Gulf Research Reports

Volume 9 | Issue 2

January 1995

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DOI: 10.18785/grr.0902.01

Recommended Citation

Waller, R., H. Perry, C. Trigg, J. McBee, R. Erdman and N. Blake. 1995. Estimates of Harvest Potential and Distribution of the Deep Sea Red Crab, *Chaceon quinquedens*, in the North Central Gulf of Mexico. Gulf Research Reports 9 (2): 75-84.
Retrieved from http://aquila.usm.edu/gcr/vol9/iss2/1

Gulf Research Reports, Vol. 9, No. 2, 75-84, 1995 Manuscript received September 13, 1994; accepted November 14, 1994

ESTIMATES OF HARVEST POTENTIAL AND DISTRIBUTION OF THE DEEP SEA RED CRAB, *CHACEON QUINQUEDENS*, IN THE NORTHCENTRAL GULF OF MEXICO

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ABSTRACT Harvest potential, relative abundance, and geographic and bathymetric distribution are discussed for the red crab, *Chaceon quinquedens*, in the northcentral Gulf of Mexico. Harvest potential is expressed as the number of trapable crabs present on fishing grounds defined as depths ranging from 677 m to 1043 m between 87.5° and 88.5°W longitude. Using various estimates of the effective fishing area (EFA) of a trap, the number of trapable red crabs on the fishing grounds ranged from 3.7×10^6 to 10.7×10^6. Estimates of crab numbers suggest there is a potential for commercial harvest in the northcentral Gulf of Mexico, east of the Mississippi River. However, fishery development must take into consideration the preponderance of females on the defined fishing grounds (M:F ratio = 1:2.1) and the high incidence of ovigerous females (~20%) during much of the year. Females generally dominated at all depth strata, but the proportion of males to females increased with depth. Reduced numbers of red crabs were collected off the western Louisiana coast and a shift in depth distribution was found. Minimum upper depth limit for red crabs west of the Mississippi River was 860 m as compared to 677 m east of the River. The known range of *C. fenneri* is extended to 92°12"W longitude.

INTRODUCTION

Deep-water crabs of the family Geryonidae are distributed worldwide. Manning and Holthuis (1989) revised the family to include two new genera and nine new species. The majority of geryonid species were placed in the genus *Chaceon*. The genus *Geryon* was restricted to two species, *G. longipes* and *G. trispinosus*, both from the northeastern Atlantic Ocean. Deep-water fisheries for geryonid crabs are conducted along both sides of the Atlantic Ocean. Eastern Atlantic fisheries for *C. maritae* exist off Namibia in southwest Africa (Melville-Smith 1988), and commercially exploitable quantities of *C. maritae* are found off the Ivory Coast, Congo, and Angola (Beyers and Wilke 1980). In the western Atlantic, a fishery for *C. quinquedens* was initiated in the northeastern United States in 1973 and 1974 (Ganz and Herrmann 1975). In 1980, the catch from this fishery was 2500 metric tons (Lux et al. 1982). Other western Atlantic species of *Chaceon* supporting limited commercial fisheries include *C. inghami* off Bermuda (Luckhurst 1986; Manning and Holthuis 1986) and *C. fenneri* off Fort Lauderdale, Florida (Erdman and Blake 1988).

Faunal surveys conducted by the National Marine Fisheries Service (Mississippi Laboratories) and Pequegnat (1970) suggest that geryonid crabs are widely distributed throughout the Gulf of Mexico. Lockhart et al. (1990) identified seasonal, geographic, and bathymetric distribution of *C. fenneri* and *C. quinquedens* in the eastern Gulf of Mexico. Red crabs occurred across the geographic arc sampled, with overall population densities and relative proportion of females highest in the northcentral Gulf of Mexico. Distribution of red crabs in this study was not explained by bottom type, temperature, or interspecific competition, and it was suggested that observed distributional patterns of *Chaceon* in the eastern Gulf of Mexico may be tied to reproductive strategies. Based on the timing of larval release (Erdman and Blake 1988; Erdman et al. 1991; Perry et al. 1991) and the concentration of females in the northward portion of the study range, a causal role for the Loop Current in red crab population structure was proposed.

There has been considerable interest in fishing for deep sea crabs in the Gulf of Mexico. However, efforts at fishery development have been hampered by lack of information on areal and bathymetric distribution patterns and estimates of stock abundance. The present study addresses the distribution, abundance, and harvest potential of *C. quinquedens* in the northcentral Gulf of Mexico.

