use of marine protected areas and seasonal closures to promote the sustainable use of marine ecosystems, few studies have examined the biological and socioeconomic performance of these management tools (Karras and Agar, 2009; Tonioli and Agar, 2009; Pita *et al*., 2011; Schärer-Umpierre et al, 2014). Evaluation of stakeholders' views can be a valuable policy appraisal tool since it provides unique insight (Pomeroy, 1995). It helps identify the shortcomings, impediments and opportunities of past policy interventions. Opposing perceptions may signal the need to adjust the scale and scope of earlier interventions and/or improve their delivery (Marshall 2007).

The objective of this project was to investigate fishermen's perceptions about the efficacy of seasonal and area closures in the Commonwealth of Puerto Rico (Figure 1). This report shares some of the preliminary findings from this work which suggest that fishermen view seasonal closures and, to a lesser extent, area closures favorably. The paper is structured as follows: Section 2 introduces the methodology employed; Section 3 summarizes the preliminary results from the interviews; and Section 4 offers the main conclusions of this study.

Methods

Perceptions about the efficacy of area and seasonal closures were investigated using in-person surveys that included both open and closed ended questions. We canvassed 150 small-scale fishermen using a stratified random sample. The sampling frame was made up of commercial fishers who reported landings at least once between 2011 and 2013. The sample was stratified by coastal area to capture the range of operations and make the data collection easier and cost-effective to operate (Table 1).

Surveys collected information on demographics, fishing capital and practices, and opinions about the performance of area and seasonal closures in general and for specific fisheries or sites. We asked fishers to appraise the efficacy of area and seasonal closures as general fishery management tools. Respondents were offered ordered choices: very effective, somewhat effective and had no effect. The survey also solicited recommendations to improve their performance.

In addition, we inquired about the efficacy of specific area and seasonal closures to meet various biological objectives such as protect spawning aggregations, increase fish abundance, and restore or maintain habitat quality. Fishers were asked to rate them using a five-point Likert scale from strongly disagree to strongly agree. Finally, we asked the fishers about their initial and present support for the closures, as well as any hardships experienced.

Results

Demographics

Most of the small-scale fishers surveyed were male, seasoned, owner operators who fished year-round (Table 2). On average, respondents were 56 years old (22-89 range) and had about 30 (1-80 range) years of fishing experience. About 89% of the sample fell in the 40 years and over age bracket (Table 3). Seventy percent of the respondents said that they fished on a full-time basis. Part-timers fished for income rather than for consumption (subsistence) purposes.

Households had between 1 and 7 members (including the fisher), averaging three members. Fishermen reported, on average, having lived in the same community for about 46 years. Commercial fishing income was found to be central to household economy. On average, fishing income made up about 66% (10-100% range) of the household income. About 71% percent of the interviewees claimed that fishing income contributed 50% or more to their household income (Table 3).

Fishing capital and practices

The average boat was 20 feet in length (12-50 feet range) outfitted with a single, outboard, gasoline engine (Tables 4 and 5). The average propulsion rate of the engines was 75 horsepower (9.5-450 horsepower range). Hulls were made of fiberglass (77%), wood (14%), or a combination of fiberglass and wood (7%). Fishers estimated that their used vessel and engine(s) were worth close to $15,000 ($500-65,000 range).

Handlines, vertical lines, scuba and fish and lobster traps were among the primary gears fishers used to pursue deep-water snappers and groupers, reef-fishes, lobsters, conchs and coastal migratory species such dolphin and wahoo (Table 6). The majority of their fishing takes place in Commonwealth waters (71%; <9 nautical miles).

Views about the efficacy of area and seasonal closures as a fishery management tool

The study found that most fishers held favorable views about the use of area and seasonal closures to manage fisheries. Figure 2 shows that 75% of fishers interviewed believed that seasonal closures were very or somewhat effective management tool whereas 58% believe that area closures were very or somewhat effective. In contrast, 21% of the respondents believed that seasonal closures had no effect and 17% felt that area closures had no effect. The vast majority of fishers who were irresolute about the efficacy of area closures (primarily responded did not know) lived in the north and south coasts.

