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NOTE

Symptoms of overexploitation in the stock of the Norway lobster (*Nephrops norvegicus*) on the "Serola Bank" (Western Mediterranean Sea off Barcelona)*

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SUMMARY: A comparison of the mean sizes for the Norway lobster population on the Serola Bank indicated a decrease of 4 mm *CL* in males and 3.6 mm *CL* in females over the past 20 years. This means a reduction between 1 and 2 years in the age of the catches. Discussion considers this aspect as symptomatic of overexploitation of this resource in the general context of the area, where CPUE for this species has suffered a significant decrease in recent years.

Key words: Norway lobster, Mediterranean, *Nephrops norvegicus*, trawl, overexploitation.

INTRODUCTION

The Norway lobster, *Nephrops norvegicus*, is a species with marked regional differences regarding its level of exploitation and size structure, due to geographical variations in its distribution area, to its exploitation pattern, population density and substrate characteristics (Briggs, 1989; Hill and White, 1990; Hillis and Geary, 1990; Hillis, 1988a; 1990; Nilsen and Hopkins, 1992; Tully and Hillis, 1995; Maynou and Sardà, 1997). In the case of the Mediterranean, the fleet operating off Barcelona traditionally works an area known as the Serola Bank fishing grounds (Fig. 1), where heavy fishing pressure is expended on the Norway lobster resource (Sardà and Lleonart, 1993; Maynou *et al*., 1998). The Final Report for the EEC-NEMED Project (Sardà, 1996) contained a yield per recruit analysis concluding that the Serola Bank stock is fully exploited but not appreciably overexploited. The present paper analyzes the current state of the fishery on the Serola Bank from historical data on catch and effort of boats based in the port of Barcelona (which operate primarily on the Serola Bank) and by comparing size frequency data from 20 years ago (Sardà, 1985) with current data collected in 1994. Few studies have been able to compare data collected by the same researcher using the same methods 20 years apart.

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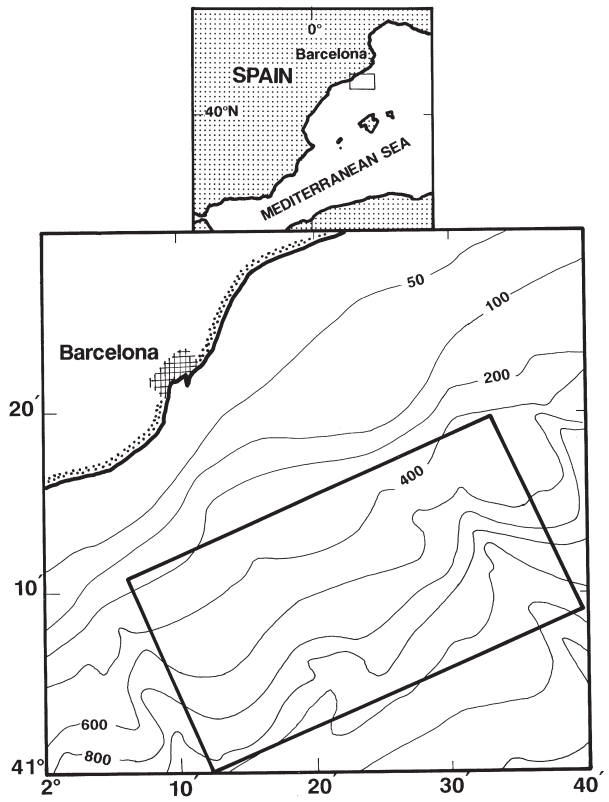

FIG. 1. – Location of the study area.

MATERIALS AND METHODS

The methodology used consisted in the comparative analysis of length frequency data for male and female Norway lobster on the Serola Bank fishing grounds (Fig. 1) based on samples distant in time, one collected in the course of 1974 (Sardà, 1985) and the other in the course of 1994 (Sardà, 1996). In both cases, measurements were taken by the author using the same methodology. Samples were collected using the same trawler (Maireta II, 750 HP in 1974 and 1100 HP in 1994), a vessel specialized in the Norway lobster fishery, operated by the same skipper. Towing time and direction was always the same, lasting around 2.15 hours at a mean towing speed of 2.7-3 knots. The size frequency data were based on carapace length (*CL*, in mm), measured from the posterior concavity of the orbit of the eye to the postero-dorsal margin of the carapace. Measurements were taken to the nearest mm, and all size frequencies were calculated in percent by 1mm interval, the interval size best suited for estimating the growth parameters for this species (Mytilineou and Sardà, 1995).