MATERIALS AND METHODS

This study was designed to establish the geographic and bathymetric limits of *Chaceon* species and to determine their relative abundance from 88° to 93°W longitude. Cruises were made in May and August 1989 onboard the Gulf Coast Research Laboratory's 29.7 m steel-hulled research vessel, the R/V *Tommy Munro*. Five areas (1, 6-9) were selected for sampling (Figure 1, Table 1). Area 1 was also sampled by Lockhart et al. (1990). Trap lines were deployed at three selected depths on the day of arrival in an area and were retrieved the following day. Sample depth was varied between the spring and summer cruises to cover bathymetric distributions of *C. fenneri* and *C. quinquedens* as reported by Pequegnat (1970) and Lockhart et al. (1990). Depths sampled in May were 494, 677, and 860 m in all areas. In August, traps were set at 311, 860, and 1043 m in all areas, with the exception of Area 1 where traps were set at 860, 1043, and 1830 m. The single set at 1830 m in Area 1 was an exploratory set to examine the lower depth limit of red crabs and was not used in statistical analyses of catch data.

Sampling protocol was similar to that followed by Lockhart et al. (1990) with the exception that limited deck space necessitated use of the smaller, stackable Fathoms-Plus® trap in addition to the Nielsen designed trap (Erdman and Blake 1988). Seven Fathoms-Plus® plastic traps and a single Nielsen trap were fished at each depth within an area. Traps were baited with mixed fish (*Peprilus burti*, Gulf butterfish; *Micropogonias undulatus*, Atlantic croaker; *Brevoortia patronus*, Gulf menhaden). Trap lines were set and retrieved using a hydraulic net reel with a 1.2 m by 1.5 m spool and stern-mounted hydraulic A-frame. Traps were attached to a groundline of 1.6 cm polypropylene, 732 m in length. Beckets were spliced at intervals of 92 m for attachment of traps fished on 2 m gangions. Anchors (23 kg) were attached at both ends of the groundline. A buoyline of 1.3 cm polydacron/nylon was deployed at one end of the trap line at a scope of 2.5 times the depth. Traps were set with the vessel under power during deployment of both groundline and buoyline to ensure proper spacing between traps along the predetermined depth contour. Fishing duration ranged from 18 to 22 hours.

On retrieval of the trap line, contents of each trap were separated into species and the crabs were placed in numbered baskets in chilled seawater. Sex and carapace width (mm) were determined for all individuals. Females were examined for presence of eggs or egg remnants, and egg mass color was noted. Bottom water temperatures were measured at each trap site with a reversing thermometer.

The effective fishing area per trap (EFA) was calculated using the method of Miller (1975) which assumed that each trap fished a circular area with a radius of one half the distance between adjacent traps. In calculations of EFA of a trap, it is assumed that all traps fish the same, i.e. that there are no significant differences (alpha = 0.05) among the catch/trap along the trap line. To test this hypothesis, the catch/trap of all traps was statistically analyzed using one-way ANOVA and a multiple range test (Duncan's method). An estimate of the number of trapable crabs on the fishing grounds of the northcentral Gulf of Mexico was calculated using the formula provided by McElman and Elner (1982):

$$\text{\# trapable crabs} = \frac{1}{\text{EFA (km}^2\text{/trap)}} \times \frac{\text{mean \# crabs}}{\text{trap}} \times \text{fishing grounds (km}^2\text{)}$$

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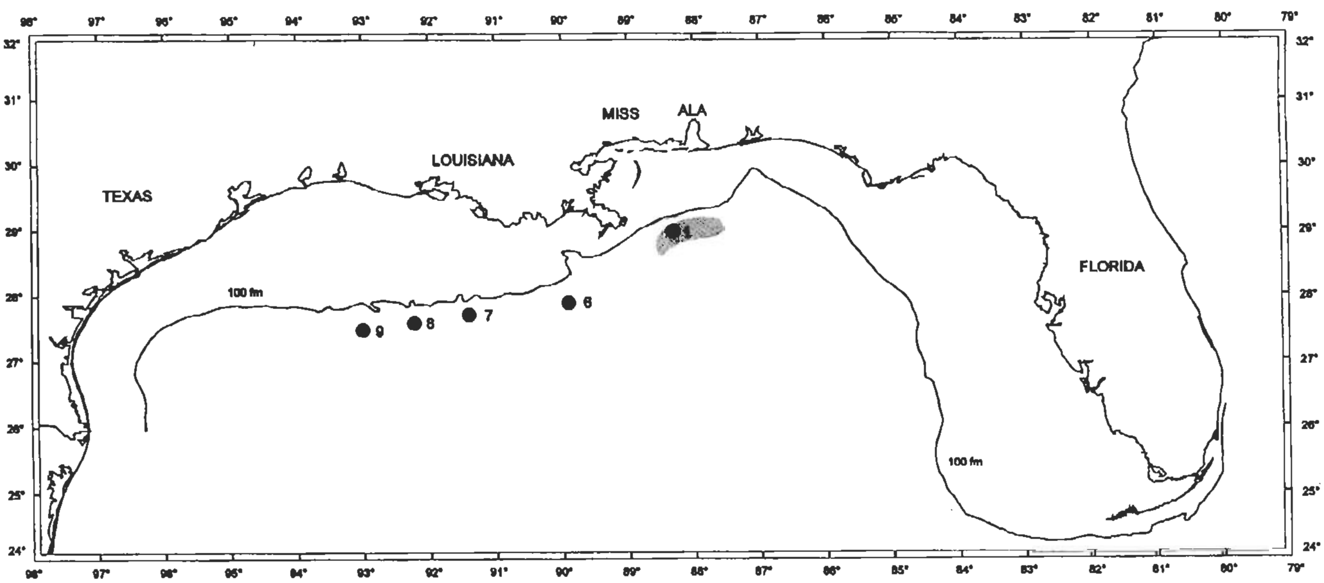

