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SOCIO-ECONOMIC STUDY OF THE HOOK AND LINE FISHERY IN THE COMMONWEALTH OF PUERTO RICO (2014)

BY

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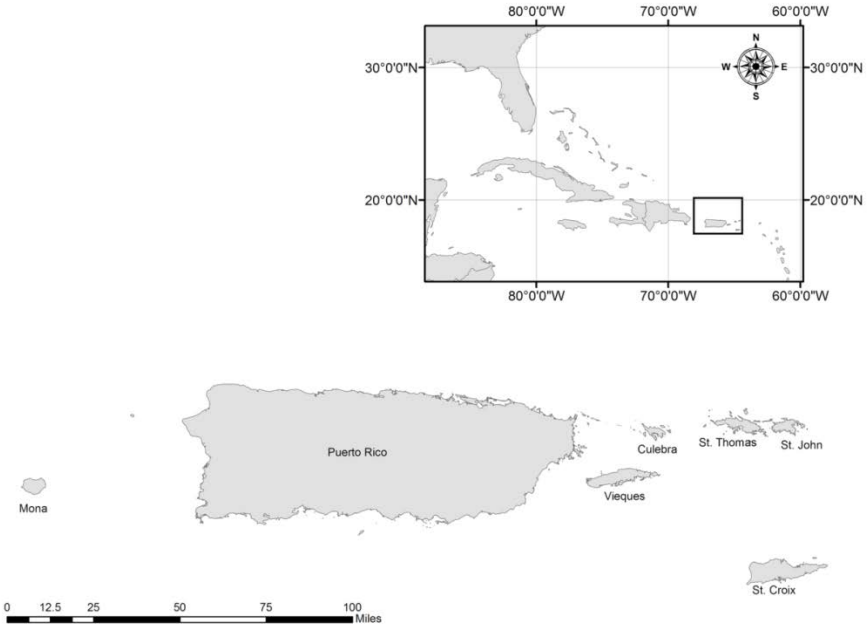
1. Introduction

The commercial hook-and-line (hereafter 'line') fishery is one the mainstay fisheries in the Commonwealth of Puerto Rico (Figure 1). In 2014, line fishermen harvested almost 1 million pounds worth $3.5 million dollars, which is about 42% of the Commonwealth's landings and 39% of the dockside revenues (NMFS, 2016).[1] There are several types of line fishing in Puerto Rico. The five most popular methods include vertical bottom lines (locally known as *calas*) which account for 17% of the Commonwealth's overall landings, followed by handlines (*cordeles de mano*, 14%), troll lines (*silgas*, 6%), rod and reels (*cañas*, 5%) and longlines (*palangres*, 1%). Figures 2 and 3 show that vessels that use vertical bottom lines and handlines are responsible for the largest share of the landings (72%) and dockside revenues (81%) derived from line fishing (NMFS, 2016).

Figure 1. Map of the Commonwealth of Puerto Rico.



[1] Correction or adjustment factors have been applied to self-reported landings and dockside revenues.

Figure 2. Line landings breakdown by gear types (2014).

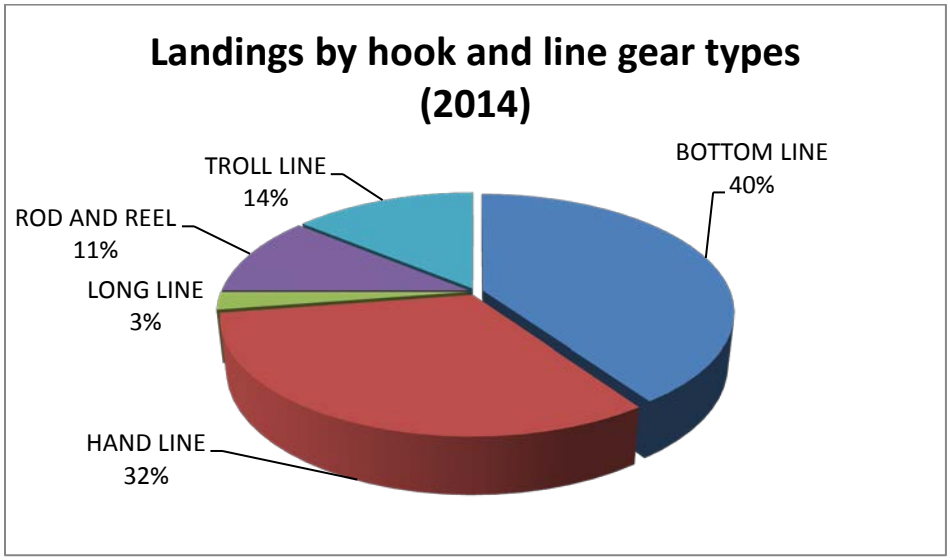
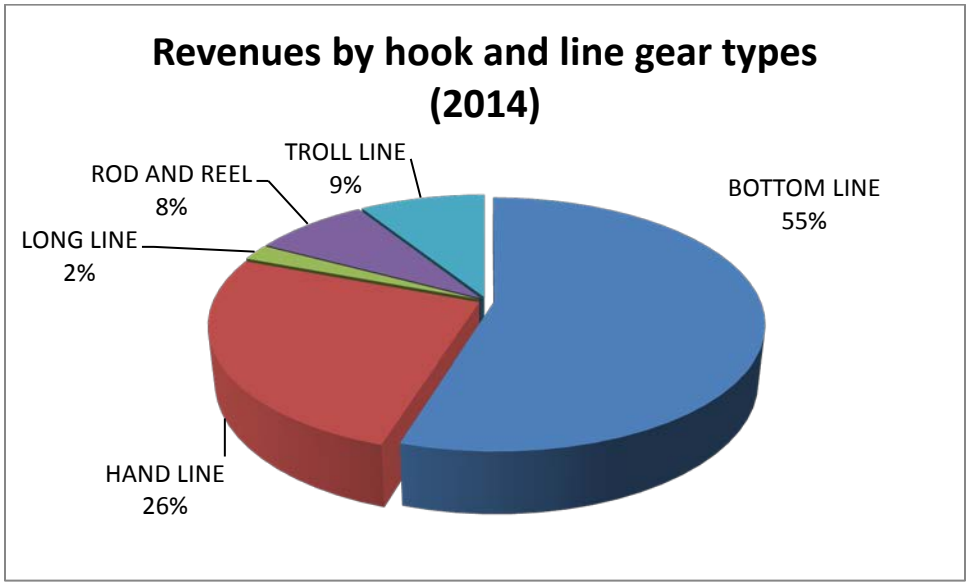


