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Effectiveness of two pots and others factors for harvesting hard blue crabs *Callinectes sapidus* in Lake Maracaibo, Venezuela

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Abstract

The blue crab *Callinectes sapidus* Rathbun supports important fisheries along Lake Maracaibo, Venezuela. The 1993 catch was 4211 MT, worth slightly more than $2 million to the fishermen. Blue crab is one of the most important fishery resources exploited by artisanal fishermen. However, little is known concerning its biology and fishery. From 1990, restrictions have been imposed on its fishery but not under scientific criteria. This study, initiated in 1993 to evaluate the effects of fishing methods and to formulate procedures for an effective management strategy for blue crab in Lake Maracaibo, presents results on selectivity of gears. The study was conducted three days monthly for a total of 19 samples using two type of pots: Commercial pot (CP, 2x1 inches mesh size, 35 pots), and experimental pot (EP, 1x1 inches mesh size, 10 pots). Pots were set along the sandy and muddy edges of the lake in depths ranging from 1.5 to 18 m. Sexual composition did not differ significantly among gears ($P>0.05$) and was about 11% females and 89% males year-round. The abundance of blue crabs in pots fluctuated seasonally. EP produced 1.642 crabs/trap.d, which was 2.2 times higher than CP. The size structure of blue crabs sampled over the sampling period was similar for both gears ($P<0.05$). Size frequency distributions of crab caught with EP and CP did not change seasonally ($P>0.05$). CP now in use do not take crabs larger than those designed as EP. EP are eventually used by crabbers when catches are lows. However, this gear has been prohibited because this type of gear does not allow an effective renewal of the crab fishing stock.

Key words: Blue crab; commercial pot; experimental pot; Lake Maracaibo; management.

Efectividad de dos nasas y otros factores en la captura del cangrejo azul *Callinectes sapidus* en el Lago de Maracaibo, Venezuela

Resumen

El cangrejo azul *Callinectes sapidus* Rathbun soporta importantes pesquerías en el Lago de Maracaibo, Venezuela. La captura en 1993 fue de 4211 TM, aportando más de 2 millones de dólares a los pescadores. El cangrejo azul es uno de los recursos pesqueros más importantes explotados por los pescadores artesanales. Sin embargo, poco se conoce en relación con su biología y pesquería. Desde 1990 se han impuesto restricciones a la pesquería pero no bajo

criterios científicos. Este estudio fue iniciado en 1993 con la finalidad de evaluar los efectos de los métodos de pesca y formular procedimientos para una efectiva estrategia de manejo para el cangrejo azul en el Lago de Maracaibo. Este reporte presenta resultados sobre selectividad de artes. El estudio se condujo mensualmente durante tres días para un total de 19 muestreos usando dos tipos de aparejos. Nasa comercial (CP, 2x1 pulgadas de tamaño de malla, 35 nasas), y nasa experimental (EP, 1x1 pulgadas de tamaño de malla, 10 nasas). Las nasas eran colocadas a lo largo de las costas arenosas y fangosas del lago a profundidades que fluctuaban entre 1,5 y 18 m. La composición sexual no difirió significativamente entre las nasas (P>0,05) y fue de aproximadamente 11% hembras y 89% machos a lo largo de todo el año. La abundancia del cangrejo azul en las nasas fluctuó estacionalmente. Las EP produjeron 1,642 cangrejos/nasaxd, lo cual fue 2,2 veces mayor que la obtenida en las CP. La estructura de tamaños del cangrejo azul durante todo el período de muestreo fue similar para ambos tipos de nasa (P<0,05). Las distribuciones de tamaño de los cangrejos capturados con las EP y CP no cambiaron estacionalmente (P>0,05). Las CP usadas actualmente no capturan cangrejos mayores que las EP. Las EP son eventualmente usadas por los cangrejeros cuando las capturas son bajas. Sin embargo, esta nasa ha sido prohibida debido a que se cree que este tipo de aparejo no permite una renovación efectiva del stock de pesca del cangrejo azul.

Palabras claves: Cangrejo azul; Lago de Maracaibo; manejo; nasa comercial; nasa experimental.

Introduction

The blue crab *Callinectes sapidus* Rathbun, is a commercially important species and a dominant invertebrate in North American Atlantic and gulf estuaries (1-7). The geographic range of the species extends from Nova Scotia to Rio de la Plata, Argentina, and includes the Caribbean Sea and the Gulf of Mexico (8).

