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Assessment of Red Crab (*Geryon quinquedens*) Populations in the Northwest Atlantic

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by

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1977 RED CRAB ASSESSMENT

Directed commercial exploitation of the red crab, Geryon quinquedens, began during 1973 in response to declines in the offshore lobster fishery and intensive fisheries development efforts (Rathjen, 1974, 1976) aimed at improving the harvesting, processing, and marketing of this species. The potential for a commercial red crab fishery had long been realized (Schroeder, 1955, 1959; McRae, 1961) but prior to the early 1970's, red crab was considered a nuisance since it was commonly caught in offshore traps with lobster (NEMRIP, 1974; Walker, 1974).

Distribution and Biology

Geographically, the red crab occurs along the continental slope from Nova Scotia to Brazil at depths of 20 to 1,200 fathoms (Rathbun, 1937). In waters off the northeastern United States (Gulf of Maine to Cape Hatteras), red crabs inhabit depths between 60-800 fathoms, with large concentrations occurring between 175-350 fathoms (Gray, 1970; Meade and Gray, 1973; Haefner and Musick, 1974; Wigley et al., 1975). High densities and quantities of crabs are found where water temperature is between 5°-8° C; at both warmer and colder temperatures, red crab abundance declines (Wigley et al., 1975).

Trawl and trap survey cruises for red crab (McRae, 1961; Anonymous, 1971, 1973; Murray, 1974; Wigley et al., 1975; Ganz and Hermann, 1975) indicate striking differences in size between male and female crabs, with males being generally larger in carapace width (Figure 1) and heavier in weight. The sexes appear also to be bathymetrically isolated; females are common at depths between 175 and 275 fathoms and relatively rare at other depths, while males are sparse in shallow water (<175 fm) but rather uniformly abundant in depths

from 175-700 fathoms (Wigley et al., 1975). Limited information from other surveys indicated that this distribution pattern may vary with season. An inverse relationship between water depth and crab size (i.e., young crabs in deep water and large crabs in shallower water) was documented by Wigley et al. (1975) and postulated as evidence for a size-related, long-term, up-slope migration. Accordingly, recruitment to the adult population would, therefore, occur from the depths. A similar pattern in life history and size distribution was noted in Tanner crabs off the northern Oregon coast (Pereyra, 1968).

In May and June 1974, a red crab tagging program was undertaken by the National Marine Fisheries Service, to obtain further information on the movements and growth of this species. A total of 7,825 red crabs were tagged with labelled spaghetti tags tied around the carapace and released in the slope area between Hudson and Veatch Canyons in about 200 to 500 fathoms. To date, 467 tags have been recovered (F. Lux, pers. comm.).

Preliminary analysis of the tags recovered during 1974 (Ganz and Hermann, 1975) indicated that most recaptures were taken less than four miles from their release site. Recoveries made in 1976 and 1977, however, showed that some crabs moved between 30 to 40 miles from the release location and that some were at large for as much as three years (F. Lux, pers. comm.). Since this type of tag is lost during molting, molting had obviously not occurred in two years in many of the crabs and in at least three years in others. This would suggest that a slow growth rate is characteristic of the species; a pattern generally observed in other deep-water, decapod crustaceans.

Commercial Fishery

Red crab landings in 1976 were the highest in the short history of the fishery. A total of 1,394,000 pounds was landed in Massachusetts and Rhode Island ports, an increase of over a million pounds from 1975 (Table 1). Landings consist only of male crabs with a minimum carapace width of 4½ inches (115 mm). Females and small male crabs are culled from the catch at sea. The harvested male red crabs are either brought back to port alive, or butchered and frozen in sections aboard ship, and delivered to shore for further processing.

Biomass and Fishery Yield

Determination of density and biomass of red crabs between offshore Maryland and eastern Georges Bank was accomplished during June-July 1974 by the National Marine Fisheries Service using the research vessel, Albatross IV. Estimates of population size in numbers of crabs were determined from in situ photographs of the sea bottom and constituent epibenthic fauna using an underwater photographic system, and from otter trawl collections of red crabs (Wigley et al., 1975).

