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DEVELOPMENT OF A SWIMMING CRAB FISHERY IN ECUADOR

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DEVELOPMENT OF A SWIMMING CRAB FISHERY IN ECUADOR

by

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INTRODUCTION

Since the 1950's, lesser developed countries have made increasing efforts to examine their fishery resources. Fishery development activities have multifaceted objectives but basically one overall goal: to improve the well-being of the people in the country through the utilization of their fishery resources (Royce, 1988). Fishery development includes activities which directly contribute to the improvement of the quality of life in rural and low income communities by providing food or increasing employment in fishing and supporting activities, or activities which contribute to the national economy through the reduction of dependence on imported food, increased export products or by stimulating national investment in fisheries (Allsopp, 1985).

In the past, Ecuador's focus has been on industrial level fisheries for small pelagic species (mackeral, sardines and threadfin herring) and tuna (Herdson et al., 1985). However, during the last decade, the rapidly expanding shrimp farming business has dominated the fisheries scene and become Ecuador's leading non-petroleum export commodity. In 1983, Ecuador emerged as the world's leading producer of farmed shrimp with an estimated 36,600 mt production (Sonu, 1985). However, this increase in shrimp production has been accompanied by several depressions in the trend caused by environmental changes and technological problems. These periodic decreases in production have caused considerable concern and promoted the development of hatchery operations, as well as a search for alternative fisheries.

In 1986, a project was initiated by The University of Rhode Island (URI) with their Ecuadorean counterpart, Escuela Superior Politecnica del Litoral (ESPOL) to investigate the potential for the development of a fishery for underutilized species of portunid swimming crabs. Based on previous field observations and conversations with commercial and artisanal fishermen, it appeared that swimming crabs were a non-utilized by-catch of the shrimp trawlers and artisanal fishermen. No information on the identification, life history, abundance or distribution of these crabs was available in Ecuador, nor had these crustaceans been considered in previous investigations for the development of alternative fisheries of underutilized species (FAO, 1978; Moran and Lopez, 1984; US Dept. of Commerce, 1982).

Potential for the development of this fishery is great. All species of Callinectes swimming crabs are apt for human consumption and produce a highly acceptable food product if properly processed (Williams, 1984; Norse and Fox-Norse, 1979). The blue crab, Callinectes sapidus is one of the most valuable crustaceans in the United States next to shrimp and lobster (Vondruska, 1986; Moss, 1979; Sholar, 1979). It is the basis of a fishery that in the 1980's is producing an annual average of 185 million pounds of whole crab worth approximately $52 million dollars (Vondruska, 1986).

Other Latin American countries have recently begun venturing into the crab fisheries; Mexico is currently harvesting 6 million pounds annually of C. sapidus, Callinectes rathbunae, Callinectes similis and Arenaeus cribarius using artisanal methods along the eastern Gulf of Mexico coast (Sarinana, 1986). In 1985, a small industry specializing in soft shell crab products was initiated in Veracruz, Mexico, with capacities of shedding up to 27,000 crabs and packing of 30 dozen soft crabs daily (Malo, 1986). Recommendations have been made for the development of a crab fishery on the Pacific coast of Mexico for Callinectes arcuatus, Callinectes toxotes and Callinectes bellicosus (Tableros, no date; Paul, 1982a and b). Callinectes spp. form part of the export industry and local market in Columbia (Estevez, 1972; Taissoun, 1969). Currently, demand exceeds the supply of domestic crab meat in the United States and USA processors have supplemented their supply with imported crab meat from Brazil, Venezuela, and Mexico (W.F. Conley; M. Oesterling, personal communications).

Several basic criteria must be satisfied before a successful crab fishery can be established (Van Engel, 1974): the species must be present in consistent levels of high abundance; the species should be vulnerable to fishing gear; the species must be relatively large, easy to handle, transport, process and market; and the product must have consumer acceptance and potential market. In order to evaluate each of these criteria the project was divided into two phases with the following objectives:

PHASE I:

(a) conduct a preliminary resource survey of coastal and estuarine waters
(b) study the abundance and distribution of swimming crabs in Guayas estuary
(c) determine the catchability of the swimming crabs in the Guayas estuary using a variety of fishing gear

PHASE II:

(a) develop processing technology
(b) investigate potential markets for the product

Phase I is nearing the end of its first year of investigation, and preliminary results are summarized in the sequel. Phase II initiation is dependent on the results of Phase I.

MATERIALS AND METHODS

Ecuador extends 950 kilometers along the western coast of the South American continent between the Latitudes of 1°00'N to 3°20'S. The country is bordered by Columbia to the north, Peru to the south and east and the Pacific Ocean to the west. The configuration of the coastline is irregular, consisting of alternating bays and capes terminating in the Guayas estuary and the Gulf of Guayaquil (Figure 1). This is the largest estuarine system on the western coast of South America and receives the runoff of almost twenty rivers.