Annual size frequencies were constructed using monthly samples weighted for 2h tows. A total of 1,600 males and 1,484 females were measured in 1974 and 13,549 males and 12,470 females in 1994. A running mean comprising three consecutive size intervals was used to smooth the histogram. The comparative analysis was based on two methods, a comparison of the similarity (using percentage of similarity index) between the areas for each size interval (VITMAN, Lleonart, unpublished software), the Kolmogorov-Smirnov non-parametric test (Sokal and Rohlf, 1969) and ANOVA, assuming normality of variances.

On the other hand, historical information on the landings at the port of Barcelona of captures originating in the Serola Bank (Franquesa 1996; Anon. 1988-1994) and the catch per unit effort in the same port (Lleonart, 1990; Martín, 1991) was collected.

RESULTS

The size frequency distributions for both sexes have been plotted in Figure 2. The Figure shows that the sizes in the 1994 samples are shifted clearly to the left of the sizes in the 1974 samples. The similarity between areas for both sexes was 74% for

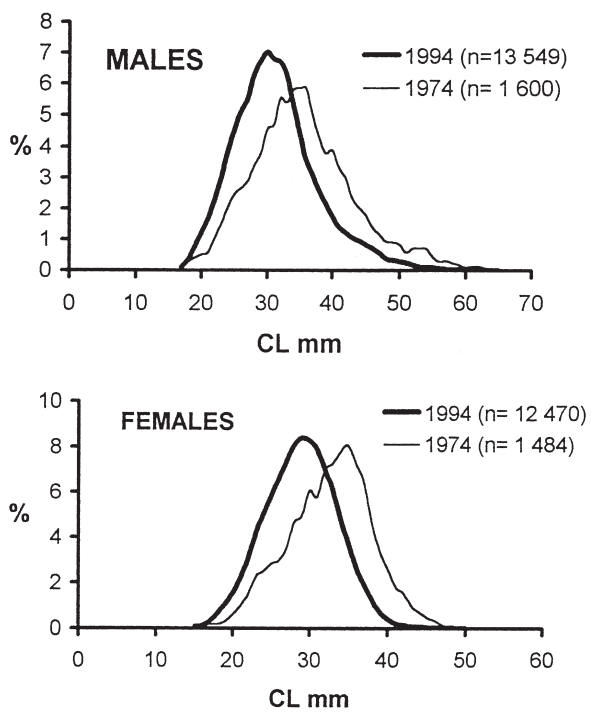

FIG. 2. – Plot of size frequencies for Norway lobster (*Nephrops norvegicus*) from samples taken in 1974 and in 1994 on the Serola Bank fishing grounds off Barcelona.

TABLE 1. – Comparisson of the size frequencies of Norway lobster populations on the Serola Bank between 1974 and 1994. Mean, Mean size of caparece length *CL* in mm; *sd*, standard deviation; *F* table value of ANOVA; *K-S (d)*; *d* value from Kolmogorov-Smirnov test. All values are significant ($p < 0.01$)

Years	Males				Females			
	Mean	*sd*	*F*	*K-S (d)*	Mean	*sd*	*F*	*K-S (d)*
1974	34.34	32.35	2.889	0.258	31.51	28.39	2.963	0.327
1994	30.35	29.21			27.89	26.20		

males and 77% for females, indicating a difference of approximately 25%. Table 1 presents the results of the ANOVA between means and *K-S* test between frequencies, which revealed significant differences for the mean sizes in both distributions for both sexes ($p < 0.01$). The size differences observed indicate a decrease in mean sizes of 4 mm *CL* for males and 3.6 mm *CL* for females.

Figure 3 shows the decrease of the catch (in tm) and catch per unit effort (CPUE, kg HP^{-1} $year^{-1}$) since 1979 (previous to this year catch statistics were not reliable). The decrease of catch and CPUE are important, although total trawler power diminished in this port from 9,610 HP (in 1979) to 6,950 HP (in 1994).

DISCUSSION

Application of the same methodology 20 years later has provided a singular opportunity to compare the size structure of the Norway lobster population exploited off Barcelona on the Serola Bank fishing grounds. The results clearly indicate that the brunt of catches currently falls on younger individuals. The differences observed indicate a mean size 3.6 mm *CL* smaller for females and 4.0 mm *CL* smaller for males. Also, a difference of 4 mm is approximately equivalent to one-year's growth (Sardà, 1985), hence the current pattern of exploitation is based on a population one year younger, i.e., with effort shifted onto younger individuals. The results