Crab densities determined from the photographic method are the most accurate available and agreed well with the results obtained from the trawl catches. A total of 182 million crabs, of all sizes, was estimated to inhabit the four geographic zones surveyed during the 1974 red crab study (Figure 2; Table 2). Of this number, 43 million crabs of commercial size, both sexes (4½ inches or larger in carapace width) was estimated for the entire survey area (Table 3). Commercial size crabs were most abundant at intermediate depths (175-350 fm) and were less populous in both shallower and deeper water. No commercial size red crabs were taken in water depths greater than 500 fm.

Estimates of standing crop biomass (weight) of commercial size red crabs were calculated from density estimates provided by the photographic analyses combined with the average weight of trawl caught crabs. A total of 59 million pounds of commercial size crabs was estimated within the study area (Table 4). This value represents 51% of the total red crab biomass, and includes both males and females. Females, however, comprised only 3% of the commercial biomass (Wigley et al., 1975).

Biomass patterns paralleled the trends noted in crab abundance (Table 2), and were greatest in the intermediate depths (175-500 fm). Geographically, the northeastern areas (Zone C and Zone D) possessed the largest quantities of crabs with the greatest biomass present in Southern New England (Zone C) at depths of 175-225 fm.

A first estimate of annual maximum sustained yield (MSY) from the red crab fishery can be determined using the commercial biomass estimate of 59 million pounds and incorporating it into Gulland's equation (Gulland, 1971) for virgin stock exploitation:

$$Y_{max} = 0.5\ MB_o$$

where: M = instantaneous natural mortality

B_o = virgin biomass of commercial size crabs

If the instantaneous rate of natural mortality (currently unknown) is assumed to be 0.2 (similar to that suspected for king crab, Eldridge, 1972), $Y_{max} = (0.5)(0.2)(59) = 5.9$ million pounds. This estimate would be identical to that derived by using the ratio between virgin biomass and maximum sustainable yield of 10:1 estimated by Caddy et al. (1974) for slow-growing, long-lived, offshore crustaceans.

The present estimate of Y_{max} includes both sexes. A yield estimate based solely on males would be 5.5 million pounds, assuming females comprised only 3% of the biomass.

Although biomass estimates for red crabs in the Gulf of Maine are not available, surveys conducted by the Rhode Island Division of Fish and Wildlife in the southern Gulf of Maine during 1974 indicated an absence of large crabs (over 115 mm) (Hermann, 1974). Hence, this region is not expected to contribute at all to the commercial red crab fishery.

Exploitation Considerations

Preliminary analysis of the red crab tag returns in 1974 (Ganz and Hermann, 1975) indicated that 4.84% (379/7825) of the tagged crabs had been accounted for. All but 25 of the recaptures were recovered by a single vessel (F/V Mars), in the course of seven fishing trips (4.52% return by this vessel).

If the rate of recovery of tagged crabs by the F/V Mars is representative, then theoretically, a single fishing trip would yield 0.646% of the population. A single vessel, fishing forty trips a year, could conceivably capture 25.83% of the sample population. As noted by Ganz and Hermann (1975), theoretically, four such vessels, fishing forty trips per year, could capture the entire tagged population.

While these early tagging results should be interpreted with caution due to the short duration of time elapsed between tagging and recapture operations and the limited area of fishing activity, they do suggest that a high rate of exploitation on red crabs is possible. Since growth of the species is relatively slow, the possibility of overfishing the resource is apparent.

Continued monitoring of the red crab fishery may be required to assure that over-exploitation does not occur.

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Table 1. Annual landings and value of red crab in Massachusetts and Rhode Island (in thousands of pounds and thousands of dollars) 1972-1976.

	Massachusetts		Rhode Island		Total	
	#	$	#	$	#	$
1972	-	-	1	<1	1	<1
1973	152	46	96	25	248	71
1974	497	149	613	183	1110	332
1975	231	70	10	3	241	73
1976	1152	317	242	71	1394	388

Source: Massachusetts landings, 1972-1976; Rhode Island landings, 1972-1976.

Table 2. Estimates numbers (in thousands) of red crabs of all sizes, both sexes, listed according to geographic zone and water depth class (from Wigley et al., 1975).

Water depth (fathoms)	Geographic Zone A	B	C	D	Total
125-175	685	235	1,562	790	3,272
175-225	11,861	(6,974)[1]	28,343	8,192	55,370
225-275	5,993	3,428	10,526	9,413	29,360
275-350	8,798	7,548	23,888	(8,150)	48,384
350-500	4,651	4,369	7,122	(5,192)	21,334
500-700	4,357	(3,690)	6,731	(5,496)	20,274
700-900	(1,352)	(596)	736	(1,232)	3,916
TOTAL	37,697	26,840	78,908	38,465	181,910

[1]Values in parentheses are estimates based on the average density of crabs in each water depth class.