The ocean is defined as sub-tropical. The coast receives the influence of the Tropical Surface Water Body of the North Pacific with water temperatures exceeding 25°C and with a salt content below 33.5 ppt. Tides are semidiurnal with a period of 12.42 hours (Lorbor, 1985).

The climate is considered tropical and is divided into two distinct seasons. The wet season is characterized by heavy rainfall and extends from December through April. The dry season is cooler and includes the period from May through November.

The preliminary resource survey was conducted during the dry season (July) of 1986. Seven locations were chosen as sampling sites along the Ecuadorean coast covering the three major estuarine systems: Esmeraldas (Esmeraldas River), Bahia de Caraquez (Chone River) and the Guayas estuary (Guayas River). A total of 41 trap samplings were made in these areas. Biological and environmental data were recorded and crabs were identified according to Williams (1974) and Garth & Stevenson (1966).

Experimental fishing for Callinectes spp. crabs was conducted in the Guayas estuary during the wet season (January) and the dry season (June-August) of 1987. Sites were chosen in three areas based on expected salinity differences in the upper, middle and lower estuary (Figure 2). Four types of fishing gears were simultaneously fished

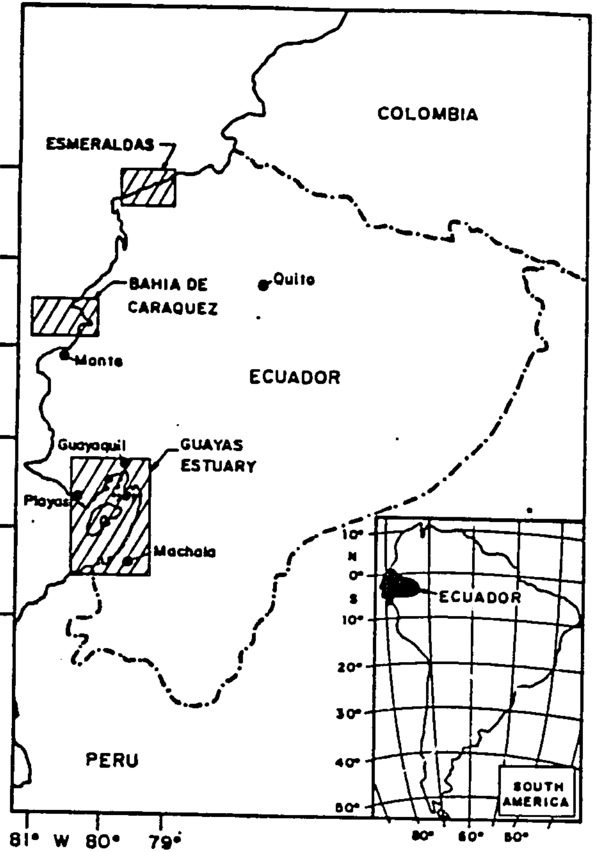


Figure 1. Map of Ecuador showing the three study areas for the preliminary resource survey.

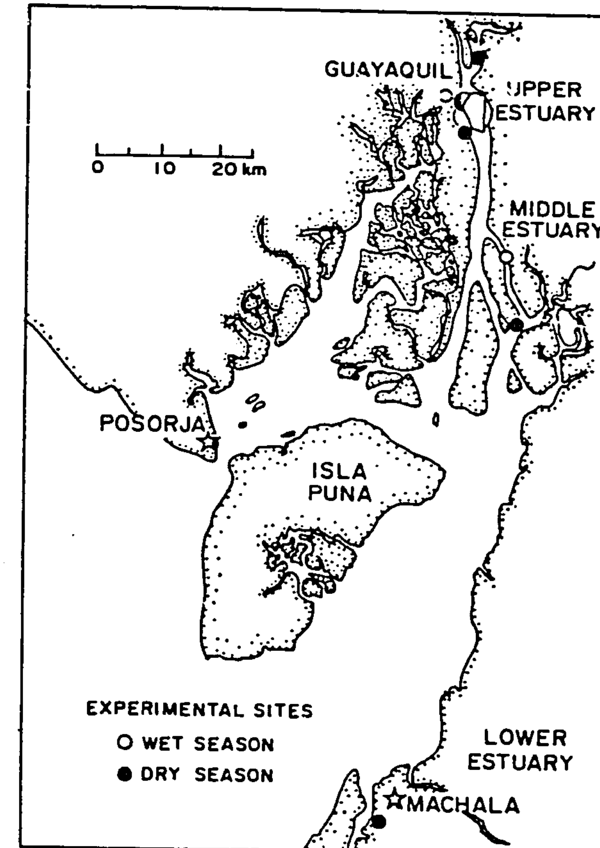


FIGURE 2. Map of Guayas Estuary showing the sampling sites for experimental fishing.