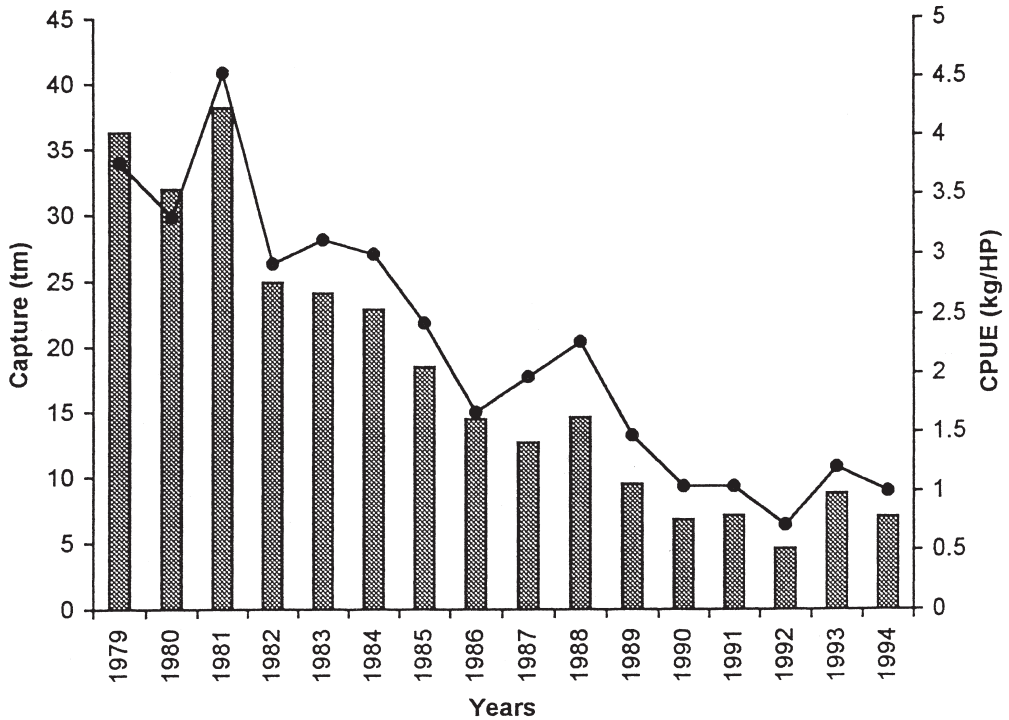

FIG. 3. – Plot of landings at Barcelona harbour and CPUE from Serola bank between 1979 and 1994. Bars, captures (in tm). Line, CPUE (in kg HP^{-1} $year^{-1}$).

likewise indicate that the right-hand portion of the size frequency curve for females, corresponding to adult females with peak spawning capacity, is being fished out, with an associated decrease in reproductive potential. This type of exploitation pattern therefore exerts a dual effect: on one hand, exploitation is directed at younger individuals closer to the size at first reproduction (Froglia, 1972; Sardà, 1991; Orsi Relini and Relini, 1989); and on the other, it removes a substantial proportion of the spawning stock.

Fariña (1996) and Anon. (1996-97) suggested that variations in recruitment success could affect the size frequency distributions during successive years. However, the present analysis does not completely support this point of view, since the Norway lobster is a long-lived species, with slow growth resulting in mode overlapping in its size frequencies. Additionally, the cod-end mesh size used in the 1970s on the population studied herein was 36-38 mm (stretched) and in 1994 was 40 mm. Thus, there was an increase in mesh-size used. Also, Hillis (1988b) did not find significant differences in size frequency distribution for small sizes between 1984 and 1988 in Irish waters, and Tully and Hillis (1995) suggested that spatially variable levels of exploitation may have an effect on the shape of the length frequency distributions of exploited populations. Therefore, the difference in the mean size may be attributed to exploitation, not to the use of different mesh sizes, inasmuch as the current mesh size is larger. This obviously suggests an increase either in effort or else in catchability (Fig. 3), and probably an outcome of improved technology, as pointed out by Sardà (1996).

Other aspects can verify the exploitation state in the Serola Bank population: Sardà (1996), based on results of Virtual Population Analysis (VPA), found that yield per recruit (Y/R), is currently slightly over the point of maximum yield; Orsi Relini *et al*. (in press), in studies of reproductive aspects in different areas of the Mediterranean, concluded that the reproductive potential of females in the Serola bank is the lowest among the observed and, following Sardà (1991), suggested that spawning might be biannual. Similar conclusions have been reported by Chapman (1980) in the Farn Deep for North Atlantic populations.

Although differences in mean size over the years my be attributed to variations in recruitment, the combined observations of (a), a decrease in mean size; (b), an increase in mesh size used (c), a strong and continuous decrease in total catches and catch per unit of effort and (d), the fully exploited conditions observed in the yield per recruit data from Sardà (in press), leads as to conclude that the Norway lobster in Serola Bank off Barcelona presents symptoms of overexploitation.

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