Figure 3. Line revenue breakdown by gear types (2014).



Fishers are drawn to line fishing because of its high earning potential. For instance, vessels that use vertical bottom lines target highly valued snapper-grouper species such as queen snapper (*Etelis oculatus*), silk snapper (*Lutjanus vivanus*), cardinal snapper (*Pristipomoides macrophthalmus*), vermilion snapper (*Rhomboplites aurorubens*), blackfin snapper (*L.*

buccanella), black snapper (*Apsilus dentatus*) and misty grouper (*Epinephelus mystacinus*). Similarly, handline vesssels pursue commercially valuable species such as yellowtail snapper (*Ocyurus chrysurus*), lane snapper (*L. synagris*), red hind (*E. guttatus*), mutton snapper (*L. analis*), bar jack (*Caranx ruber*), and coastal migratory species such as cero mackerel (*Scomberomorus regalis*), king mackerel (*S. cavalla*) and dolphinfish (*Coryphaena hippurus*).

In addition to its high earning potential, many fishers turned to line fishing because they are not subject to catch and gear theft problems associated with traps, nor exposed to the dangers and health risks attendant with diving. Ease of usage, family tradition, enjoyment, and low maintenance costs relative to traps and nets were additional reasons offered for favoring line fishing.

Despite the significant economic contribution of line fishing to coastal communities, there is a limited socio-economic knowledge about the fishery. Moreover, the fishery is being increasingly regulated. In the past decade, annual catch limits (or quotas), trip limits, seasonal and area closures, minimum size limits, and miscellaneous gear restrictions were introduced (Matos-Caraballo, 2009; Tonioli and Agar, 2009; Matos-Caraballo and Agar, 2011). In 2013, the Commonwealth of Puerto Rico implemented its first limited entry program for Snapper Unit 2 species, namely queen snapper and cardinal snapper, to extend the commercial fishing season. Presently, the Caribbean Fishery Management Council is considering establishing a federal permit for the commercial harvest and sale of queen and cardinal snappers in the exclusive economic zone surrounding Puerto Rico. The aim of this paper is to describe the current economic and social conditions of the Puerto Rico line fishery focusing on the vessels that use vertical bottom lines and handlines to assist with the development and evaluation of policy proposals.

2. Methods

We conducted 118 in-person interviews, which represents about a quarter (24.5%) of the population of commercial line fishers who report catch and effort statistics (Table 1).[2] The questionnaire collected information on demographics, capital investment on boats and equipment, fishing practices, revenue and cost structure, remunerative arrangements, crew organization and recruitment.[3] The sample was stratified into four coastal areas: north, south, west and east. The northern region extends from the municipalities of Isabela to Luquillo. The eastern region runs from the municipalities of Fajardo to Maunabo, including the islands of Vieques and Culebra, and the southern region stretches from the municipalities of Patillas to Lajas. The western region spans the municipalities of Cabo Rojo to Aguadilla. The stratification was conducted to spatially detail the variety of operations and made the interviewing easier and more cost effective.

To satisfy the requirements of the sampling protocol, interviewers were instructed to draw a replacement fisher only if the randomly selected fisher: (a) refused to participate in the survey; (b) was unavailable due to illness, death, or travel; (c) could not be contacted after six separate attempts; or (d) was not identified by others at the fishing cooperative. Despite the significant effort devoted to sampling, the unadjusted response rate was 44.9%. The unadjusted response rate was obtained by dividing the total number of completed interviews by the total number of people contacted (Table 1). Reasons for non-response included that line fishers could not be reached (126), no longer qualified because they no longer line fished (13), gear misclassification (1), and refused to partake in the survey (5). The fieldwork took place between May 2014 and March 2016.

[2] The sampling frame consisted of line fishers who reported landings at least once between 2011 and 2013.
[3] A copy of the survey of instrument can be obtained by contacting the authors.