Figure 1. Location of sampling areas and fishing grounds (shaded area).

TABLE 1

Station locations by area, depth, latitude and longitude.

Area	Depth (m)	Latitude (°N)	Longitude (°W)
1	494	88° 23.00	29° 03.73
1	677	88° 24.64	29° 00.59
1	860	88° 19.27	28° 59.67
1	1043	88° 19.23	28° 56.02
1	1830	88° 08.59	28° 44.08
6	311	90° 00.01	28° 06.50
6	494	89° 56.83	27° 58.50
6	677	89° 55.88	27° 56.25
6	860	89° 54.74	27° 53.86
6	1043	89° 51.39	27° 47.95
7	311	91° 22.71	27° 50.59
7	494	91° 18.38	27° 47.82
7	677	91° 21.18	27° 44.71
7	860	91° 23.84	27° 43.20
7	1043	91° 25.80	27° 36.56
8	311	92° 04.52	27° 47.78
8	494	92° 11.89	27° 39.98
8	677	92° 12.39	27° 37.65
8	860	92° 13.99	27° 35.44
8	1043	92° 08.77	27° 33.39
9	311	93° 02.21	27° 39.15
9	494	93° 07.77	27° 33.29
9	677	93° 03.00	27° 32.88
9	860	93° 00.11	27° 29.16
9	1043	93° 08.12	27° 22.58

Fishing grounds were defined using red crab distribution and abundance data from Lockhart et al. (1990) and the present study. Fishing grounds were located at depths from 677 to 1043 m between 87.5° and 88.5°W longitude and encompassed approximately 1200 km^2.

Male to female abundance by trap set, catch/trap by depth, and catch/trap by season were statistically analyzed by a paired comparison of difference in abundance. Results are reported using a t-statistic with alpha set at 0.05. Carapace width of males and females was compared using a two sample analysis of means assuming unequal variances (t-test, alpha=0.05). Percent of catch of commercial size was determined for males and females by area.

RESULTS

Temperature

Bottom water temperatures within depth strata ranged from 11.4 to 12.7°C at 311 m, 8.0 to 8.8°C at 494 m, 6.4 to 7.2°C at 677 m, 5.6 to 6.0°C at 860 m, and 5.2 to 5.6°C at 1043 m. Temperature was not taken at the deepest depth sampled, 1830 m. Bottom water temperatures decreased with depth, and the range in temperature within a depth stratum narrowed with increasing depth. In May, for stations west of the Mississippi River, temperatures tended to increase from east to west within the 494 and 677 depth strata. Comparative seasonal data are available only for the

860 m sampling depth, and there was little difference in the temperature extremes between May (5.6 to 6.0°C) and August (5.8 to 6.0°C).

Distribution Studies

Carapace width (CW), sex, male to female ratio, and bathymetric distributions by area and season were recorded for *C. quinquedens* (Table 2). Mean carapace width per trap set ranged from 109 to 140 mm for females and 95 to 143 mm for males. Smallest crabs occurred in deeper depths west of the Mississippi River in Areas 8 and 9. Overall mean carapace width of males (128 mm) was significantly different from the mean carapace width of females (116 mm), ($P = 0.00$, $t = 1.97$ at 458 df). Total number of male and female crabs and total number of crabs $\geq$ 114 mm CW (minimum size for harvest in the Atlantic fishery as reported by Armstrong 1990) were determined (Figure 2). In Area 1, east of the Mississippi River, 99% of males and 61% of females were $\geq$ 114 mm CW. Combining all areas, 87% of the males and 63% of females were of commercial size, with 81% of all crabs $\geq$ 114 mm CW regardless of sex. Areas 1 and 9 produced 65% and 17% of the red crabs taken, respectively (Figure 3). Contribution to total catch was between 3% and 7% for all other areas (6-8).