at each site: Chesapeake Bay style crab traps (Van Engel, 1962), trotline, gillnet and lift nets. Five Chesapeake Bay style baited crab traps were constructed of locally available galvanized rectangular mesh wire with a mesh opening of 2.5 x 5 cm. Each trap measured 65 x 65 x 52.5 cm and had four entrance funnels. A smaller trap with a mesh size of 2.5 x 2.5 cm was also employed during the January sampling to capture juveniles; however, use of these was discontinued due to the possible exclusion of the larger animals. Two 30m trotlines baited every 1.5 m were fished twice per hour. These were constructed of 1 cm diameter, hard lay nylon and anchored at both ends. Five baited liftnets were constructed with a square iron frame, covered with 1.2 cm webbing. These were lifted twice per hour. Two 30 m gillnets with 7.6 cm stretched mesh were constructed of soft lay polyamide webbing. Traps, trotlines and liftnets were baited for each set with locally available species. These included Chloroscombrus orquesta, Selene perviance and Scomber japonicus. All gears were fished simultaneously for 3 hour periods. Fishing effort is expressed as gear-hour which represents one unit of gear with a one hour soak.

All crabs collected were identified, measured (carapace width) and weighed. Carapace width refers to the distance between the tips of the longest cephalothorax spines. General appearance of the crabs was noted, including sex, maturity and loss and regeneration of appendages. Environmental data including sediment type and bottom and surface temperature, salinity and dissolved oxygen levels were recorded.

RESULTS AND DISCUSSION

Resource Survey

The existence of five species of portunid crabs inhabiting the coastal and estuarine waters of Ecuador, as suggested by Williams (1974), was confirmed during these investigations. Callinectes toxotes and Callinectes arcuatus were captured in estuarine areas while samples of Euphylax robustus, Portunus asper and Cronius ruber were obtained from fishermen working in offshore areas. Initial indications suggest that these latter three species are not of sufficient size or quantity to support a fishery, although Hendrickx (1985) indicates that the large abundance of the genera Portunus and Euphylax in trawl nets in the Gulf of California may support a fishery in that area.

The apparent abundance and size of the two Callinectes species and conversations with artisanal and commercial fishermen suggest the presence of a large unexploited resource in Ecuador. No abundance estimates can be calculated as a result of this preliminary phase of the resource survey, but previous investigations in other geographic areas have indicated that these species are found in high concentrations. Dittel et al. (1985) reports that C. arcuatus in Costa Rica has potential commercial importance. Paul (1981) and Tableros (no date) studied abundance, breeding and growth of C. arcuatus and C. toxotes in a lagoonal estuary on the Pacific coast of Mexico and suggest that a crab fishery would coincide with a lull in the shrimp fishery, providing income at a time when local fishermen are unemployed. It is possible that the Ecuadorean swimming crab population does not equal the proportions found in other areas, but the preliminary results of the resource survey suggest that the two species exist in sufficient quantities to warrant further investigations.

Callinectes toxotes was the largest of the swimming crabs found in the Guayas estuary and has been described as the largest species in the genus (Williams, 1974). The largest specimen captured measured 22 cm in width, and weighed 660 gr. The average size of C. toxotes captured was 14.5 cm, ± 1.9 with average weight of 211 gr. ± 89. Callinectes arcuatus, a smaller species, had a mean carapace width of 10.3 cm ± 1.8 and weight of 60 gr. ± 30. Average carapace width and weight for both species for each area summarized in Table 1.

Abundance and Distribution

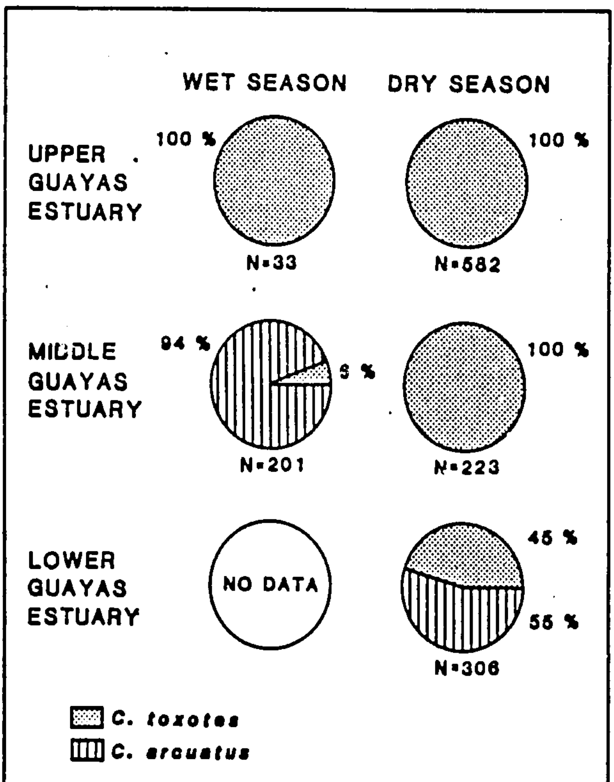
A detailed investigation of the abundance and distribution of the Callinectes spp. in the Guayas Estuary is currently being conducted by ESPOL. However, limited observations to date have indicated that the species distribution found in Ecuador is similar to that described by Norse and Estevez (1977) along the Pacific coast of Columbia, where C. toxotes dominated the less saline estuarine areas but was replaced by C. arcuatus in the higher salinity areas with some overlap in intermediate and high salinity areas (Figure 3). They suggest that salinity plays an important role in the distribution of the Callinectes species and describes both as being euryhaline.