Table 3. Population estimates (in thousands) of red crabs of commercial size, 4.5 inch (114 mm) or larger in carapace width, both sexes, listed according to geographic zone and water depth class (from Wigley et al., 1975).

Water depth (fathoms)	Geographic Zone A	B	C	D	Total
125-175	268	235	1,084	529	2,116
175-225	1,243	870	11,278	1,835	15,226
225-275	1,750	557	2,202	1,529	6,038
275-350	(2,463)[1]	2,058	3,626	5,460	13,607
350-500	412	655	1,282	3,479	5,828
500-700	0	(0)	0	(0)	0
700-900	0	(0)	0	(0)	0
TOTAL	6,136	4,375	19,472	12,832	42,815

[1]Values in parentheses are estimates based on the size composition of samples collected in adjacent geographic zones.

Table 4. Standing crop biomass (thousands of pounds per unit area) of red crabs of commercial size, 4.5 inch (114 mm) or larger in carapace width, both sexes, listed according to geographic zone and water depth class (from Wigley et al., 1975).

Water depth (fathoms)	Geographic Zone A	B	C	D	Total
125-175	360	297	1,482	455	2,594
175-225	1,598	1,124	16,072	2,557	21,351
225-275	2,382	729	2,948	2,130	8,189
275-350	(3,367)[1]	2,812	4,764	7,897	18,840
350-500	532	798	1,622	4,939	7,891
500-700	0	(0)	0	(0)	0
700-900	0	(0)	0	(0)	0
TOTAL	8,239	5,760	26,888	17,978	58,865

[1]Values in parentheses are estimated values based on crab sizes from adjacent geographic zones.