When asked to provide recommendations to improve the efficacy of area closures, fishers suggested improving monitoring and enforcement, controlling other sources of fish mortality such pollution and recreational fishermen, conducting research to find optimal siting (e.g., deep areas may yield small conservation benefits), and rotating and/or opening closed areas every five years.

We also solicited recommendations to improve the efficacy of seasonal closures. Among the recommendations offered were increasing policing and enforcement, excluding certain species (e.g., red hind) from seasonal restrictions that spawn year round, and reducing the length (e.g., silk snapper restrictions from three to two months) and overlap of the various closures to minimize economic dislocation, particularly during the Christmas season. Respondents also suggested changing the dates of the closures since some of the species did not spawn during the closure. One fisher explained that, at least in the north, mutton snappers spawn before the start of the season and silk snappers spawn after the season opens. Several fishers also called for more research on the biological impacts of the closures and fisher education.

Views about the efficacy of specific seasonal closures

The survey revealed that fishers believe that seasonal closures play an important role protecting spawning aggregations and, to a lesser degree, augmenting fish biomass (Tables 7 and 8). After dichotomizing fishers' responses into those who believed they were effective protecting spawning aggregations versus those who held a negative or neutral opinion, we observe that fishers' approval rates ranged from 62% for the silk, vermilion, black and blackfin snapper closure to 77% for the queen conch closure. Conversely, disapproval scores ranged from 21% for queen conch and mutton snapper closures to 35% for the silk, vermilion, black and blackfin snapper closure.

When we dichotomize fisher's opinions about the ability to seasonal closures to augment fish abundance we observe considerable variation across seasonal closures. The share of fishers who had favorable views ranged from 50% for yellowfin, black, tiger, red and yellowedge grouper closure to 69% for the mutton snapper closure. In contrast, disapproval ratings ranged from 24% for the mutton snapper closure to 45% for the silk, vermilion, black and blackfin snapper closure.

Table 9 shows that opposition to all the closed seasons studied lessened over time. Noteworthy is that the highest disapproval ratings for protecting spawning aggregations and augmenting fish biomass correspond to the silk, vermilion, black and blackfin snapper closure which is the most economically important fishery under season closures. It is interesting to note that silk, vermilion, black and blackfin snapper closure had one the lowest initial support rates (40%) and continues to have one the lowest support rate (44%). Also, unsurprisingly, 56% of the fishers who fished for these species stated they continue to face hardships (Table 9).

Views about the efficacy of specific area closures

The survey showed that most of the fishers believed that area closures studied played an important role protecting spawning aggregations, augmenting fish biomass within and outside the reserve, and restoring or maintaining the quality of the habitat within the closed area. Table 10 shows that proportion of the sample that strongly agreed or agreed that closed areas helped protect spawning aggregations ranged from 45.5% for the island of Desecheo to 92.8% for Caja de Muertos.

Tables 11 and 12 show that the share of fishers who had a positive view about the ability to of closed areas to increase fish biomass within and outside the area ranged from 50% in the Desecheo to 91% in Canal Luis Peña and from 40% in Bajo de Sico to 86% in Canal Luis Peña, respectively. Similarly, table 13 shows that fishers who strongly agreed or agreed that closed areas restored or maintained habitat quality ranged from 46% in Desecheo to 77% in Canal Luis Peña.

Another significant result is that respondents in all the closed areas reported that hardships lessened (and support levels increased) over time as fishers reorganize their annual round and, in some cases, rely more on non-fishing activities. Nonetheless, fishers who fished in the Bajo de Sico (70%) and Abrir la Sierra (59%) continue to report that they face significant hardships.

Conclusions

Notwithstanding the increasing use of area and seasonal closures to promote the sustainable use of coral reef fisheries, few studies have examined the socio-economic performance of these management strategies. This study fills this gap by describing small-scale fishers' views regarding the biological and socioeconomic performance of these management tools off Puerto Rico.