The distribution and relative abundance results illustrate that the two Callinectes spp. appear to be spatially and temporally restricted to areas of the Guayas estuary. A shift in the distribution of C. arcuatus was

TABLE 1
Average Carapace Width (CW) and Weight (WT) for
Callinectes toxotes (TOX) and *Callinectes arcuatus* (ARC) Crabs Captured

	Wet Season				Dry Season			
	TOX		ARC		TOX		ARC	
	CW (cm)	WT (gr)	CW (cm)	WT (gr)	CW (cm)	WT (gr)	CW (cm)	WT (gr)
Upper Guayas Estuary	11.9	113	•	•	14.7	198	•	•
Middle Guayas Estuary	15.1	320	11.3	69.5	13.4	219	•	•
Lower Guayas Estuary	•	•	•	•	15.3	250	9.1	48.7

FIGURE 3. Species composition in the Guayas Estuary.



observed in the middle estuary between the two seasons. Although salinity is thought to play a major role in the distribution of this species, it seems unlikely that the small differences in salinity during the sampling periods (from 15-18 to 19 ppt) is responsible for causing such a major shift in distribution. Other environmental factors may be influencing this change in distribution, as well as the life history and behavior of these crabs. No shift in species composition was seen in the upper estuary (0.1 - 5.0 ppt), although there was an indication of size difference. No data is available for the wet season of 1987 for the lower Guayas estuary.

If C. toxotes and C. arcuatus follow a similar pattern of distribution as Callinectes sapidus, a differential distribution by sex and maturity can be expected. Mating would occur in the fresher areas of the estuary, with females later migrating to estuary mouths to spawn, resulting in the dispersion of the larvae into the offshore high salinity waters (Hail, 1984). Little data is available on the spawning habits of C. toxotes, although Williams (1974) mentions that the distribution of ovigerous females is presumed to be similar to that to C. sapidus.

Assuming that the combination of gears eliminated individual gear biases and catches represented the actual population structure, preliminary results indicate differential distribution of C. toxotes by sex and maturity in the three sites during the dry season sampling period (Figure 4). Data from the wet season are not included in the analysis due to the small sample sizes collected. Chi-square contingency table analysis was used to test population differences between the three sites. Results indicate significant differences in the distribution of mature males ($P < 0.001$), immature males ($P < 0.001$), mature females ($P < 0.001$) and immature females ($P < 0.05$). In general, during the dry season, more mature males were observed in the lower estuary; more immature males were found in the middle estuary, more mature females were found in the upper estuary; and more immature females were found in the upper and lower estuary. These results do not indicate a similarity to the distribution described for C. sapidus, although data were restricted to a three month period and patterns may not be completely illustrated. A possible complication in the description of the distribution of C. toxotes may be due to distinct populations of the species in the different sites. Campbell and Mohn (1983) defined a stock to be a group of individuals that sustains itself over time and responds in a similar way to environmental changes within a discrete geographical area. Gene flow may occur between stocks. If two or more stocks