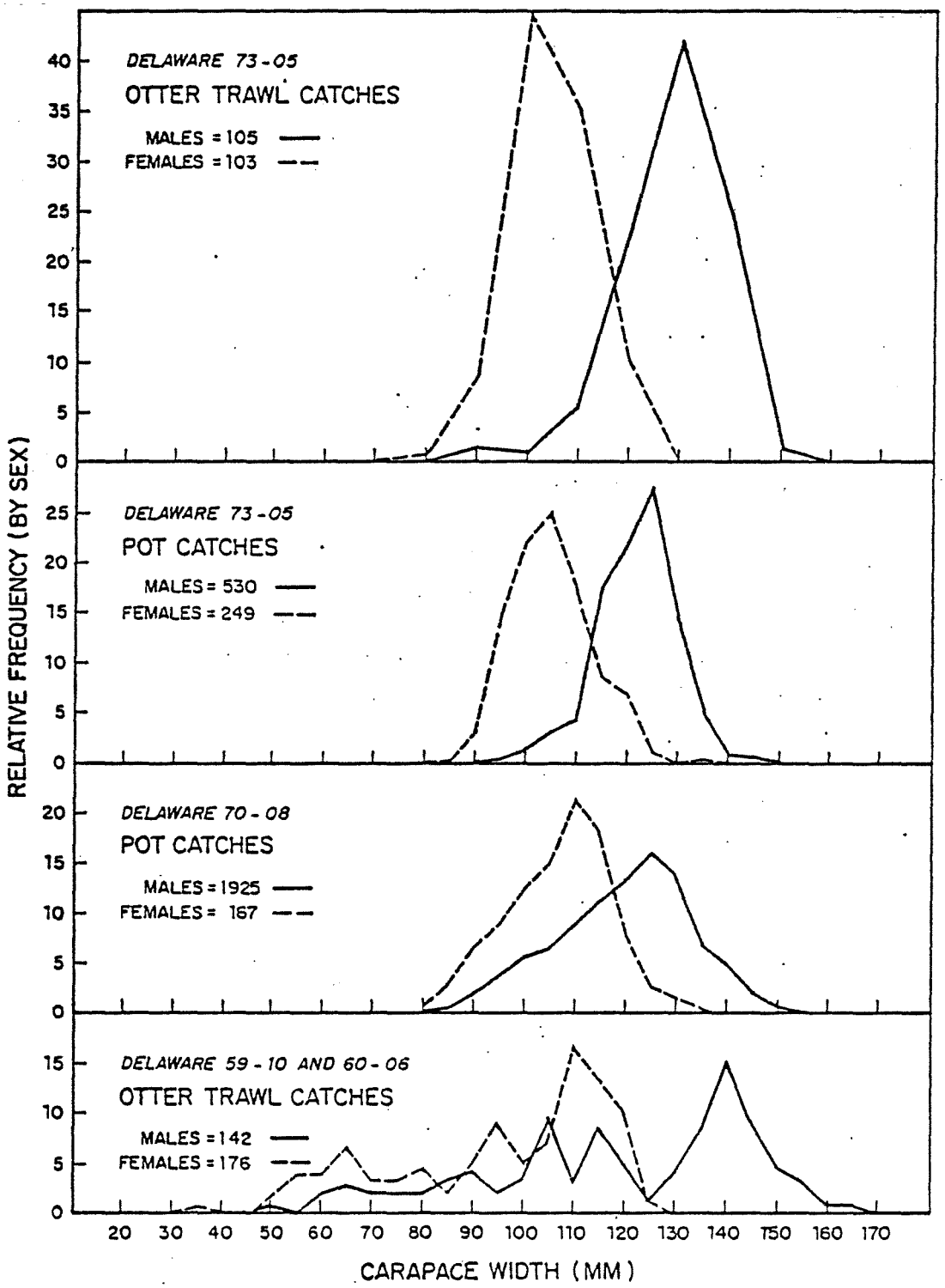


Figure 1. Carapace width frequency, by sex, of red crabs obtained from research and exploratory fishery cruises, 1959-1974, and from commercial landings at Point Judith, Rhode Island, 1973-1974.