The blue crab supports important fisheries along Lake Maracaibo, Venezuela. Landings in 1989-1993 averaged about three million kg per year (9). The 1993 catch was 4211 metric tons, worth slightly more than $2 million to the fishermen. Fishery of blue crab in Lake Maracaibo started in 1969 (10), and currently is one of the most important fishery resources exploited by artisanal fishermen. A sharp increasing trend in both number of crabbers and number of enterprises in the crab meat industry have been observed since then. However, little is known concerning its biology and fishery.

The fishery has only produced hard crabs using crab pots as the only fishing gear from its establishment. This fishing gear was introduced in Venezuela as a modification of the Lewis' Crab Pot (11). The crab pot has become popular because it is simply constructed, easily handled, and requires relatively little time to gather the catch. Since all pots are handmade, their construction can be varied to suit local conditions, individual preference and budget.

From 1990, some restrictions have been imposed on its fishery, including regulations of mesh size and seasonal closure, because some evidences suggest that the species was overexploited. Nonetheless, these regulations have not been imposed under scientifical criteria. Fishing regulations are useful and effective tools for fishery management when applied on the basis of sound fisheries science (12). Fishing regulations should be considered when harvest or other factors prevent the attainment of specific management goals. These goals are part of a broader management plan and may be based on biological properties or socioeconomic needs (13-14). Valid uses of fishing regulations include maintaining or protecting a unique fishery, improving

or maintaining fishing quality, protecting threatened or endangered species, etc. In every situation, the purpose of fishing regulations should be clearly defined to avoid confusion and possible misapplication (15). Fishing regulations have been used extensively in recent years around the world (16), but not all regulations have been proposed, deliberated, adopted, and evaluated in a consistent and objective manner. As a result, substantial confusion regarding the efficacy of regulations exists among managers and fishers. Many perceive fishing regulations as a panacea for all existing fisheries problems. Others have promoted the use of fishing regulations that have never been proven effective. Unfortunately, improper use of an otherwise effective tool can result in negative fisher perceptions, continued decline of fishing quality, loss of agency and professional credibility, and unrealistic fisher expectations (17). The few fishing regulations adopted for managers at Lake Maracaibo, were short-lived, often politically influenced, and generally ineffective.

This study was initiated in 1993 to evaluate the effects of currents fishing methods and to formulate procedures for an effective management strategy for blue crab on the Lake Maracaibo basin, Venezuela. However, this report only presents the results of studies in 1993, 1994 and 1995 on selectivity of gears of the blue crab in the southwestern zone of Lake Maracaibo.

Study site and Methods

Lake Maracaibo, located on the western coast of Venezuela, is the most important South American lake system entering the Caribbean Sea. The southwestern zone, where the sampling was concentrated, is little influenced by tides, salinity generally ranges from 0 to 8‰ and temperature ranges from 26 to 30°C. The zone has a maximum depth of about 25 m and its substrates are primarily fine sand and mud. Along this zone, the lake receives the flow of many tributaries and during the rainy season, the lake exhibits freshwater conditions. An intensive artisanal fishery is developed in the zone.

The study was conducted three days monthly during March, June, September-November 1993; March-December 1994; and January-April 1995, for a total of 19 samples. I used crabs caught both by a commercial potter (2x1 inches mesh size designed as commercial pot, CP) and by my own pots (1x1 inches mesh size designed as experimental pot, EP). Pots were set along sandy or muddy edges of the lake in depths ranging from 1.5 to 18 m in continuous or parallel series. One day prior to the beginning day of the monthly sample, traps were pulled, emptied, and baited with fresh whole manamana (*Potamorhyna laticeps*), bocachico (*Prochilodus reticulatus*), and/or carpeta (*Eugerres plumieri*). Each trap was allowed to soak only 24 h with fresh bait. Unit fishing effort is expressed as a trap-day. The number of commercial pots depended on the success of fishing in the locality but usually 50-100 per potter. In my case, catch reported by CP and EP, represents catch per 35 and 10 pots, respectively. Commercial potter and I lifted our pots twice daily working from small outboard motor boats 10 m in length. All crabs from each catch were counted, measured to the nearest mm from point to point across the width of the carapace, weighted to the nearest gram, and sexed. Catches by gear, sex, and month were analysed using SAS (Statistical Analysis System) general linear models procedure, and tested for significant differences (18).