Average catch/trap set by sex at all areas, depths, and seasons in sets where crabs were caught was used to compare abundance of males versus females. There was a significant difference in the mean number of males to females per trap set ($P = 0.02$, $t = 2.57$ at 17 df). Mean number of males per trap set was 18.2, compared to 38.6 for females. The ratio of males to females varied from 0:1.0 to 1.0:32 among trap sets (Table 2), with females twice as abundant as males overall (M:F = 1.0:2.1).

Bathymetric distribution as a function of mean catch/trap by area and season is shown in Tables 3 and 4. The highest overall mean catch/trap was 23.8 crabs at 677 m in May at Area 1. With the exception of the shallowest depth (494 m, n = 1), mean catch/trap in Area 1 was not significantly different between sampled depth strata for May ($\bar{x} = 23.8$ at 677 m and $\bar{x} = 16.9$ at 860 m) or August ($\bar{x} = 20.9$ at 860 m and $\bar{x} = 19.3$ at 1043 m). Catch/trap for Area 6 was not statistically compared between seasons due to lost trap lines. Mean catch/trap for Areas 7, 8, and 9 was compared between 860 m and 1043 m depths for August. In Area 7, there was no significant difference in mean catch/trap at 860 m ($\bar{x} = 2.8$) and 1043 m ($\bar{x} = 2.6$). For Area 8, mean catch/trap was significantly greater at 1043 m ($\bar{x} = 6.6$) than at 860 m ($\bar{x} = 1.6$; $P = 0.00$, $t = 4.61$ at 7 df). The reverse was true for Area 9; there was a significantly higher catch/trap at 860 m than at 1043 m ($P = 0.01$, $t = 3.90$ at 7 df). Mean catch/trap at 860 m was 9.6, compared to 3.9 crabs at 1043 m. Catch/trap was used to compare seasonality of catch at the common depth of 860 m at each area. No significant differences in mean catch/trap were found at any area between May and August at 860 m.

Upper depth limit of red crabs west of the Mississippi River (Areas 6-9) was 860 m, compared to 677 m for crabs taken in Area 1, east of the River. Catches of a single crab at 494 m in Area 1 and at 677 m in Area 7 were considered solitary events and were not used in defining the observed upper depth limit.

Recent oviposition in *C. quinquedens* is indicated by the presence of orange egg masses; eggs become purple-black prior to hatching (Haefner 1977). Seventeen percent of all females collected in May were ovigerous, with either orange or brown egg masses. Egg remnants were recorded on the pleopods of 11 individuals. Ovigerous females collected in August comprised 18% of all females. Egg colors were predominantly brown, and no egg remnants were observed. Ovigerous females were more abundant at the shallower depths of their bathymetric distribution (677 and 860 m). The size range of ovigerous females in August (95-135 mm CW) was comparable to those collected during May (100-130 mm CW). One immature female crab (64 mm CW) was taken at 860 m in May in Area 6.

A comparison among catch/trap by trap number was performed with one-way ANOVA and a multiple range test (Duncan's method). These tests were applied over all areas, depths, and seasons in sets where crabs were caught. The mean catch of end traps (traps 1 and 8) was 7.0 and 9.6, respectively, compared to the mean catch of inner traps (traps 2 through 7, $\bar{x}$ range = 6.1 to 11.3). The Nielsen trap had the highest mean catch/trap ($\bar{x} = 11.3$) due to two high catches in Area 1. Statistically significant differences in mean catch were not found among crab traps (ANOVA). Catch was found to be homogeneous among traps (multiple range test). The EFA/trap was calculated to be 6,647 m^2. Based on the formulas of McElman and Elner (1982) and Miller (1975), the estimated number of trapable red crabs was extrapolated to be 3.7×10^6 on a calculated fishing ground of 1,200 km^2.

Chaceon fenneri was not abundant in the study area. Golden crabs occurred in samples in May. Four specimens were taken in Area 6 (3 at 494 m, 1 at 677 m). Areas 7 and 8 each produced a single crab at 494 m.

TABLE 2

Summary of catch data of *Chaceon quinquedens* in the northcentral Gulf of Mexico.