Knowledge of fishers' views about the performance of management tools can help policy-making since they provide unique insight into strengths, weaknesses and opportunities of these tools. The study found that generally fishermen viewed seasonal and, to a lesser extent, area closures favorably. We found high levels of acceptance towards seasonal closures as a means of protecting spawning aggregations and, to a lesser extent, augmenting fish biomass. We also found that fishers believed that closed areas helped protect spawning

aggregations, increase fish abundance within and outside the area and restore and maintain habitat quality; however, the number of observations available to rate specific area closures was significantly smaller than the sample size for specific closed seasons. Hence, care must applied when drawing inferences about the fishers' perceptions about the performance of selected closed areas.

The study also showed that despite these reported benefits fishermen's support for existing area and seasonal closures has only marginally increased over the years. This marginal change may be reflective of the economic impacts of displacement faced by fishing communities. Fishermen also stated that limited enforcement adversely impacts the efficacy of these management tools by dissipating conservation gains. As global concern over reef fisheries declines challenges us to rethink current management approaches, this research suggests that use of seasonal closures deserves more attention, especially in small-scale data poor setting given the high information and setup costs for other management approaches (e.g., marine protected areas).

Figure 1: Map of the Commonwealth of Puerto Rico.

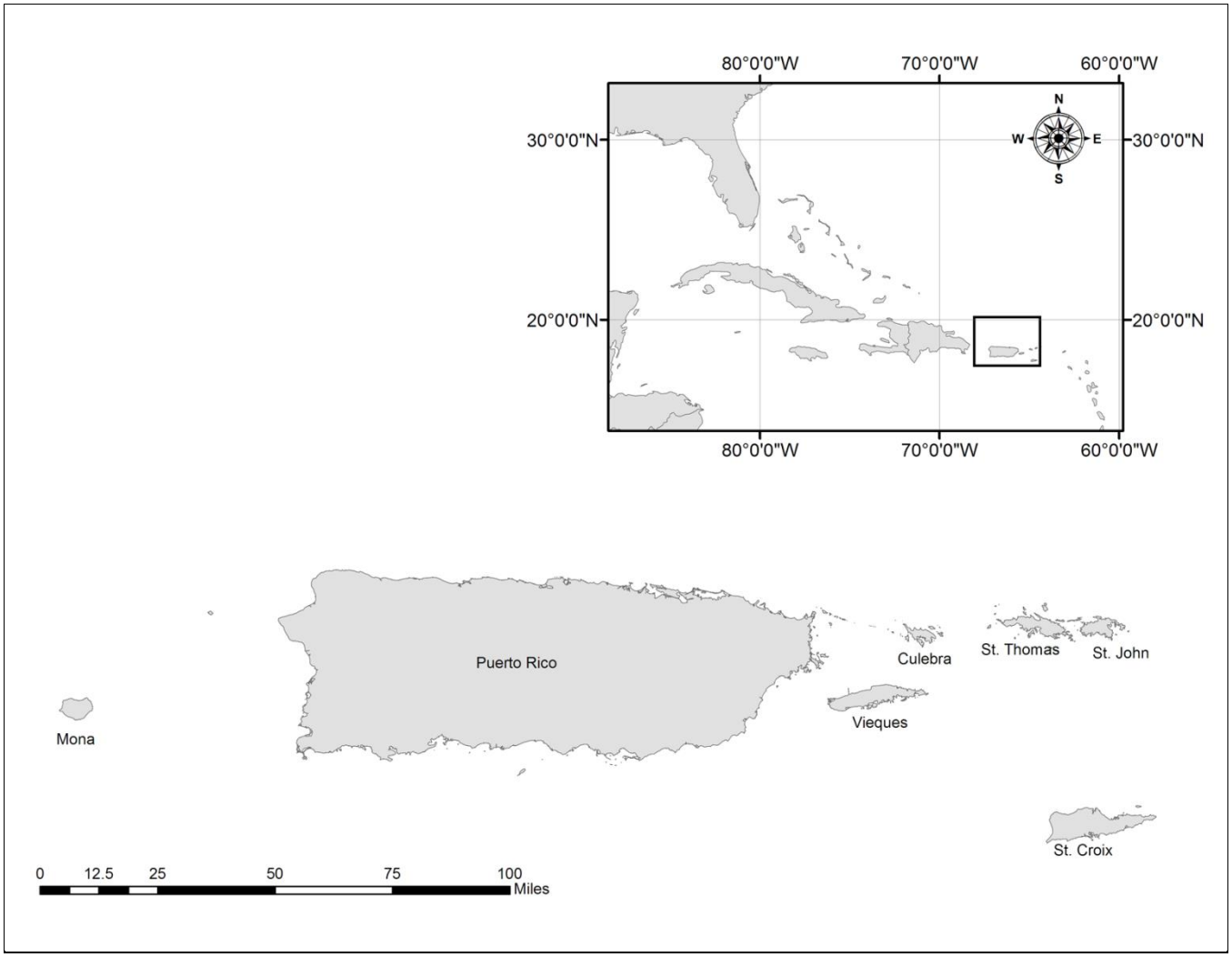
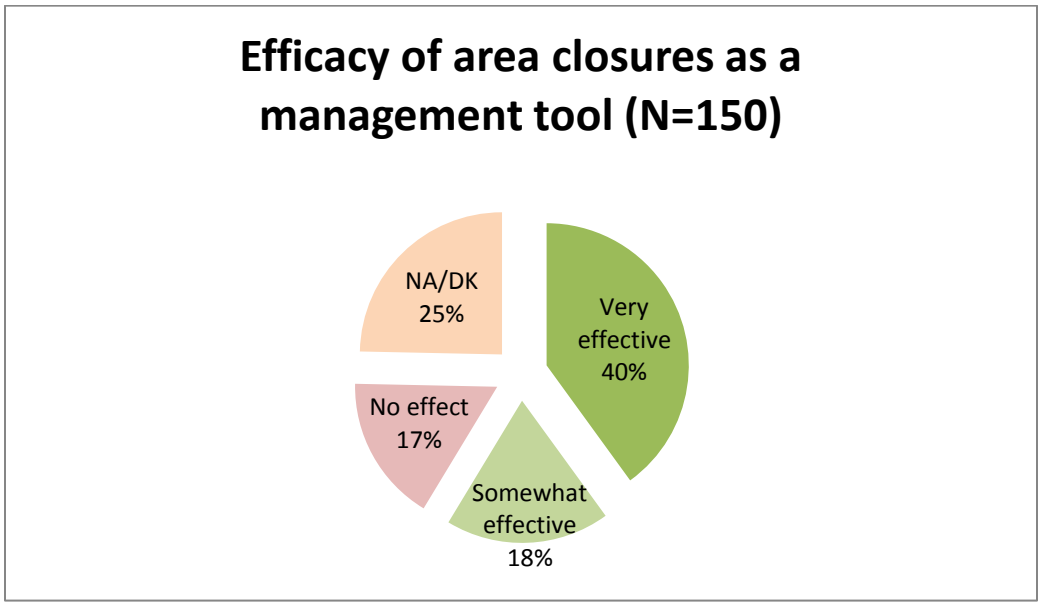