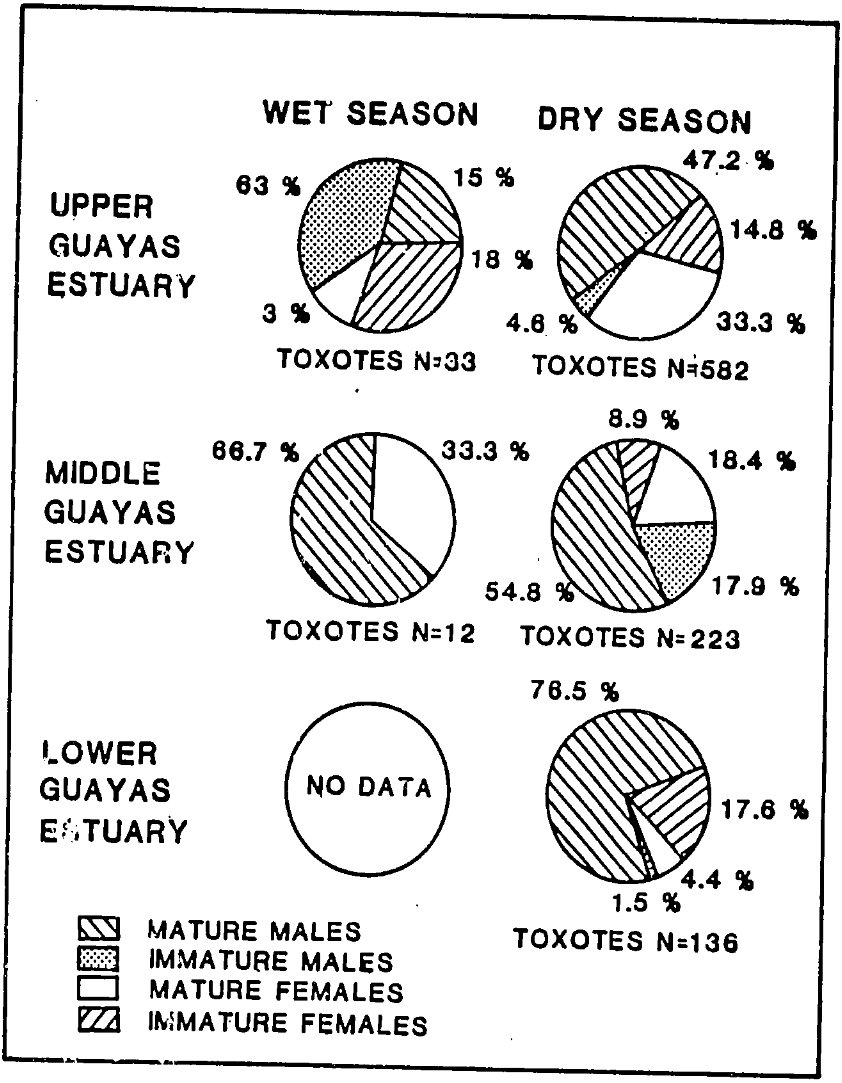


Figure 4. Sex and maturity of Callinectes toxotes in the Guayas estuary.

are present in these diverse environments, distribution by sex and maturity may not be discerned until populations can be identified.

The majority of the C. arcuatus captured in the sampling periods were males; principally mature males were found in the middle Guayas estuary, and mature and immature males were found in the lower estuary (Figure 5). Very few females were captured, which suggests their absence from the estuarine areas sampled. Dittel and Epifanio (personal communication) in their investigations on C. arcuatus in Costa Rica, captured mostly females, but their sampling was conducted by trawling offshore in the Gulf of Nicoya area. The offshore waters were not sampled in this study, but literature supports the theory that C. arcuatus and C. toxotes may form large breeding populations in coastal waters throughout the year (Hendrickx, 1985) and that the estuarine phase of the life cycle is a growth phase as suggested for Callinectes latimanus in Ghana (Kwie, 1978). Paul (1982a and b) found that in Mexico, the female C. arcuatus continue their migration out of the estuary and continue spawning out on the continental shelf.

General aspects of size and weight are of considerable interest to both fishermen and ecologists. Of even greater interest to fisheries managers is size or age at sexual maturity. Age is difficult to determine for decapods in general, but size (width/length) can be used to set some limits for sexual maturity although these can vary in different geographical locations. Sexual maturity is an important parameter because it may indicate the start of reproductive activity, although Cobb and Caddy (in press) make a distinction between functional and physiological maturity in Homarus americanus. Through management regulation of gear, fishing season or location, a certain percentage of the immature population can be protected and allowed to contribute to future recruitment before becoming accessible to fishing gears.

There are many methods for determining sexual maturity in female crustaceans, ranging from ovarian development to the presence of extruded eggs. Callinectes females undergo a terminal pubertal molt during which they must become fertilized. The post-molt configuration of the abdomen radically changes, indicating that the female is mature. The maturity of males is not considered to be as important a factor in recruitment or management because they can mate several times with several females during their lifetime. Maturity is indicated by the internal presence of developed testes and vas deferens and externally by the looseness of their abdominal flap. Immature males have the flap closed

Figure 5. Sex and maturity of Callinectes arcuatus in the Guayas estuary.