			Males				Females					
			Carapace Width				Carapace Width					
Date	Area	Depth Meters	Mean	Max.	Min.	No.	Mean	Max.	Min.	No.	Total No.	Ratio M/F
05/15/89	1	494				0	130	130	130	1	1	0:1
05/15/89	1	677	133	147	122	42	116	144	93	148	190	1:3.5
05/15/89	1	860	132	145	108	45	114	133	95	90	135	1:2
05/13/89	6	494				0				0	0	
05/13/89	6	677				0				0	0	
05/13/89	6	860	143	143	143	1	120	140	64	10	11	1:10
05/13/89	7	494				0				0	0	
05/11/89	7	677				0	140	140	140	1	1	0:1
05/11/89	7	860	140	140	140	1	128	139	110	28	29	1:28
05/09/89	8	494				0				0	0	
05/09/89	8	677				0				0	0	
05/09/89	8	860				0	118	125	112	6	6	0:6
05/07/89	9	494				0				0	0	
05/07/89	9	677				0				0	0	
05/07/89	9	860	130	136	125	2	114	135	98	64	66	1:32
08/12/89	1	860	134	148	123	61	115	137	95	106	167	1:1.7
08/12/89	1	1043	132	147	118	98	114	132	94	56	154	1.8:1
08/14/89	1	1830	127	133	123	3	114	123	103	16	19	1:5.3
08/10/89	6	311*										
08/10/89	6	860*										
08/10/89	6	1043	129	140	120	8	118	132	102	18	26	1:2.3
08/08/89	7	311				0				0		
08/08/89	7	860	138	141	136	5	129	142	114	17	22	1:3.4
08/08/89	7	1043	139	151	127	2	126	137	117	19	21	1:9.5
08/06/89	8	311				0				0		
08/06/89	8	860	135	140	130	2	130	142	109	11	13	1:5.5
08/06/89	8	1043	95	137	63	40	109	131	76	13	53	3.1:1
08/04/89	9	311				0				0		
08/04/89	9	860	125	144	89	9	111	127	92	68	77	1:7.6
08/04/89	9	1043	120	139	95	8	110	131	85	23	31	1:2.9