Results

Fourty five traps were fished on 57 days during the 19 monthly periods and caught 2464 blue crabs. 35 CP accounted for 62% of the total catch. Of the 1528 crabs caught with this trap, 88.4% were male and 11.6% females. 10 EP accounted for 38% of the total catch. Of the 936 crabs caught with this trap, 88.1% were male and 11.9% females.

In a year-round basis sexual composition did not differ significantly among gears (P>0.05). The sexual composition of the commercial and experimental catches was about 11% females and 89% males (Figure 1).

The abundance of blue crabs caught in pots fluctuated seasonally (Figure 2). Experimental traps produced 1.642 crabs/trap.d, which was 2.2 times higher than commercial traps. Male, female, and total catches from experimental traps were significantly different from those of the commercial traps (P<0.05, Table 1).

The size structure of blue crabs sampled over the 19 monthly periods was similar for both gears (Kolmogorov-Smirnov tests, P<0.05; Figures 3 and 4). Both males (Commercial: mean= 105.2 mm; range: 62 to 194 mm. Experimental: mean= 99.4 mm, range: 55 to 160 mm) and females (Commercial: mean= 85 mm; range: 60 to 115 mm. Experimental: mean= 82.7 mm; range: 58 to 131 mm) had unimodal distributions. Size-frequency distributions of crabs caught with EP and CP did not change seasonally (Kolmogorov-Smirnov tests, P>0.05).

Discussion

There are few studies concerning selectivity of gears of blue crabs (e.g.: 19-21). Except for Villasmil's (22) technical report, no other study has accounted for selectivity of gears at Lake Maracaibo. Nonetheless, this report only refers to differences among plastic and galvanized pot wire.

Width distributions of blue crabs do not differ significantly among gears. Crab pots now in use (2x1 inches mesh size) at Lake Maracaibo, do not take crabs larger than those designed as EP (1x1 inches mesh size). EP are eventually used by crabbers when catches are low. However, this gear has been prohibited from 1990 because of it was thought this type of gear did not allow an effective renewal of the crab fishing stock.

Blue crabs in Lake Maracaibo exhibited marked seasonal cycles in abundance but

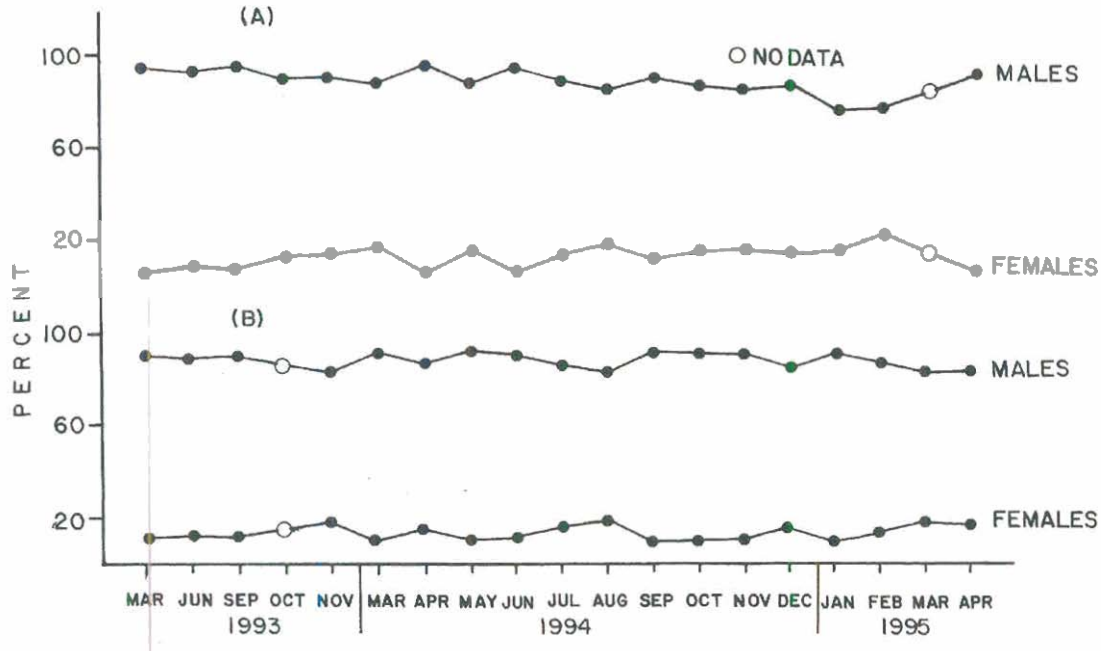

Figure 1. Sexual composition of blue crabs caught in pots in Lake Maracaibo. A-Experimental pots, B-Commercial pots.