Table 1. Sampling statistics.

Regions	Line population	Target number of interviews	Number of completed interviews	Number of non-responses	Non-response reasons				Number of contacts
					Cannot be found	Wrong gear	Refusal	No longer fishing	
East coast	80	20	20	29	25	1	1	2	49
North coast	136	34	33	26	22	0	2	2	59
South coast	105	26	26	33	29	0	2	2	59
West coast	161	40	39	57	50	0	0	7	96

3. Results and Discussion

3.1. Demographic Profile

The majority of the line fishers surveyed were experienced owner-operators with high levels of fishing dependence (Table 2). Their ages ranged from 22 to 89 years, averaging 54 years. Almost 83% of the line fishers fell in the 40 years and over age bracket, and only 4% of the sample was in the under 30 years age bracket. Interviewees said that, on average, they had been fishing for 28 years (2-80 years range). Broadly speaking, the average handline fisher was slightly older (55.2 vs. 52.5) but marginally less experienced (27.7 vs 28.4) than the average vertical bottom line fisher.

Fishing was reported to be an important component of the household economy. On average, fishing income contributed about 66% of their household income. Vertical bottom line fishers reported a greater dependence on fishing than did their handline counterparts. Their mean (median) household income derived from fishing was 69.4 (72.7)% relative to 62.3 (56.4)% from handline fishers.

Past studies have reported that commercial fishers derive their household income from a variety of sources including commercial fishing, wage labor, and government transfer (welfare) payments (Valdés-Pizzini, 1985; Griffith & Valdés-Pizzini, 2002; Pérez, 2005; Griffith *et al.*, 2007, Agar *et al*, 2005, Agar and Shivlani, forthcoming 2017; and Agar *et al*., forthcoming 2017). Pérez (2005) observes that much of this wage labor is derived from low paying, casual occupations (i.e., odd jobs, known as *chiripas* locally). Government transfer payments such as food stamps, health, utility and housing subsidies, and social security are also important supplemental sources of household income. About 67% of the line fishers interviewed declined to describe their involvement in non-fishing activities most likely because they were concerned that

their access to welfare programs could be threatened. The other line fishermen reported working in agriculture, construction, boat maintenance, fish sales, plumbing, landscaping, and security services among others.

Most line fishers stated that they fished year-round on a full-time basis, whereas the few part-timers fished for income rather than for consumption purposes. Line fishers spent, on average, 38 hours per week on fishing and fishing related activities, such as boat and engine maintenance and fish marketing. The number of dependents (including the fisher) ranged between 1 and 7, averaging 3.1 (Table 2).

Aside from line fishing, respondents said they also fished with cast-nets (20%), traps or pots (18%), and SCUBA (16%). Line fishers reported primarily targeting deep-water snappers and groupers, reef-fishes, dolphinfishes, wahoos, and tunas (Table 3). Among the most common other species cited were mackerels, and octopuses. About 59% of the line fishers stated that they primarily fished in Commonwealth waters (<9 nautical miles) and another 39% said that they fished in both federal and Commonwealth waters (Table 2). Less than 2% of the line fishers said they primarily fished in federal waters (9-200 nautical miles).

Table 2. Demographic characteristics.

	Mean	Median	Minimum	Maximum	Std. Error	n
Age (years)	54.1	54.0	22	89	1.0	116
Fishing experience (years)	28.1	28.0	2	80	1.2	116
Household income derived from fishing (%)	65.9	71.3	5	100	2.6	116
Number of dependents	3.1	2.3	1	7	0.1	114
Time spent on fishing activities (hrs/wk)	38.3	36.3	8	81	1.1	117

Table 2. Demographic characteristics (cont.)

	Frequency	Percent (%)		Frequency	Percent (%)
Fishing role			Age distribution		
Captain-owner	106	91.4	<30 years	5	4.3
Hired captain	2	1.7	30-39	15	12.9
Crew	8	6.9	40-49	23	19.8
			50-59	28	24.1
Fish year-round	115	98.3	60-69	33	28.5
			>=70	12	10.3
Full-time	87	75.0			
			Fishing income distribution		
Waters fished					
			<25%	17	14.7
Territorial waters	69	59.0	25-49.9	15	12.9
Federal waters	2	1.7	50-74.9	25	21.6
Both	46	39.3	75-100	59	50.9

Table 3. Main fishing gears and target species.

	Frequency	Percent (%)		Frequency	Percent (%)
Gears used			Target species		
Vertical line	57	48.7	Deep-water snapper-grouper	82	70.1
Longline	17	14.5	Reef fish	67	57.3
Handline	90	76.9	Dolphin/Wahoo	49	41.9
Shark longline	2	1.7	Tuna	31	26.5
Rod and reel	28	23.9	Shark	13	11.1
Troll	20	17.1	Lobster	32	27.4
SCUBA	19	16.2	Conch	21	18.0
Skin	16	13.7	Baitfish	16	13.7
Fish and lobster trap	21	18.0	Other species	21	17.9
Trammel net	9	7.7			
Cast net	23	19.7			
Beach seine	5	4.3			
Gillnet	3	2.6			

3.2. Capital investment in boats, fishing and electronic equipment

Most boats used by line fishers were small in size and had limited technology (Table 4). The average boat was about 21 feet in length (14-50 ft. range) powered with a single, outboard, gasoline engine. The average engine power was 89 horsepower (8-400 hp. range). Most hulls were constructed of fiberglass (79%), and to a lesser extent, of a combination of fiberglass and wood, or wood. Line fishers valued their used boat and engine at $10,723 and stated that annual maintenance costs ran about $1,425 (Table 4).