Figure 2: Fishers' views about the efficacy of area and seasonal closures as a management tool.



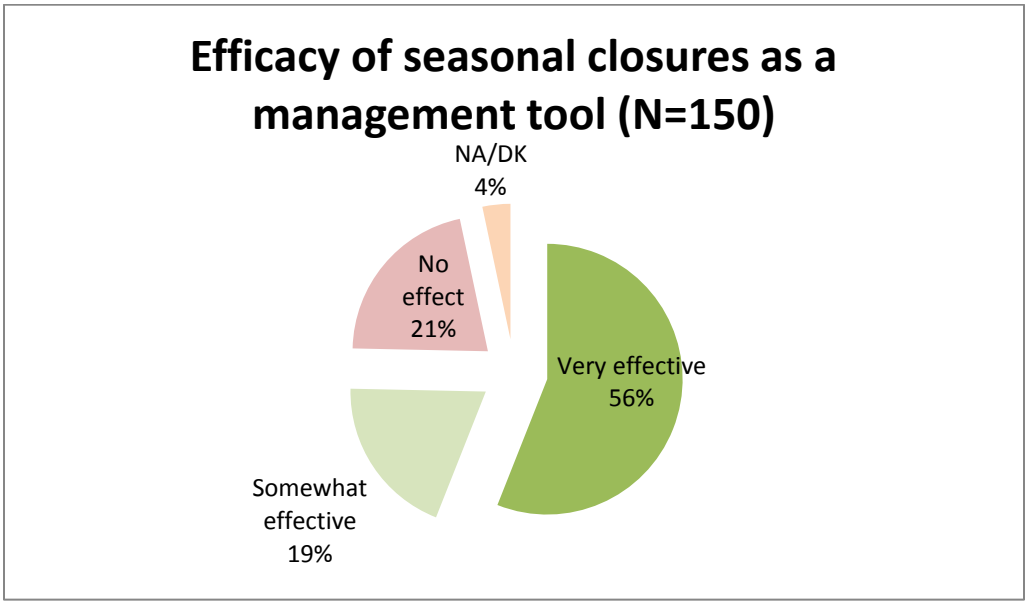


Table 1: Sampling statistics.

Regions	Fishermen population	Target number of interviews	Number of completed interviews	Number of non-responses	Number of contacts
East coast	141	26	26	31	57
North coast	194	36	36	30	66
South coast	203	38	38	45	83
West coast	271	50	50	212	262

Table 2: Demographic characteristics

	Mean	Median	Minimum	Maximum	Std. Error	n
Age (years)	55.6	56.0	22.0	89.0	1.1	150
Fishing experience (years)	29.6	30.0	1.0	80.0	1.3	150
Residence in community (years)	46.4	47.0	3.0	89.0	1.6	143
Household income derived from fishing (%)	66.4	75.0	5.0	100.0	2.7	147
Number of dependents	2.8	2.0	1.0	7.0	0.1	148
Time spent on fishing activities (hrs/wk)	33.8	35.0	6.0	72.0	1.1	144

Table 3: Demographic characteristics (cont)

	Frequency	Percent (%)		Frequency	Percent (%)
Fishing role			Age distribution		
Captain-owner	129	86.0	<30 years	5	3.3
Hired captain	4	2.7	30-39	12	8.0
Crew	15	10.0	40-49	35	23.3
Other	2	1.3	50-59	37	24.7
			60-69	37	24.7
Fish year-round	143	95.3	>=70	24	16.0
Full-time fisher	105	70.0			
			Fishing income distribution		
Waters fished					
			<25%	27	18.4
Territorial waters	106	70.7	25-49.9	16	10.9
Federal waters	1	0.7	50-74.9	26	17.7
Both	43	28.7	75-100	78	53.1

Table 4: Vessel, fishing equipment, and gear characteristics.

	Mean	Median	Minimum	Maximum	Std. Error	n
Vessel length (ft)	20.4	20.0	12.0	50.0	0.4	148
Engine propulsion (hp)	74.3	60.0	9.5	450.0	5.2	147
Value of vessel and engine ($)	14,868.2	6,500.0	500.0	65,000.0	4,802.6	136

Table 5: Vessel, fishing equipment, and gear characteristics (cont).

	Frequency	Percent (%)		Frequency	Percent (%)
Number of engines			Hull type		
Single	110	74.3	Fiberglass	111	77.1
Twin	38	25.7	Fiberglass & wood	10	6.9
			Wood	20	13.9
Engine type			Aluminum	3	2.1
Inboard	9	6.1			
Outboard	139	93.9			
Fuel type					
Gasoline	139	93.9			
Diesel	9	6.1			

Table 6: Main fishing grounds and target species.

	Frequency	Percent (%)		Frequency	Percent (%)
Gears used			Target species		
Vertical line	49	32.7	Deep-water snapper-grouper	99	66.0
Longline	9	6.0	Reef fish	106	70.7
Handline	85	56.7	Dolphin/Wahoo	42	28.0
Shark longline	2	1.3	Tuna	20	13.3
Rod and reel	25	16.7	Shark	11	7.3
Troll	24	16.0	Lobster	78	52.0
SCUBA	54	36.0	Conch	58	38.7
Skin	12	8.0	Baitfish	16	10.7
Fish and lobster trap	38	25.3	Other species	30	20.0
Trammel net	10	6.7			
Cast net	21	14.0			
Beach seine	11	7.3			
Gillnet	4	2.7			

Table 7: Fishers' perceptions about the efficacy of seasonal closures to protect spawning aggregations.