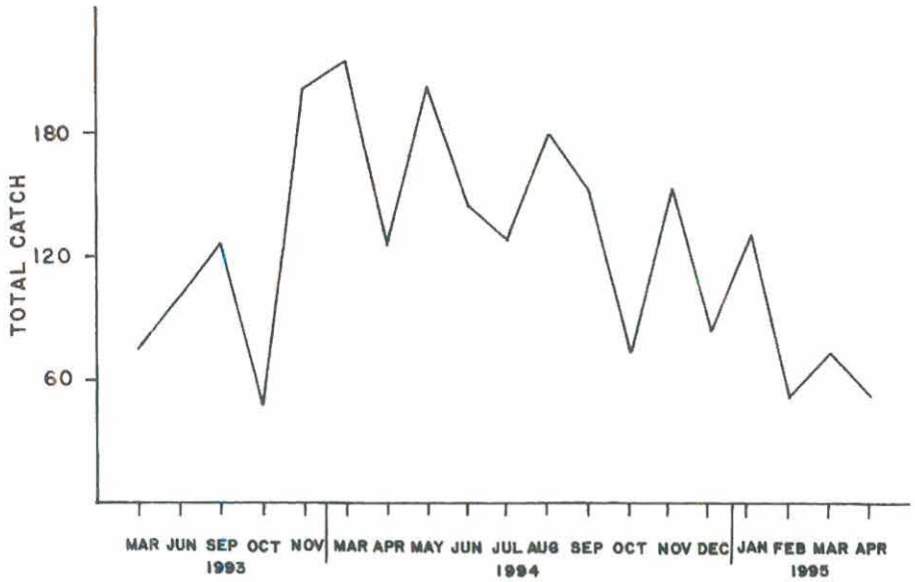

Figure. 2 Abundance of blue crabs caught in pots during 1993 to 1995.

Table 1
Mean catch of blue crabs per trap-day

	Trap Type	
Crab Type	Commercial	Experimental
Males	0.677	1.447
Females	0.089	0.195
Total	0.766	1.642

there was not evident trend of peaks (both low as high catches) during the study. Lowest catch was observed in October 1993 (47 crabs) and highest catch in March 1994 (213 crabs). Large annual fluctuations in abundance is characteristics of blue crabs populations in Lake Maracaibo (9, FONAIAP unpublished data).

The size structure of the crab population also showed a consistent pattern each year. Only one size-class mode in carapace width for both males and females was presented all around the year. Unimodal size-frequency distributions would indicate that the population was composed of 2 or 3 superimposed year classes, and that there is a constant flux of new recruits from the northern saline zone to the southern Fresh- Water zone. The historical and popular conception of the life history of the blue crab in Lake Maracaibo is that zoeae and megalopae are produced and retained in the highly saline portion of the northern end of the lake and that their further development to juveniles within the lake precede migration to the nursery grounds in the lower salinity regions.

Implications for management

Blue crabs have been Lake Maracaibo's second most valuable seafood crop since about 1980, and annual production has generally ranged between 2000 and 5000 tons

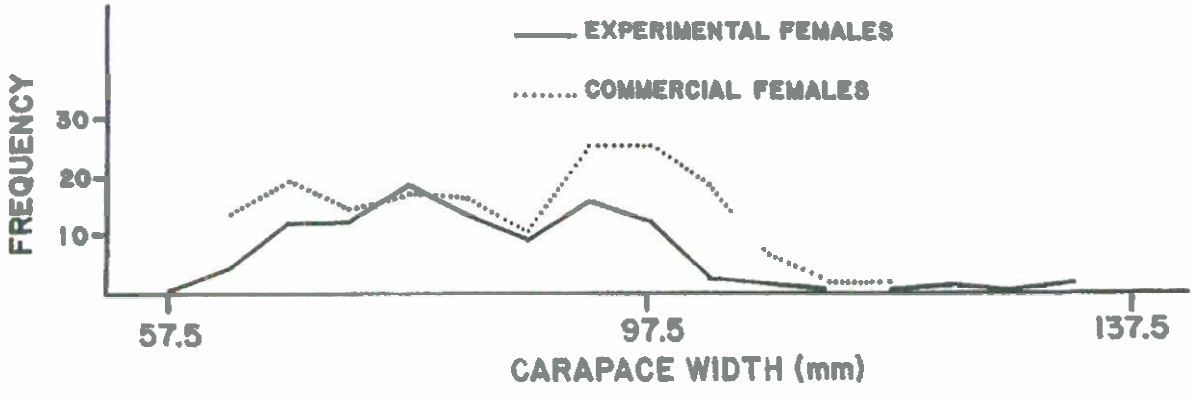

Figure 3. Size-structure of female blue crabs caught in pots in Lake Maracaibo, based on crabs caught over all samples (1993 to 1995).