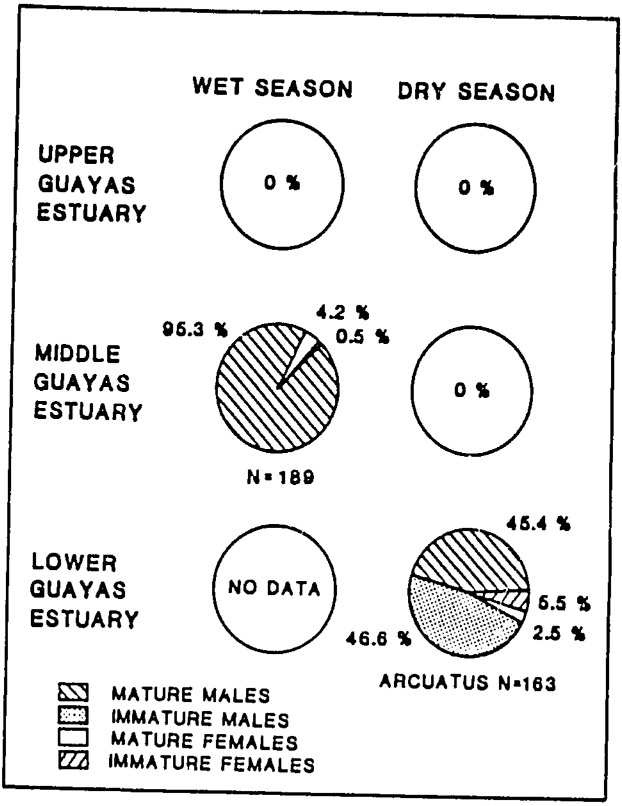


TABLE 2
Catch per Unit Effort (CPUE)

	Wet Season		Dry Season			
	Lg Mesh Traps	Sm Mesh Traps	Lg Mesh Traps	Gillnet	Lift Net	Trotline
Up. Guayas Est.	0.27(4)	0.09(2)	0.77(123)	1.03(8)	0.49(25)	0.85(10)
Mid. Guayas Est.	0.82(7)	0.95(5)	0.55(62)	0.23(8)	1.50(20)	0.92(8)
Low. Guayas Est.	-	-	0.37(131)	0.42(4)	0.67(10)	0.08(4)
Average	0.62(11)	0.70(7)	0.56(316)	0.59(20)	0.89(55)	0.73(22)

Note: Number of replicates are indicated by parenthesis.

and efforts to force it open result in breakage. Mature males are easily pried open (Haefner; Van Engel, personal communications).

Results of size at sexual maturity in animals captured in this investigation indicate that immature male C. toxotes range from 2.1 to 17.5 cm. The 50% mature/immature range is between 10.6 and 11.0 cm in width. Immature female C. toxotes range from 1.1 to 17.0 cm in width with the 50% mature/immature size between 13.6 and 14.0 cm. Immature male C. arcuatus range from 5.1 to 12.5 cm with the 50% mature/immature size between 8.6 and 9.5 cm. Immature females C. arcuatus range from 4.6 to 8.0 cm with 50% mature/immature size range between 7.6 to 8.0 cm (small sample size).

Catchability

The blue crab in the United States may be subject to the most diverse kinds of fishing gear for any single species (Haefner, 1985). Gears can range from a simple baited hand line to the 50 kg crab dredge used in the winter months in the Chesapeake Bay. Only a few gears have proven to be economically practical on a commercial basis (Sholar, 1979): crab traps (80%), trotlines (10%) and dredges (10%). In Ecuador, there are technological, social, cultural and environmental factors that must be considered in the selection of the appropriate harvesting gear. The final recommendation for the most appropriate harvesting gear will be a compromise between these factors as well as catch per unit effort or performance data for each type in the Guayas Estuary.

Gear performance is measured by the catch per unit effort (CPUE) which is defined in this study to be the number of crabs caught in a one hour period by one defined gear unit. Average CPUE for each gear was obtained by taking the mean for all replicates used in each site. These are summarized in Table 2. Data from the wet season were not included in the statistical analysis due to the small sample size. Gears performed differently in each site and in relation to each other. Unlike the results obtained by Bishop et al. (1984), no similar patterns among gears were observed between sites. The gillnet produced the highest CPUE in the upper estuary in the dry season while liftnets produced the highest CPUE in the middle and lower estuary.

Since variability in CPUE between replicates and trials was great, ANOVA analysis showed no significant differences in CPUE, as defined in this study, in gear type in the upper and lower estuary during the dry season. However, liftnets produced a significantly higher CPUE than either gillnets or traps in the middle estuary ($P < 0.001$).