Protects spawning aggregations	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/No answer	N
Red hind (Dec 1- last day of Feb.)	57.0	9.3	8.1	8.1	17.4	-	86
Silk, vermilion, black and blackfin snapper (Oct. 1 – Dec. 31)	47.3	14.9	6.8	6.8	21.6	2.7	74
Yellowfin, black, tiger, red and yellowedge grouper (Feb 1- Apr. 30)	66.7	5.6	11.1	5.6	5.6	5.6	18
Mutton and lane snapper (Federal only, Apr. 1 –Jun 30)	57.5	10.0	5.0	7.5	15.0	5.0	40
Queen conch (Territorial only, Aug 31 - Oct 31)	71.9	5.3	7.0	7.0	7.0	1.8	57
Mutton snapper (Territorial only, Apr. 1 – Jun. 30)	65.1	9.3	2.3	4.7	14.0	4.7	86

Table 8: Fishers' perceptions about the efficacy of seasonal closures to augment fish biomass.

Augments fish abundance	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/No answer	N
Red hind (Dec 1- last day of Feb.)	50.0	9.3	9.3	11.6	14.0	5.8	86
Silk, vermilion, black and blackfin snapper (Oct. 1 – Dec. 31)	41.9	9.5	16.2	12.2	16.2	4.1	74
Yellowfin, black, tiger, red and yellowedge grouper (Feb 1- Apr. 30)	44.4	5.6	33.3	11.1	-	5.6	18
Mutton and lane snapper (Federal only, Apr. 1 –Jun 30)	52.5	12.5	7.5	12.5	10.0	5.0	40
Queen conch (Territorial only, Aug 31 - Oct 31)	59.7	5.3	14.0	8.8	10.5	1.8	57
Mutton snapper (Territorial only, Apr. 1 – Jun. 30)	61.6	7.0	7.0	8.1	9.3	7.0	86

Table 9: Fishers' support for seasonal closures and hardship before and after their adoption.

	Fished area	Fished a lot	Fished a little	Initial hardship	On-going hardship	Initial Support	Now Support	N
Red hind (Dec 1- last day of Feb.)	86/150=57.3	31/86=36	55/86=64	46/86=53.5	35/86=40.7	34/86=39.5 (4 guys unaware of closure)	57/86=66.3	86
Silk, vermilion, black and blackfin snapper (Oct. 1 – Dec. 31)	74/150=49.3	47/74=63.5	27/74=36.5	47/74=63.5	32/73=56.2	29/73=39.7 (3 unaware)	32/73=43.8	74
Yellowfin, black, tiger, red and yellowedge grouper (Feb 1- Apr. 30)	18/150=12	6/18=33.3	12/18=66.7	10/18=55.6	6/48=33.3	8/18=44.4 (1 unaware)	9/18=50	18
Mutton and lane snapper (Federal only, Apr. 1 –Jun 30)	40/150=26.7	14/39=35.9	25/39=64.1	21/40=52.5	15/40=37.5	19/40=47.5 (3 unware)	26/40=65	40 (note 2 non-response on some answers)
Queen conch (Territorial only, Aug 31 - Oct 31)	55/150=36.7	36/56=64.3	19/56=33.9	38/57=66.7	27/57=47.4	29/56=51.8	38/57=66.7	57
Mutton snapper (Territorial only, Apr. 1 – Jun. 30)	86/150=57.3	38/86=44.2	48/86=55.8	47/86=54.7	29/86=33.7	36/86=41.9 (7 unaware)	56/86=65.1	86

Table 10: Fishers' perceptions about the efficacy of area closures to protect spawning aggregations.