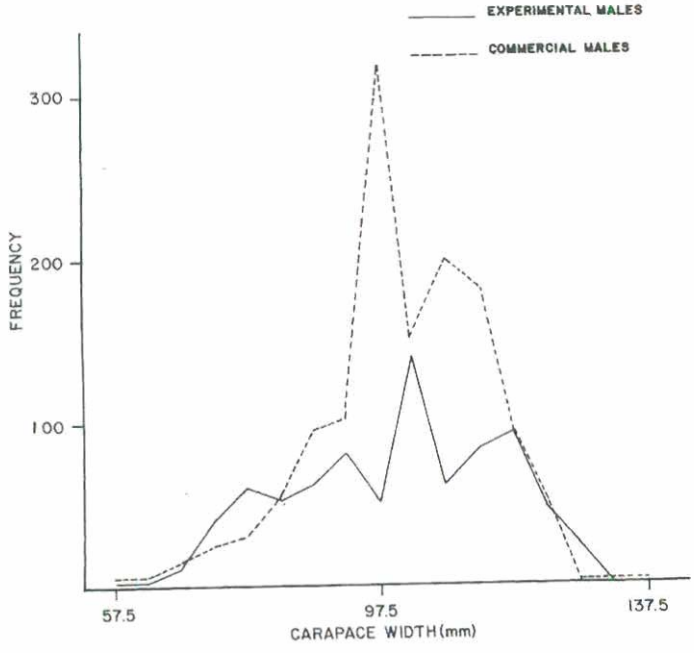

Figure 4. Size-structure of male blue crabs caught in pots in Lake Maracaibo, based on crabs caught over all samples (1993 to 1995).

(9). Principal explanations for fluctuations in landings may lie in variations of any one or a combination of the following factors: 1) fishing effort, 2) the parent-progeny relationship, and 3) the atmospheric and oceanographic environment (23). Nevertheless, progress in relation to these facts has been hindered by the unavailability or incompleteness of biological, environmental and landings data, and particularly the uncertainty of their reliability. Daily landings of crabs are determined by 1) their availability, that is, the portion of the total population susceptible to capture, and 2) the intensity of fishing. Fishing intensity for crabs in the Lake Maracaibo basin is very high. Each crabber set about 100 pots 7 days a week. Villasmil (9) has determined that the total effort is about 190000 pots/year.

Protection of blue crabs fishing stocks in Lake Maracaibo has been attempted in a variety of ways in the past. Recently, mesh size, seasonal closure, and other regulations have been established in order to prevent stock overfishing. My findings indicate that these regulations do not assure an effective and rational management of the fishing stocks of the blue crab in Lake Maracaibo. Then, the question that arises is how does this resource should be managed?. There are three approaches to modeling populations: 1) an empirical method in which fishery trends are associated with trends in environmental variables, 2) the surplus-yield model which requires an input of catch and effort data, and 3) the dynamic pool model for which we need details of the biological characteristics of the stock, such as growth, mortality and recruitment rates. An examination of some of the Lake Maracaibo blue crab population parameters seems to suggest that a spawner-recruit model would not be useful in setting a management policy, as it is not density-dependent. The species exhibits large interannual fluctuation in production, rapid growth, early attainment of maturity, high mortality rates and short life span. Those (together with others) are the characteristics of a density-independent species, exposed to a variable environment in which population's resources are spent mostly on reproductive functions. In short, the blue crab appears to be an r selected strategist. Because of these characteristics, the blue crab can be fished at high levels of fishing effort, and, because of the short life span and rapid succession of year classes, would have a quick recovery if overfishing occurred. Species with such characteristics are strongly affected by physical, chemical and biological environmental factors (24). It is axiomatic that for populations fluctuating widely as a response to environment variation that the maximum sustained yield cannot be realistically estimated. Therefore, I believe the exact mechanisms through which environmental factors affect year class strength must be determined. It is believed that they occur at critical times early in the life cycle of the blue crab (23). However, further testing must be conducted to understand their intricacies.

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