* Trap line lost

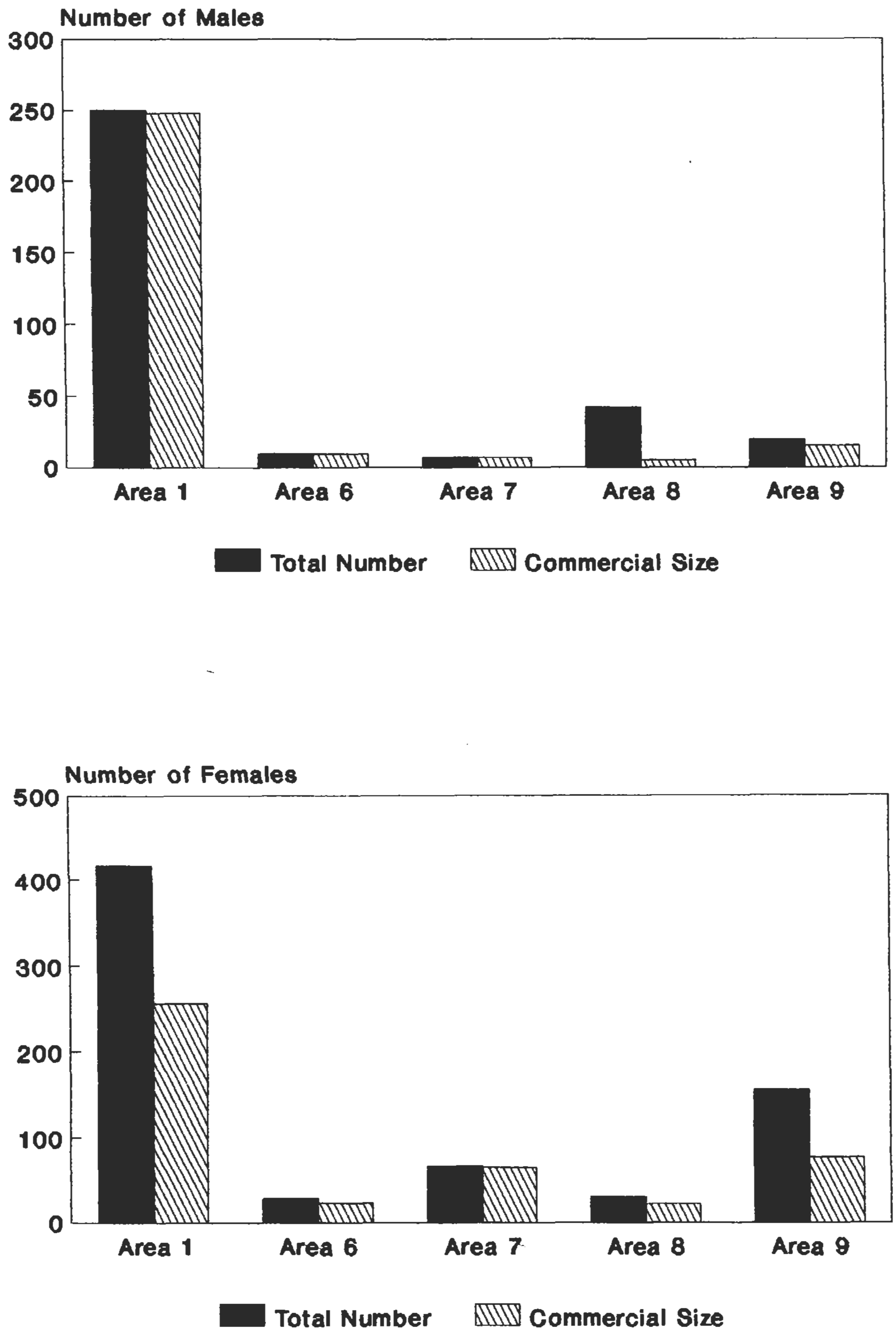

Figure 2. Total number of male and female *Chaceon quinquedens* ≥ 114 mm carapace width.

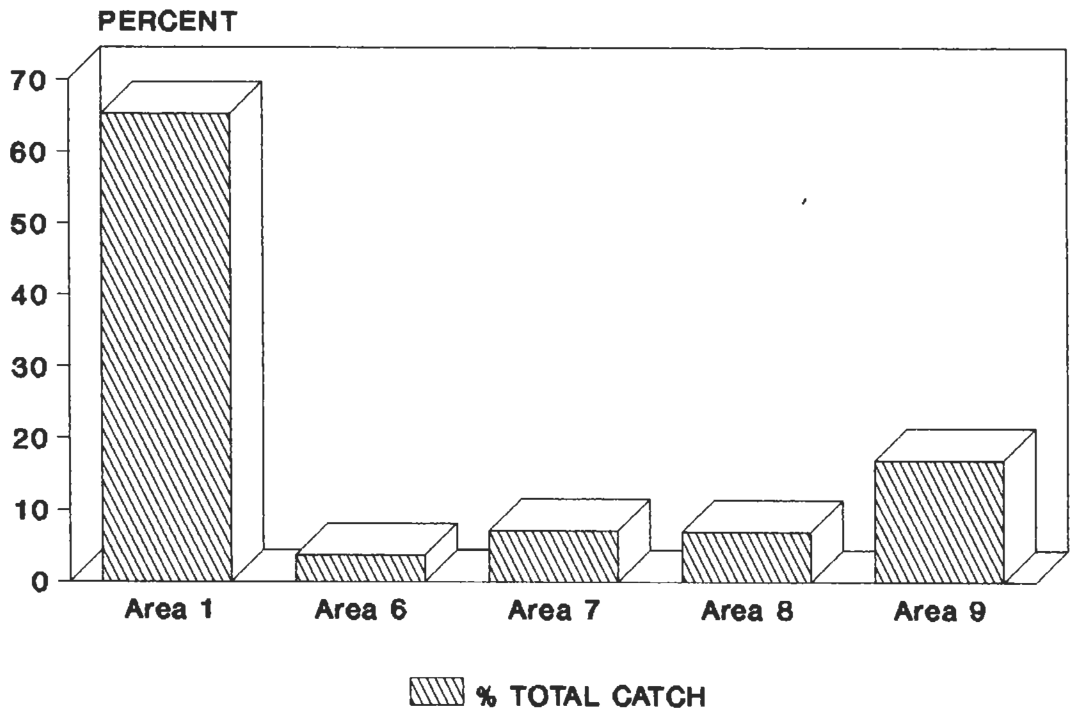

Figure 3. Percent catch, *Chaceon quinquedens*, by area.

DISCUSSION

Bathymetric and Geographic Distribution

Previous reports of geryonid crabs in the Gulf of Mexico include references to two species. Data from trawl surveys contain records of *C. quinquedens* and *C. affinis* (NMFS, Mississippi Laboratories). Pequegnat (1970) recorded *C. quinquedens* in the northern Gulf of Mexico and in the Caribbean. With the recognition and description of *C. fenneri* from slope waters of the western Atlantic and Gulf of Mexico, it is probable that early accounts of *C. affinis* from the eastern Gulf of Mexico are referable to *C. fenneri* (Manning and Holthuis 1984). Otwell et al. (1984) found *C. fenneri* common in the Gulf of Mexico at depths ranging from 384 to 641 m within latitudes 29°03' and 26°50' and longitudes 84°50' and 85°32'.

Lockhart et al. (1990) described the distribution of red and golden crabs in the eastern Gulf of Mexico and noted that there were geographic and bathymetric differences in distribution and abundance. They found red crabs widely distributed in the eastern Gulf of Mexico at depths of 677 m, their deepest sampling depth and the upper limit of red crab distribution. Highest concentrations were found in the northcentral Gulf of Mexico between 87.5 and 88.5°W longitude. A supplemental sample taken during their study found red crabs at 900 m in that area. Golden crabs were more restricted in geographic distribution, with abundance centered in slope waters below 28°N latitude. They occurred at all depths sampled, but were most abundant at the shallower depths (311 and 494 m). Golden crabs were not abundant in our study (n = 6); thus geographic and bathymetric data are limited. Based on our samples, the known range of *C. fenneri* is extended to the western Gulf of Mexico (92°12"W longitude).