When disaggregated by gear type, the survey showed that the vertical bottom line fleet had marginally larger vessels, more powerful engines and a higher capital investment in vessels and engines than the handline fleet. The average (median) vertical bottom line vessel was approximately 21(20) ft. long, had a 97(76) hp. engine, and was valued in its current condition at $13,581($9,387). In contrast, the average (median) handline vessel was about 20 (19) ft. long, had an 82 (55) hp. engine, and was valued at $8,078 ($4,784).

In addition to the boat and engine, electronic and safety equipment are important components of the capital stock held by line fishers (Table 4). Respondents valued their used electronic (e.g., cellular, global positioning systems, radio, fish and depth finders) and safety equipment (e.g., personal flotation devices, fire extinguisher, etc.) at $1,669 and $296, respectively.

Table 4. Vessel, equipment, and gear characteristics.

	Mean	Median	Minimum	Maximum	Std. Error	n
Vessel length (ft)	20.5	19.5	14.0	50.0	0.3	117
Engine propulsion (hp)	89.1	70.6	8.0	400.0	6.0	115
Value of vessel and engine ($)	10,723.0	7,416.9	400.0	60,000.0	778.6	114
Vessel and engine maintenance costs ($/year)	1,425.0	770.9	100.0	10,000.0	128.1	109
Value of electronic equipment ($)	1,669.1	991.1	15.0	15,000.0	153.9	110
Value of safety equipment ($)	296.2	230.1	60.0	1,700.0	17.5	116

Table 4. Vessel, equipment, and gear characteristics (cont.).

	Frequency	Percent (%)		Frequency	Percent (%)
Number of engines			Electronic equipment		
Single	93	79.5	GPS	77	65.8
Twin	24	20.5	Winch	51	43.6
			Depth finder	52	44.8
Engine type			Fish finder	51	44.0
			Radio	85	48.7
Inboard	8	6.8	Cellular	93	80.2
Outboard	109	93.2	EPIRB	13	11.2
Fuel type			Hull type		
Gasoline	110	94.8	Fiberglass	92	78.6
Diesel	6	5.2	Fiberglass & wood	6	5.1
			Wood	17	14.5
			Aluminum	2	1.7

3.3. Fishing practices, costs and earnings, and crew dynamics

a. Vertical bottom line

Fishing practices

The majority of the vertical bottom line fleet activity is centered on the west coast, particularly in the municipalities of Rincón and, to a lesser extent, Cabo Rojo. In 2014, the west, north, east and south coasts were responsible for 62% 18%, 15%, and 5%, respectively of this gear's landings (NMFS, 2016). The municipality of Fajardo on the east coast is the third most important landing site in Puerto Rico. Queen and silk snapper alone accounted for 86% of the vertical bottom line revenues in 2014 (NMFS, 2016).[4]

The survey showed that the average vertical bottom line operation fished 3 times per week (Table 5). Fishers reported that fishing trips averaged about 15 hours, although some said they fished up to 120 hours over a multi-day trip. These longer trips corresponded to operations fishing in distant grounds such as Mona, Cabo Engaño, and Pichincho. Other popular fishing grounds along the west coast include La Corona, Desecheo, Bajo de Sico, and Bajo Medio (Tonioli and Agar, 2009). Fishers stated that they avoided going out fishing when wind speeds exceeded 15-20 knots, which can generate 6-foot waves, due to the small size of their craft.

Respondents stated that the average vertical bottom line operation was crewed with a captain and one helper (or *proel* as they are locally known). Valdés-Pizzini (2006) reports that fishing is a cooperative venture where the captain and helper fish nonstop (until they run out of bait) and take turns cleaning, gutting and storing the catch in coolers. Helpers either bait the hooks (and freeze them) the evening prior to the trip, or on the way back to land if any bait remains (Figure 5). The vertical bottom line fishers surveyed reported that their average landings ranged from 10 to 500 lbs. per trip, averaging about 91 lbs. per trip (Table 5). However, some

[4] Queen snapper landings take place on the west (40%), south (28%) and east (20%) coasts, and silk snapper landings occur on the west (43%), south (27%) and east (19%) coasts.

fishers reported that during exceptional trips they could land up 1,700 lbs. per trip. The median landings were 71 lbs. per trip.

Most vertical bottom line fishers reported targeting queen and silk snappers offshore with electric reels (*malacates*), although a few fishers said they targeted silk snapper, and, to a lesser extent, yellowtail and mutton snappers closer to shore with manual reels. Suárez-Caabro (1979) notes that electric reels are popular with deep-water snapper- grouper fishers because it allows them to land fish from 900 to 1,200 feet quickly and with minimal effort.