Protects spawning aggregations	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/No answer	N
Tourmaline (Buoy 8)	65.5	6.9	3.4	6.9	13.8	3.4	29
Bajo de Sico	55.0	10.0	5.0	15.0	15.0	0.0	20
Abrir la Sierra	58.6	13.8	6.9	6.9	10.3	3.4	29
Islas de Mona y Monito	53.3	0.0	13.3	6.7	20.0	6.7	15
Isla de Desecheo	45.5	0.0	13.6	13.6	22.7	4.5	22
Caja de Muertos	85.7	7.1	7.1	0.0	0.0	0	14
Canal Luis de Peña	54.5	18.2	4.5	9.1	9.1	4.5	22

Table 11: Fishers' perceptions about the efficacy of area closures to augment fish abundance within it.

Increase fish abundance within the reserve	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/No answer	N
Tourmaline (Buoy 8)	55.2	-	13.8	6.9	10.3	13.79	29
Bajo de Sico	50.0	5.0	5.0	10.0	15.0	15.0	20
Abrir la Sierra	51.7	3.4	6.9	10.3	10.3	17.2	29
Islas de Mona y Monito	46.7	13.3	13.3	6.7	6.7	13.3	15
Isla de Desecheo	40.9	9.1	13.6	9.1	13.6	13.6	22
Caja de Muertos	42.9	14.3	14.3	-	14.3	14.3	14
Canal Luis de Peña	77.3	13.6	4.5	-	-	4.5	22

Table 12: Fishers' perceptions about the efficacy of area closures to augment fish abundance outside of it.

Increase fish abundance outside the reserve	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/No answer	N
Tourmaline (Buoy 8)	37.9	6.9	17.2	10.3	17.2	10.34	29
Bajo de Sico	30.0	10.0	10.0	20.0	20.0	10.0	20
Abrir la Sierra	37.9	6.9	17.2	17.2	13.8	6.9	29
Islas de Mona y Monito	53.3	0.0	13.3	6.7	13.3	13.3	15
Isla de Desecheo	45.5	0.0	4.5	13.6	18.2	18.2	22
Caja de Muertos	57.1	-	14.3	14.3	14.3	-	14
Canal Luis de Peña	77.3	9.1	9.1	-	-	4.5	22

Table 13: Fishers' perceptions about the efficacy of area closures to restore or maintain the quality of habitat.

Restore or maintain habitat quality	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree	Don't know/No answer	N
Tourmaline (Buoy 8)	55.2	6.9	13.8	3.4	6.9	13.79	29
Bajo de Sico	45.0	15.0	15.0	5.0	10.0	10.0	20
Abrir la Sierra	55.2	10.3	10.3	3.4	6.9	13.8	29
Islas de Mona y Monito	53.3	0.0	20.0	6.7	6.7	13.3	15
Isla de Desecheo	45.5	0.0	13.6	4.5	22.7	13.6	22
Caja de Muertos	57.1	7.1	14.3	7.1	7.1	7.1	14
Canal Luis de Peña	68.2	9.1	13.6	4.5	-	4.5	22

Table 14: Fishers' support for area closures and hardship before and after their adoption.

	Fished area	Fished a lot	Fished a little	Initial hardship	On-going hardship	Initial Support	Now Support	N
Tourmaline (Buoy 8)	29/150=19.3	11/29=37.9	18/29=62.1	22/29=75.9	15/29=51.7	9/29=31	17/29=58.6	29
Bajo de Sico	20/150=13.3	10/20=50	10/20=50	17/20=85	14/20=70	8/20=40	14/20=70	20
Abrir la Sierra	29/150=19.3	14/29= 48.3	15/29= 51.7	22/29=75.9	17/29=58.6	8/29=27.6	15/29=51.7	29
Islas de Mona y Monito	15/150=10	6/15=40	9/15=60	10/15=66.7	8/15= 53.3	8/15= 53.3	7/15=46.7	15
Isla de Desecheo	22/150=14.7	7/22=31.8	15/22=68.2	16/22=72.7	10/22=45.5	9/22=40.9	10/22=45.5	22
Caja de Muertos	14/150=9.3	9/14=64.2	6/14=42.8	6/14=42.9	4/14=28.6	3/14=21.4	10/14=71.4	14
Canal Luis de Peña	22/150=14.7	4/22=18.2	15/22=68.2	2/22=9.1	1/22=4.5	9/22=40.9	19/22=86.4	22 (18 fished 4 gave opinions wo fishing)

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