Bathymetric distribution of red crabs differed east and west of the Mississippi River. Red crabs were taken consistently at the 677 m sampling depth in the eastern Gulf of Mexico. However, the upper depth limit for red crabs west of the Mississippi River was 860 m. Although there was a downward shift in bathymetric distribution west of the River and different depth strata were sampled in May and August, a differential distribution by sex and depth was observed. While females outnumbered males at most depths sampled (two exceptions), the proportion of males to females increased at deeper depths. Approximately the same number of individuals were taken at the 860 and 1043 m sampling depths west of the River, indicating that deeper

TABLE 3
Catch per trap by area and depth for May 1989.

	Area 1			Area 6			Area 7			Area 8			Area 9		
	494 m	677 m	860 m	494 m	677 m	860 m	494 m	677 m	860 m	494 m	677 m	860 m	494 m	677 m	860 m
Trap #1	1	16	13	0	0	2	0	0	8	0	0	0	0	0	10
Trap #2	0	26	17	0	0	0	0	1	1	0	0	1	0	0	6
Trap #3	0	10	9	0	0	1	0	0	4	0	0	3	0	0	10
Trap #4	0	20	8	0	0	1	0	0	1	0	0	2	0	0	4
Trap #5	0	30	30	0	0	4	0	0	6	0	0	0	0	0	2
Trap #6	0	34	13	0	0	1	0	0	3	0	0	0	0	0	8
Trap #7	0	17	20	0	0	1	0	0	2	0	0	0	0	0	9
Trap #8	0	37	25	0	0	1	0	0	4	0	0	0	0	0	17
Total	1	190	135	0	0	11	0	0	29	0	0	6	0	0	66
Mean	0.125	23.750	16.875	0.000	0.000	1.375	0.000	0.125	3.625	0.000	0.000	0.750	0.000	0.000	8.250
Std. Dev.	0.331	8.899	7.236	0.000	0.000	1.111	0.000	0.331	2.288	0.000	0.000	1.090	0.000	0.000	4.265
Variance	0.109	79.188	52.359	0.000	0.000	1.234	0.000	0.109	5.234	0.000	0.000	1.188	0.000	0.000	18.188

TABLE 4
Catch per trap by area and depth for August 1989.

	Area 1			Area 6			Area 7			Area 8			Area 9		
	860 m	1,043 m	1,830 m	311 m	860 m	1,043 m	311 m	860 m	1,043 m	311 m	860 m	1,043 m	311 m	860 m	1,043 m
Trap #1	15	19		*	*	9	0	4	2	0	3	3	0	8	6
Trap #2	17	13				1	0	2	0	0	1	5	0	5	7
Trap #3	20	9				7	0	1	1	0	1	6	0	4	0
Trap #4	15	14				6	0	5	5	0	0	10	0	11	4
Trap #5	49	44				3	0	1	1	0	0	3	0	13	6
Trap #6	19	11				0	0	0	2	0	0	8	0	13	3
Trap #7	19	26				0	0	3	2	0	2	6	0	11	1
Trap #8	13	18				0	0	6	8	0	6	12	0	12	4
Total	167	154	19			26	0	22	21	0	13	53	0	77	31
Mean	20.875	19.250				3.250	0.000	2.750	2.625	0.000	1.625	6.625	0.000	9.625	3.875
Std. Dev.	10.868	10.604				3.382	0.000	1.984	2.446	0.000	1.932	2.997	0.000	3.314	2.315
Variance	118.109	112.438				11.438	0.000	3.938	5.984	0.000	3.734	8.984	0.000	10.984	5.359

* Trap line lost

sampling depths were well within the bathymetric range of this species.

Lockhart et al. (1990) discussed the distribution of red crabs in the eastern Gulf of Mexico in relation to bottom sediment type and temperature. They concluded that neither temperature nor bottom type fully explained red crab distribution. Similar sediment types (silt, clayey silt, silty clay, clay) are found across the northcentral Gulf of Mexico (Uchupi and Emery 1968; Gallaway et al. 1988); thus reduced catches of red crabs west of the Mississippi River and the absence of red crabs at shallower depths in the present study do not appear to be explained by bottom type. Because bottom water temperatures at sampling depths within and among areas were not appreciably different, temperature does not seem to be the controlling factor in depth distribution. Working off New England, Haefner (1978) reported taking red crabs at depths as shallow as 200 m in temperatures as high as 12°C, further compounding the disparate depth distribution and temperature data for this species.