Fishing excursions typically start early in the morning (around 5 to 6 am), but some begin late afternoon or in the evening (4 pm to 8 pm). Fishers who leave late in the afternoon or evening tend to either fish closer to shore or stay fishing overnight (Crespo, pers. comm.).[5] Respondents stated that they fished mainly over rocky (or hard) bottoms at depths that ranged from 250 to 3,000 feet; however, most of them reported fishing depths that ranged from 600 to 1,200 feet. The majority of the vessels fishing with vertical bottom lines targeting queen and cardinal snappers, at least in the west coast, tend to drift fish (*galoneando*) whereas those that target Snapper Unit 1 species such as silk, black, blackfin, vermilion snappers, and wenchman tend to fish while anchored because Snapper Unit 1 species are found in shallower waters (600 ft.) relative to Snapper Unit 2 species which are found in deeper waters (800-1,400 ft.; Crespo, pers. comm.).

Matos-Caraballo and Torres-Rosado (1989) report that there are several vertical bottom line configurations, including *cala* (or *fuete*), *ballestilla*, and *arbol de navidad*. Crespo (pers. comm.) notes that *cala* (*or fuete*) is the common vertical bottom line configuration along the west coast; however, a few fishers continue to use a bow rig (*ballestilla)* configuration (Figure 5). The *ballestilla* configuration uses a bow-shaped wire spreader attached to end of the main line (Jarvis, 1932; Matos-Caraballo and Torres-Rosado, 1989).

[5] Crespo, Nelson. President of the Asociación de Pescadores de Pargos de Profundidad de Rincón. Personal communication. November 17, 2016.

Table 5. Fishing practices of vertical bottom line vessels.

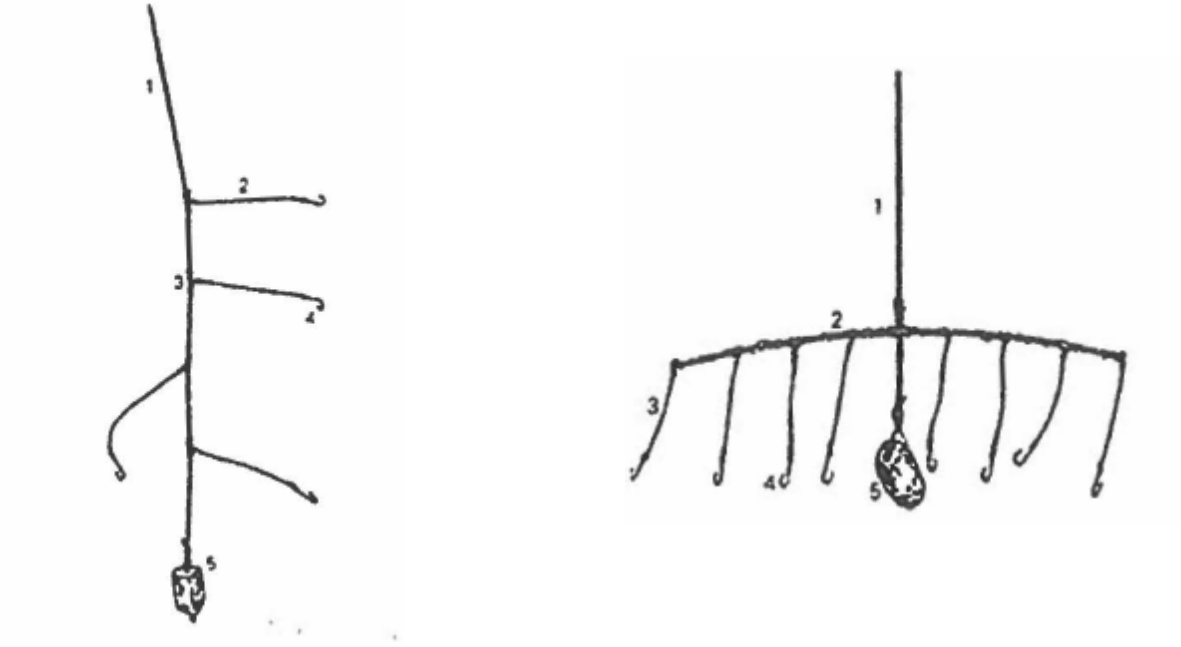
	Mean	Median	Minimum	Maximum	Std. Err.	n
Number of trips (trips/week)	3.0	2.7	0.5	6.5	0.2	43
Trip duration (hours/trip)	15.0	11.0	4.0	120	2.6	43
Total crew (inc. captain)	2.2	2.0	2.0	4.0	0.1	43
Average landings (lbs./trip)	90.7	71.1	10.0	500.0	10.9	43
Minimum landings (lbs./trip)	26.2	12.9	0	250.0	5.9	43
Maximum landings (lbs./trip)	235.0	143.8	20.0	1,700.0	36.0	43
Fuel consumption (gallons/trip)	27.2	19.3	5.0	100.0	2.8	36

Figure 4. Photo of an electric reel.