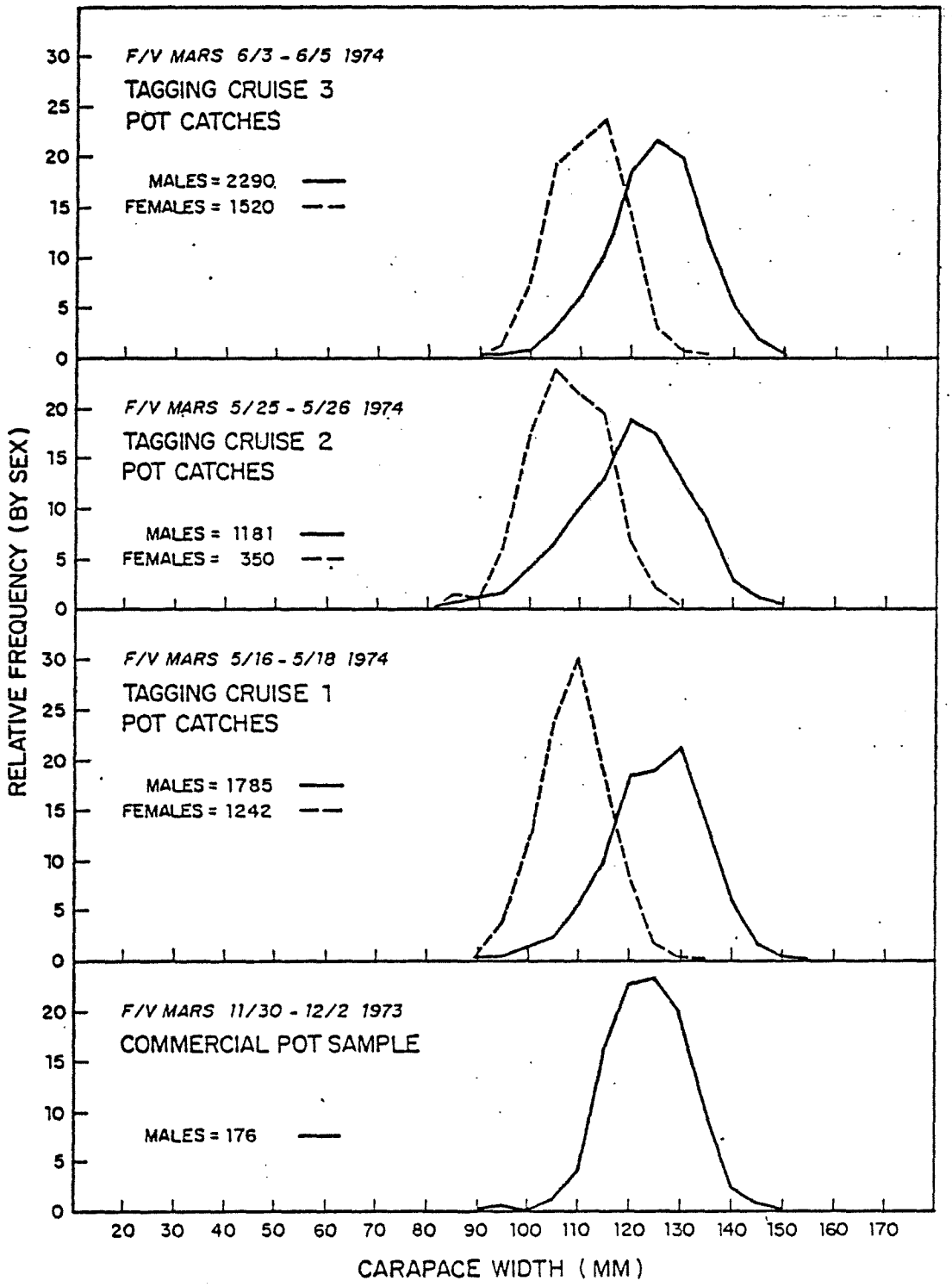
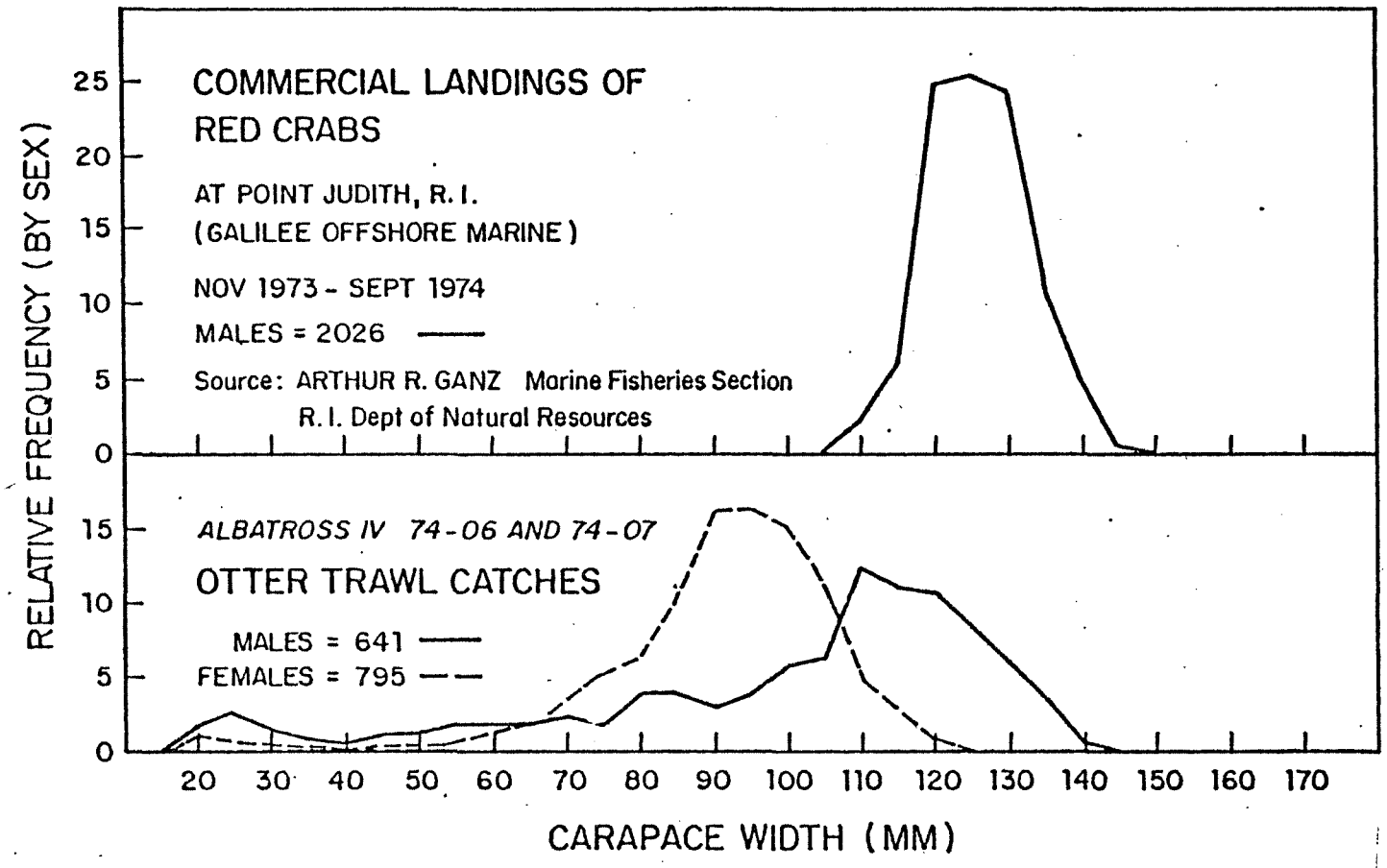