Data from Area 1 corroborated the observations of Lockhart et al. (1990) on the population structure of *C. quinquedens* in the eastern Gulf of Mexico. Females were preponderant in our samples in this area and outnumbered males 2.1:1. Although Lockhart et al. (1990) sampled only at the upper depth limit of red crab distribution in the eastern Gulf of Mexico, they noted that the abundance of females in the northern Gulf of Mexico coupled with the lack of females to the south may indicate migration of females northward. Melville-Smith (1987 a,b,c) reported that *C. maritae* females exhibited significant directional movement and that this movement was counter to the prevailing surface currents. The concentration of females northward of their sampled range, their occurrence in shallower, warmer waters, and the timing of larval release led Lockhart et al. (1990) to suggest that distribution of *Chaceon* in the eastern Gulf of Mexico may be tied to reproductive strategy; specifically, larval transport and recruitment. They proposed a causal role for the Loop Current System in basic life history adaptations and suggested that larvae released in February and March, a time of minimal penetration of the Loop Current, would avoid entrainment and flushing from the system. While this assumption may hold true during some years, the extent of northward incursion of the Loop Current into the Gulf of Mexico is highly variable, and maximum intrusion can occur during any season (Vukovich et al. 1978). Cooper and Humphreys (1981) noted that "it is difficult if not impossible to identify a typical Loop Current position with any given season or month." Circulation processes in the Gulf of Mexico are complex and variable, and while observed distribution may be tied to reproductive strategies, the relationship of biological processes to physical mechanisms remains speculative.

Commercial Potential

Area 1 produced 65% of the red crabs taken during this study and is the only area sampled that showed potential for fishery development. Mean catch/trap in Area 1 was similar at each depth stratum for May and August, with highest overall mean catch/trap (23.8) occurring at 677 m in May (Tables 3 and 4). Catch/trap rates in this area compare favorably with those reported in the New England red crab fishery (Ganz and Herrmann 1975), particularly in light of the high percentage (81%) of market size crabs ($\geq$ 114 mm CW) taken in this study. These rates are also comparable to the highest rates reported by Wenner et al. (1987) for golden crabs in the South Atlantic Bight off South Carolina.

Estimates of red crab population densities derived from trap studies were made by Stone and Bailey (1980) and McElman and Elner (1982) along the Scotian Shelf. Using a study area of 2767 km^2, Stone and Bailey (1980) projected population densities of 2.3 x 10^6. McElman and Elner (1982) provided various population estimates for their study area based on changing EFAs. Lowest estimates used an EFA of 4,100 m^2 to produce 2.8 x 10^6 crabs. Highest population estimates were based on an EFA of 2300 m^2 which produced an estimate of 5 x 10^6 crabs. Because greater catches at end traps did not occur in their studies, these authors suggested that there was no overlap in fishing area in traps placed 54 m (Stone and Bailey 1980) and 62 m apart (McElman and Elner 1982). They noted that density and biomass estimates were best based on an EFA of 2300 m^2. Using an EFA of 6647 m^2, we calculated minimum crab densities of 3.7 x 10^6 on the northcentral Gulf of Mexico fishing grounds. If we assume an EFA of 2300 m^2 for the total calculated fishing grounds (1200 km^2), our estimate of population size would increase to 10.7 x 10^6 crabs. An intermediate EFA of 3000 m^2 would produce a population estimate of 8.1 x 10^6 crabs. Based on these catch rates, the red crab in our calculated area could potentially support a small commercial fishery. Fishery development, however, must take into consideration the preponderance of females on the fishing grounds (M:F ratio 1:2.1) and the incidence of ovigerous females (~20%) during much of the year (Lockhart et al. 1990 and present study). In addition, data on recruitment to fishing grounds as well as information on critical life history parameters are necessary before fishery development is encouraged.

ACKNOWLEDGMENTS

Support for this project was provided by USDOC/NOAA/NMFS MARFIN Grant No. NA89WC-H-MF021. We thank the crew of the R/V *Tommy Munro* for their ability to adapt to any situation and to endure the long hours of boredom followed by periods of intense activity associated with deep-water biological sampling. We also thank Dennis Koi who supplied the computer program used to develop Figure 1 and David Donaldson who assisted with graphics. Marjorie Williams aided in manuscript preparation. Special thanks to the University of Georgia, Sea Grant Extension Service, Brunswick Laboratory, for supplying the Fathoms Plus traps used in this study. Exploratory fishing data (NMFS, Mississippi Laboratories) was supplied by Bennie Rohr and the late Elmer Gutherz. We are appreciative to the late Dr. Harold Howse, director emeritus of the Gulf Coast Research Laboratory, for his support of this project.

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