Respondents said that, on average, they fished 2 vertical bottom lines (1-5 range, 2 median). The average vertical bottom line was 1,800 feet long (200-9,000 ft. range, 1,800 ft. median) and had 18 hooks (5-80 hooks range, 12 median, 30 mode). These statistics are in line with figures provided by key informants. For example, Crespo (pers. comm.) reports that west coast fishers tend to use between 1 and 3 vertical bottom lines which are 1,800 feet long (200 lbs.

braided line). He also reports that each line has, on average, 25 circle hooks which range in size from 9/0 to 12/0 (Figures 6 and 7). He also notes that a number of fishers use underwater lights to attract deep-water snappers; however, he added that there was no consensus among fishers whether underwater lights improved catch rates.

Figure 5. Vertical bottom line configurations.



Fuete *Ballestilla*

Source: Matos-Caraballo and Torres-Rosado (1989).

Figure 6. Photo of *cala (fuete)* configuration.

Courtesy of Michelle Schärer

Figure 7. Common fishing rig for deep-water snappers and groupers (*sutilillo*).

Costs and Earnings

Vertical bottom line fishers reported diverse objectives for their fishing trips. Broadly speaking, 37% of the respondents stated that they wanted to cover costs (*cubrir gastos* and presumably generate some profit), and another 35% said they wanted to maximize revenues. About 23% of the interviewees said that they had a catch target that ranged between 50 and 3,000 pounds of deep-water snappers and another 2% reported miscellaneous objectives (e.g., fish for pleasure).

Fishers who used vertical bottom lines reported an average of $511 in gross returns per trip ($60 to $3,000 per trip range; Table 6). Fuel and oil expenses accounted, on average, for 64% of the non-labor variable costs. Boats used between 5 and 100 gallons of fuel per trip, averaging 27.2 gallons. Average bait and grocery expenses were responsible for 24% and 10% of the non-labor variable costs, respectively. Most fishers (81%) claimed that they purchased bait and the rest said they caught their own. Squid (mostly bought), sardines, ballyhoo, and miscellaneous tunas (blackfin, skipjack and little tunny) were among the most popular baits. Ice costs represented a relatively minor expenditure (5%). Almost 70% of the fishers said they purchased ice, 21% said they made their own and the remainder said they did not take ice on their trips. After deducting non-labor variable costs (e.g., fuel, bait, groceries, etc.), net returns per trip ranged from $10 to $1905, averaging $307 (Table 6). The median gross and net returns were $382 and $196, respectively.

Table 6. Costs and earnings of vertical bottom line vessels.

	Mean	Median	Minimum	Maximum	Std. Error	n
Variable costs ($/trip)						
Fuel expenditures	115.3	91.3	10.0	475.0	11.8	43
Trailer fuel expenses	4.5	0.00	0.00	50.0	1.3	43
Ice expenditures	8.8	7.1	0.00	45.0	1.3	43
Bait expenditures	45.4	28.1	0.00	500.0	10.3	43
Food/groceries expenditures	19.3	13.8	0.00	100.0	2.3	43
Other expenditures	0.00	0.00	0.00	0.00	0.00	43
Total variable costs ($/trip)	188.4	149.2	10.0	1,095.0	22.7	43
Gross earnings ($/trip)	510.7	382.1	60.0	3,000.0	67.5	41
Net earnings ($/trip)	307.2	196.3	10.0	1,905.0	48.0	41

Crew composition and remunerative arrangements

Most vertical bottom line operations had a captain and one helper, seldom two. About 40% of the crew members were kin and the remaining 60% were primarily friends. The lay arrangement was the predominant remuneration mechanism.[6] Under lay or share arrangements, capital and labor are rewarded based on a share of the net returns (gross revenues minus variable expenses) rather than a fixed wage. Lay arrangements are designed to cope with fluctuating landings and prices, and encourage and reward teamwork and productivity by making crew members partners in the fishing venture (Acheson, 1981; Doeringer *et al.*, 1986).

Almost half (49%) of the two-person operations sampled did not charge a boat share, 30% did charge a boat share (34%), and the remainder had miscellaneous arrangements (e.g., some captains received 67-70% revenues which included an implicit boat share, others required a $10 (or $150) per trip boat contribution, etc.). Respondents provided several reasons for the egalitarian distribution of income (50%-50%) between captain and crew including family owned business, customary regional practice, and fairness in rewarding crew's effort which included boat maintenance and repairs.

The study estimated that in two-person operations, the average owner-operator (captain) earned about $114 per trip ($76 median, $5-$727 range), the helper netted almost $95 per trip ($66 median, $5-$358 range) and the boat received about $25 per trip ($0 median, $0-$185 range).[7]

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[6] Other arrangements included paying each helper $1 (or $1.25) per pound after covering trip costs, or paying them $25-30 and giving them 1/8 of the catch to the crew before trip costs.

[7] The disaggregated net returns to capital and labor do not closely match the net earnings reported in Table 6 because the latter figure captures all vertical bottom line operations (i.e., not only two-person operations).We only report the statistics of two-person operations because they were the most common and the 'other' operations had a relatively small number of observations.

b. Handline

Fishing practices

In contrast to the vertical bottom line fleet, the landings of the handline fleet were more evenly spread out throughout the Commonwealth. In 2014, the east, north, west and south coasts were responsible for 37%, 25%, 22%, and 17%, of this gear's landings, respectively (NMFS, 2016). The municipality of Fajardo on the east coast was responsible for most of the landings, followed by the municipality of San Juan on the north coast, and the municipality of Cabo Rojo on the west coast. In 2014, yellowtail snapper, lane snapper, and red hind accounted for 51%, 16%, and 5% of the handline revenues, respectively (NMFS, 2016).