The width frequencies (sizes) of the crabs captured per gear type over the sampling period were analyzed with the Kruskal-Wallis non-parametric test. Significant differences were seen in the upper estuary ($P < 0.005$) and the middle estuary ($P < 0.05$). In both sites, smaller crabs in the catch of the liftnet were present. This probably accounts for the higher CPUE of the liftnets in the middle estuary due to the great number of small crabs caught by this gear. All other gears did not retain the smaller animals. In the lower estuary there were no significant differences between the width frequency of the total catch and the gear involved, although the number of crabs captured was much lower than other sites.

To examine the possibility of sex or maturity influencing the selectivity of the gears, the percent catch composition of immature, mature females and males were analyzed using a one-way analysis of variance. No significant differences between gears were found in the upper or lower estuary for the capture of C. *toxotes*. However, in the middle estuary a significant difference was found in the CPUE of immature males in liftnets, which coincides with the results pertaining to the retention of smaller animals by this gear and the availability of this size crabs in this site. Liftnets additionally demonstrated selectivity for immature C. *arcuatus* in Machala.

In summary, gear type using the unit-effort defined in this study did not affect the catch of marketable (mature) crabs. Liftnets produced a higher CPUE because of the inclusion of the smaller, immature crabs which would not be marketable; however, this gear did provide a less biased sampling method for examining species distribution. Due to the mesh size available for trap construction, small animals were not retained. Gillnets did not retain juveniles, for unknown reasons; and when fishing trotlines, small crabs were usually not spotted while raising gear and dropped off or fell through the meshes of the fishing basket.

The CPUE of both trotlines and liftnets can be dramatically changed if soak times are altered; if fished at shorter intervals, the CPUE can be expected to increase. The CPUE for gillnets and traps are subject to saturation effects with increasing soak time so CPUE may actually decline with increasing soak time.

Environmental parameters did not appear to affect the CPUE of any gear, although other authors have confirmed the effects of many. Moon phase has been shown to cause variations in catches of *C. sapidus* premolt females (Bishop et al., 1984), reef fishes (Munro et al., 1971) and lobsters (Chittleborough, 1970). Effects of increased temperature on catchability has been documented with the rock lobster (Chittleborough, 1970). Although salinity and oxygen levels play significant roles in the distribution of *Callinectes* spp. (Norse, 1975), no information is available on their effects on catchability. Changes in salinity are known to cause physiological changes in *C. sapidus* such as increased respiratory activity when crabs were transferred from seawater to dilute salinities (Norse, 1975).

The presence of high or low oxygen levels may be responsible for changes in the distribution of *Callinectes* spp. *C. sapidus* is known to tolerate O_2 tension as low as 0.08 mg/l in estuarine tertiary sewage treatment pools, but crabs confined in baited traps in the Chesapeake Bay suffered a 25 percent mortality at O_2 concentrations of 0.6 mg/l at temperatures above 28°C (Williams and Duke, 1979). Loesch (1960) described a shoreward migration phenomenon, termed jubilees, for fish and crustaceans in Alabama. He postulated that animals were escaping low oxygen, high salinity bottom water by congregating on the surface. There is verification of *Callinectes* crabs actually leaving the water in an area believed to be low in oxygen. More information is required to clarify relationships between CPUE of these crabs and environmental parameters.

Since most of the resource survey was conducted during the dry season (July - August), only partial answers to the original questions proposed in this study can be addressed. To completely describe the distribution and relative abundance of these species, a minimum one year sampling should be conducted at designated sites due to possible seasonal variations. However, this study provides insight into potential harvesting areas and techniques which could be utilized by artisanal and commercial fishermen in Ecuador.

Artisanal fishermen are the main source of fresh fish for the Ecuadorian population. There are no estimates of the number of artisanal fishermen in the Guayas estuary because of the dispersed nature of the villages and homes along the shoreline. A large number of fishermen are thought to be located in Estero Salado, Puna Island and the Guayas River, including many fishing in the polluted waters of Guayaquil (Herdson et al., 1985). The majority of the vessels in common use by these fishermen are small, non-motorized dugout canoes between 3 and 10 m in length. Most non-motorized fishermen plan their fishing activities in coordination with the tide. Tidal flow carries them to their fishing site; fishing occurs at slack tide and then reverse tidal flow carries them home or to market. Fishing activity from start to finish may only last between 3 to 6 hours.

The gear most utilized in the Guayas estuary by small-scale fishermen is the gillnet (and trammel net). Traditional gear such as this could be used with little modification to capture crabs in marketable quantities without requiring the introduction of new or more expensive gears such as the trap and trotline. The cost of one gillnet used in the study with new material was approximately 11,000 sucres (US$52) in 1987 (Table 3). Gillnets do not fish well in the heavy currents and fouling occurs frequently. Boat traffic and theft require constant supervision by the owner.

A form of liftnet is currently being used to fish crabs in the Guayas River. These can be manufactured at little cost by utilizing discarded materials. The cost of new line, buoys and frames for 10 liftnets was approximately

TABLE 3. Approximate costs of (sucres) material for gears used inthis investigation.