Figure 1 (continued). Carapace width frequency, by sex, of red crabs obtained from research and exploratory fishery cruises, 1959-1974, and from commercial landings at Point Judith, Rhode Island, 1973-1974.



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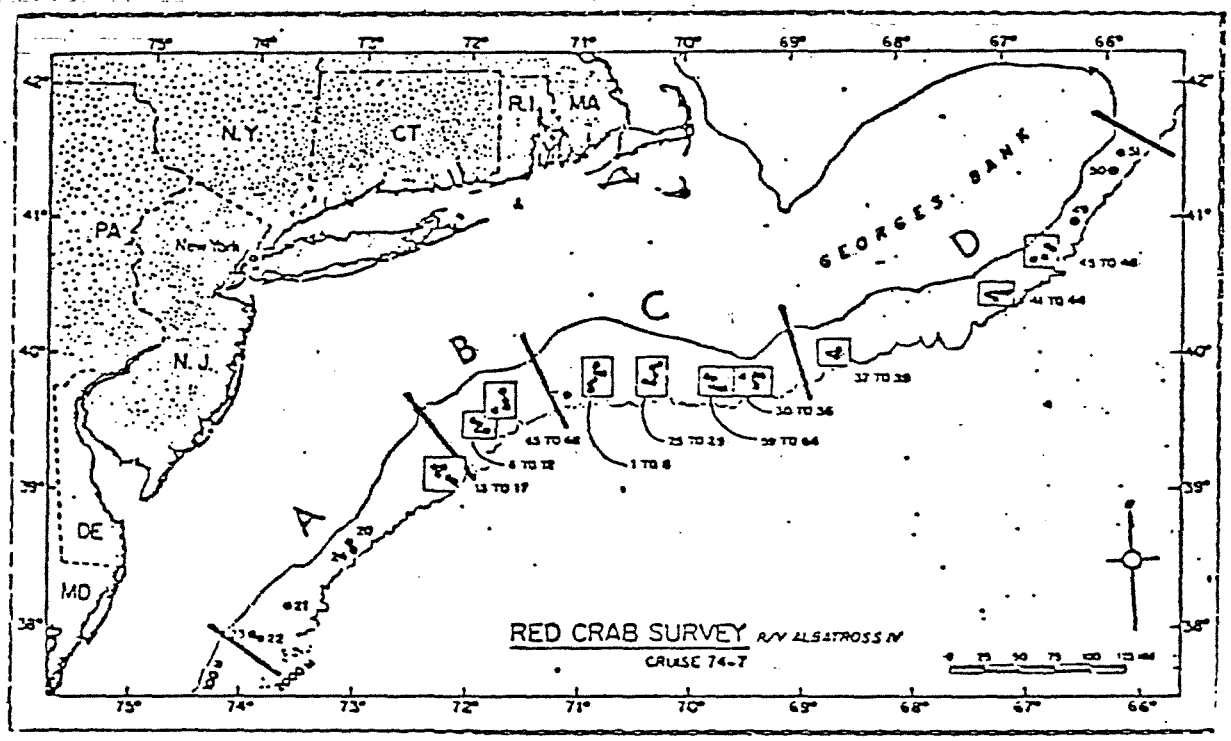

Figure 2. Sampling stations and the four geographic zones (A-D) occupied during the red crab survey conducted from the R/V Albatross IV, June-July, 1974. (From Wigley et al., 1975)