Most handline operations fished, on average, 3 times per week for about 9 hours per trip (Table 7). Most vessels were staffed with a captain and one crew member, occasionally two. The handline fishers surveyed reported targeting yellowtail snapper, mutton snapper, silk snapper, and groupers, as well as dolphinfish, king mackerel and tunas. Respondents stated that their average landings ranged from 12 to 300 lbs. per trip, averaging about 66 lbs. per trip (Table 7). However, some fishers reported that during exceptional trips they could land up to 1,200 lbs. per trip. The median landings were 58 lbs. per trip.

Handline fishers reported starting their fishing trips either early in the morning (around 5 to 6 am), or late afternoon or evening (3 pm to 7 pm). Fishers who target yellowtail snapper mainly fish during the night; hence, they tend to leave the dock in late afternoon or evening (3 pm to 7 pm) and return the next day early in the morning (1 am to 5 am; Matos-Caraballo, pers. comm.).[8] On the other hand, handline operations that catch coastal migratory species (dolphinfish, wahoo, tunas), silk snapper and groupers (with or without catching yellowtail

[8] Daniel Matos-Caraballo. Puerto Rico's Fisheries Research Laboratory, Department of Environmental and Natural Resources. Personal communication. November 18, 2016.

snapper) tend to begin their fishing excursions early in the morning (5 to 6 am) and return by mid to late afternoon (1-5pm).

Fishers reported fishing over a variety of habitats and depths depending on the species sought. For example, those targeting yellowtail snapper stated they mainly fished at depths between 40 to 120 feet over muddy and hard bottoms whereas those pursuing silk snapper fished at depths that ranged between 80 and 1500 feet primarily over hard or rocky bottom.

On average, respondents said they fished with 3 handlines (1-10 range, 2 median). The average handline length was 785 feet (15-4,500 ft. range, 600 ft. median). Each handline had, on average, 3 hooks (1-14 hook range, 2 hook median, 1 hook mode). Matos-Caraballo (pers. comm.) notes that fishers targeting yellowtail snapper tend to use 2 handlines with 2 hooks in each line. Multiple hook rigs (>4) are mainly used to pursue deep-waters species such as silk snappers.

Costs and Earnings

Fishers who used handlines reported diverse aims for their fishing trips. Broadly speaking, over two-thirds (38%) of the interviewees reported that they wanted to maximize revenues whereas 27% said they wanted to reach a certain catch and/or income target (e.g., filling two coolers to make $100 per fisher or land at least 50 lbs. of yellowtail snapper which would gross $150). Another 22% of the interviewees said that their fishing objective was to cover trip costs. Although recovering costs is essential to survive with an irregular fishing income, we suspect that most cost defrayers aimed for sufficient income not only to finance their next trip (i.e., cover costs) but also to meet bare household needs.

Handline operation gross returns per trip ranged from $40 to $750, averaging $246 (Table 8). Fuel and oil expenses accounted, on average, for 66% of the non-labor variable costs. These boats used between 2 and 60 gallons of fuel per trip, averaging about 14 gallons. Bait and grocery

expenses were responsible for 14% and 13% of the non-labor variable costs, respectively. About 45% of the respondents bought bait, mainly squid and sardines, whereas the rest caught their own (e.g., ballyhoo. dwarf herring, barracuda). Ice costs were relatively minor, accounting, on average, for about 6% of the fishing costs. About 26% of the respondents said that they made their own ice, and another 17% said that they did not use ice.

After deducting non-labor variable costs (e.g., fuel, bait, groceries, etc.), net returns per trip ranged from $0 to $638, averaging $151 (Table 8). The median gross and net returns were $211 and $107, respectively.

Table 7. Fishing practices of handline vessels.

	Mean	Median	Minimum	Maximum	Std. Err.	n
Number of trips (trips/week)	3.3	2.8	0.5	6.5	0.2	65
Trip duration (hours/trip)	9.4	7.8	4.0	24.0	0.4	65
Total crew (inc. captain)	2.0	1.5	1.0	3.0	0.1	65
Average landings (lbs./trip)	65.8	57.6	12.0	300.0	5.1	64
Minimum landings (lbs./trip)	24.3	15.2	0.0	100.0	2.1	65
Maximum landings (lbs./trip)	138.8	96.4	20.0	1,200.0	18.1	65
Fuel consumption (gallons/trip)	13.5	10.8	2.0	60.0	1.2	62

Table 8. Costs and earnings of handline vessels.