Gear	Trap (10)	Liftnet (10)	Gillnet (1)	Trotline (1)
Fixed costs				
Quantity	10	10	1	-
Wire Mesh	975	-	-	-
Line	3000	600	1286	643
Buoys	2500	2500	3750	500
Rebar frame	1667	1667	-	-
Webbing	-	min.	6000	min.
Lead	-	-	-	-
Man-hours	10	3	5	1
Operating Costs				
Bait	50-1000	50-1000	-	50-1000
Total	16917-	4767	11036	1143

*1 dollar = 191 sucres in 1987.

4000 sucres. Bait can be purchased for 50 to 1000 sucres/box depending on quality and availability. Liftnets are easily maneuvered from boats or bridges, and can capture more than one animal at each lift.

Traps offer many advantages in terms of producing less variable catches, fishing in heavier currents and being a passive gear. However, the expense of the material to construct this gear (17,000 sucres/10 traps, US$92), its large size and loss rate may cause this to be a less favored gear. Trotlines are less expensive in regards to construction (1000 sucres, US$8.4), however cumbersome in terms of baiting and manipulating the line and basket. Fishing operations with trotlines are hindered with moderate wind and currents.

Other traditional gears employed by Ecuadorean artisanal fishermen are the handline and castnet. Handlines are fished similar to the liftnet, although limited to capturing one crab at a time. Cast nets employed initially in this study did not appear to capture swimming crabs well. Through conversations with artisanal fishermen employing this gear and observations of fishing activities, it also appeared that crabs were not captured frequently.

On the commercial level, trawlers capture large quantities of swimming crabs as a non-utilized by-catch of the shrimping operation. Due to the tow duration of three to four hours, crabs are usually in poor marketable condition. Aimed trawling for these species would require significant changes in the fishing operation to ensure a marketable product.

If the assumption is made that the catch rate will be constant during the entire fishing time, ignoring effects of gear saturation and species interaction, CPUE can be extrapolated into expected daily catch for an artisanal fisherman working from a non-motorized vessel such as a canoe, and for a small-scale commercial fisherman with a motorized vessel less than 6 m in length (Table 4).

At present, a very small local market exists for fresh _Callinectes_ spp. crabs in Guayaquil. They are captured with handlines and liftnets by artisanal fishermen and children and vendors sell them on the streets of Guayaquil for 20 to 100 sucres each (US10-50 cents). Demand for swimming crab increases during the closed season of the preferred red mud crab, _Ucides occidentalis_, and prices up to 500 sucres each (US $2.50) have been reported. Crab processors from the United States, Japan and Turkey have visited Ecuador during

TABLE 4. Expected catch with unit effort defined in this study with assumption of constant rate of capture.

Artisanal Level				Small-Scale Commercial Level			
Gear	Units	Soak Time (hrs)	Catch	Gear	Units	Soak Time (hrs)	Catch
Trap	10	24	134	Trap	100	24	1350
Lift Net	10	8	58	Lift Net	100	8	584
Trotline	200m	8	43	Trotline	1600m	8	376
Gillnet	200m	12	43	Gillnet	1600m	12	374

this past year and a new Ecuadorean crab processing facility, "Jaiba Azul", has recently received funding to begin operations.

It is difficult to ascertain the resource potential of Callinectes spp. from this preliminary resource study, although the results do offer some encouragement. Crabs were captured in all of the areas sampled, although variability in the catch rates was due in large part to the exploratory nature of this investigation. From the preliminary data obtained thus far, the Callinectes spp. crab resource is sufficient to sustain an artisanal based fishery such as in Mexico. However, it is recommended that more detailed investigations be conducted before any large scale commercial level fishery be established for this resource.

The development of a Callinectes spp. swimming crab fishery in Ecuador could directly affect several areas relating to improving the well-being of the people of Ecuador through the utilization of a previously unexploited resource. In addition to providing an inexpensive food resource available to the poorest sector of the coastal population, the processing of the crab meat is a labor intensive operation providing substantial employment. Although crab-picking machinery is available on the market, US crab processors prefer the quality of the hand-picked product (W.F. Conley, personal communication).

As in Mexico, (Malo, 1986) the potential exists for the development of a soft-shell crab industry. Unoccupied shrimp ponds could be utilized as a semi-natural growing out pond in which shedding operations could be carefully monitored.

Crab waste products have been successfully used as fish food supplement (Haefner, 1985) and pond owners in Ecuador are currently experimenting with using crabs as potential shrimp feed for the culture ponds (M. Velarde, personal communication). Waste from crab processing, if proven to be acceptable food, could be used as a substitute for other, more expensive foods being utilized presently.

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