	Mean	Median	Minimum	Maximum	Std. Error	n
Variable costs ($/trip)						
Fuel expenditures	60.7	48.4	8.0	250.0	5.3	65
Trailer fuel expenses	1.1	0	0	20.0	0.4	65
Ice expenditures	5.5	3.1	0	40.0	0.9	65
Bait expenditures	13.3	10.6	0	60.0	1.5	65
Food/groceries expenditures	12.2	9.2	0	45.0	1.0	65
Other expenditures	0.2	0	0	15.0	0.2	65
Total variable costs ($/trip)	93.0	73.0	10.0	305.0	6.8	65
Gross earnings ($/trip)	246.4	210.7	40.0	750.0	17.4	62
Net earnings ($/trip)	151.3	106.5	0	638.0	14.3	62

Crew composition and remunerative arrangements

The majority of the handline operations had a captain and one helper, seldom two. About one-third of the crew members (32%) were kin and the remaining were mainly friends. The majority of the crew members were remunerated using a lay or share arrangement; however, some vessel owners paid their helpers $100 per trip or $1 per pound after covering trip costs.

About 67% of the 2-person operations sampled did not charge a boat share and the remaining had miscellaneous arrangements that had varying levels of boat share or fixed payment ranging from $10 to $40. Several reasons were offered for the egalitarian distribution of income (50%-50%) between captain and crew, including family owned business, customary regional practice, fairness and rewarding crew's hard effort, which included boat maintenance.

The study estimated that in 2-person operations the average owner-operator (captain) earned about $65 per trip ($52 median, $0-$236 range), the helper netted almost $58 per trip ($46 median, $0-$195 range) and the vessel earned $7 (0$ median, $0-$127 range).[9]

3.4. Crew assistance, recruitment and turnover

About the 70% of the line fishermen interviewed stated that helpers assisted with various fishing related activities, including cleaning, maintaining, and repairing the boat and gear. Most of these fishing related activities were unpaid. Agar *et al.* (2008) believe that this unremunerated assistance arises from shared cultural values of mutual help. About 18% of the respondents said that crew members helped with fishing related expenses. Most of this assistance helped finance trip-related expenses (e.g., fuel) and, to a lesser extent, helped purchase crafts, engines and/or gear.

[9] The disaggregated net returns to capital and labor do not closely match the net earnings reported in Table 8 because the latter figure captures all handline operations (i.e., not only two-person operations). We only report the statistics of two-person operations because the 'other' operations had a relatively small number of observations.

Line fishermen also reported that crew members exhibited a high degree of occupational fidelity. About 81% of respondents stated that they rarely employed new crew, underlining the close knit nature of the operation; only 6% said they occasionally changed crew. Less than 4% of the line fishers surveyed stated that they had at least one different fisher on each trip. Views on crew recruitment were mixed but the plurality (48%) of the respondents said that it was hard to find new (dependable) crew members, 14% held that it was neither hard nor easy, and an additional 28% stated that it was easy. Finally, line fishers were asked how they would respond if fuel prices rose substantially. Over half (53%) believed that they would change the way they operate. A third of the respondents said that they would raise fish prices, 13% stated that they would fish closer to shore and 12% said that they would take fewer trips. Only 2 fishers said that they would change gears (i.e., nets) and none said that they would fish with fewer crew.

4. Summary

This study provides a brief socio-economic profile of the Puerto Rican small-scale line fishery focusing on the vertical bottom line and handline operations. The study revealed a number of dissimilarities (not necessarily statistically significant) with respect to demographics, capital usage and investment, and costs and earnings across line gear types. Demographically, the handline fishers were found to be slightly older (55.2 vs. 52.5) and less experienced (27.7 vs 28.4) but less fishing dependent (62.3% vs. 69.4%) than their vertical bottom line counterparts.

In terms of capital usage and investment, both gear types took about the same number of weekly trips (3) and operated with the same crew size (2) but vertical bottom line operations took longer trips (15 vs. 9 hrs.) and landed more fish per trip (91 vs. 66 lbs.) than handline operations. While both handline and vertical bottom line vessels were approximately the same size (20-21 ft.), vertical bottom line vessels had greater propulsion rates (97 vs. 82 hp.) and more capital invested ($13,581 vs. $8,078) than handline vessels.

There were also important differences in the revenue and costs structure. Gross revenues ($511vs. $246) and non-labor cost ($188 vs. $93) per trip were almost twice as high for vertical bottom line operations as for handline operations. These differences were driven by the value of species targeted ($6-7 per lb. for queen snapper vs. $2-3 per lb. for yellowtail snapper) and the fuel (27 vs. 13 gallons) and bait ($45 vs. $13) requirements. After deducting non-labor running costs, vertical bottom line operations averaged about $307 per trip and handline operations averaged $151 per trip. The median net return per trip for vertical bottom line and handline operations were $196 and $107, respectively.

Finally, the presence of a diverse line fishery underscores the need for greater care when developing management proposals because fishing fleets may respond differently to regulatory proposals, given their unique economic, social and technological characteristics. For example, past efforts to extend the seasonal area closure provisions off the west coast of Puerto Rico were vehemently opposed by members of the vertical bottom line fleet for two main reasons. The first reason for their opposition stemmed from the direct impacts arising from the partial loss of access to traditional silk snapper grounds. The second reason for their opposition arose from the indirect, cumulative impacts resulting from the various rolling deep-water snapper and grouper seasonal closures which further limited the fleet's ability to participate in these fisheries (Tonioli and Agar, 2009). Detailed socio-economic assessments, such as the present study, can inform decision-makers about the magnitude of the anticipated socio-economic consequences of management proposals and their distributional impacts as well as their likely cumulative impacts.

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