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Long-term changes in ray populations in the North Sea

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Three data sets have been analysed: landing statistics (1903–1993), International Bottom Trawl Surveys (1979–1993), and survey data collected in Dutch coastal waters between 1951 and 1994. Landings of rays and skates have decreased by more than half compared with the post-war level. Starry ray has increased in abundance in the central North Sea between 1970 and 1993. Thornback ray virtually disappeared from the Dutch coastal area in 1958. No significant trend has been observed for the other species.

Key words: abundance, distribution, *Raja* spp.

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Introduction

Rays and skates are a by-catch of the present demersal fisheries and have only a limited commercial value. Of the 11 species of rays and skates occurring in the North Sea, the starry ray (*Raja radiata*) is the most abundant, representing 80% of the biomass (Table 1). However, this species is not landed for consumption. The most common species at fish markets is the thornback ray (*R. clavata*). The biology of the species (low fecundity and high age and length at maturity) makes most of them susceptible to increased mortality, for example by fisheries (Holden, 1973, 1974, 1977). However, Holden (1977) and Brander (1981) have shown that not all species are equally sensitive, and those with a relatively low length at maturity, such as the starry ray (50 cm), should be more resilient than, for example, the thornback ray and common skate (70 and 140 cm, respectively). It is to be expected that fisheries exploitation will have a direct effect on the abundance and distribution of the most sensitive species.

This paper addresses available information on long-term changes in abundance and distribution of a

Table 1. Characteristics of ray and skate species occurring in the North Sea. L indicates whether the species is landed for human consumption. Biomass estimates (B: '000 t) from Daan *et al.* (1990). Female length at maturity data (M: cm) for *R. clavata* from Holden *et al.* (1971); all other values are estimated as 70% of the maximum length (Wheeler, 1969). Occurrence in the catches during IBTS and transects (T) are indicated.

Species	Common name	Type	L	B	M	IBTS	TR
R. batis	Common skate	Boreal	+	2.2	140	×	×
R. brachyura	Blonde ray	Lusitanian	+	0.2	90	×	
R. circularis	Sand ray	Lusitanian		2.5	85	×	
R. clavata	Thornback ray	Lusitanian	+[1]	11.6	70	×	×[2]
R. fullonica	Shagreen ray	Boreal	+	2.5	80	×	
R. microocellata	Small-eyed ray	Lusitanian	+	—	60		×
R. montagui	Spotted ray	Lusitanian	+	16.1	65	×	×
R. naevus	Cuckoo ray	Lusitanian	+	45.5	50	×	
R. oxyrinchus	Long-nose skate	Boreal	+	1.2	100		
R. radiata	Starry ray	Boreal	−	308.4	50	×	
R. undulata	Undulate ray	Lusitanian		—	70	×	

[1]Prime species for human consumption.
[2]Represents 95% of the catches.

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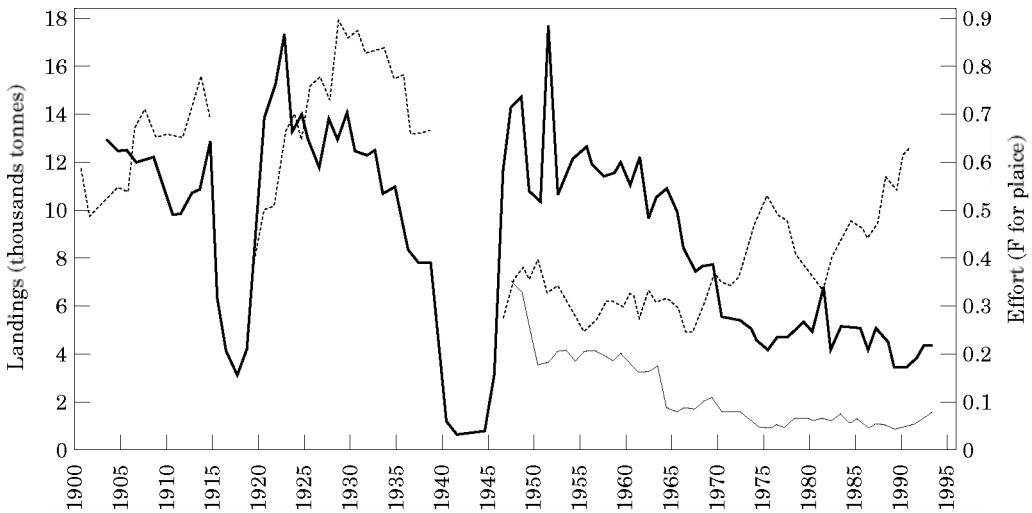

Figure 1. Landings of rays and skates from the the southern (——) (Subarea IVc) and total North Sea (——) (Area IV) separately. Trend in fishing mortality on plaice is shown as an index of fishing effort (· · · F-extrapolated) (from Rijnsdorp and Millner, 1996).

number of ray and skate species present in the North Sea.

Materials and methods

Landings statistics

Nominal catch data on rays and skates have been collected by ICES member countries since 1903 and published in *Bulletins Statistiques*. No distinction is made between species. Catches have been reported for the entire North Sea up to 1946, but since then separate figures are given for the southern, central, and northern North Sea (ICES subareas IVc, IVb, and IVa, respectively). Only data for the total North Sea and the southern area have been used.

International Bottom Trawl Survey (IBTS)

Details of the IBTS are published in the *Atlas of North Sea Fishes* (Knijn *et al.*, 1993). Rays and skates were identified to species level. Data from the February cruises in 1974–1993 are presented as average catch/hour by year for the entire North Sea and as average catch/hour per statistical rectangle for four periods of five years (1974–1978, 1979–1983, 1984–1988, 1989–1993).

Transect Programme and Sole Net Survey

Three transects of approximately 60 miles (Fig. 7) have been sampled in April/May and October/November for 14 years (1950–1960, 1965–1967). This programme was later continued and extended as the Sole Net Survey from 1969 until the present day. Abundance data from all three transects and length data from two transects (Scheveningen and IJmuiden) are shown.

Results

Landings from the total North Sea decreased significantly during the 1930s, but increased just after World War II, during which period fishing had almost stopped (Fig. 1). In the southern North Sea landings declined around 1948 and again in 1963, whereas in the northern and central areas the major decline started around 1965. Since the early 1970s, total landings have remained more or less constant. Rijnsdorp and Millner (1996) show that fishing mortality on plaice has increased substantially during the post-war period. Although this species is not representative of the total North Sea demersal fisheries, mortalities of such demersal species as cod and haddock have likewise increased. Thus, it seems likely that catch rates have decreased much faster than total catches.

Species caught during the IBTS are listed in Table 1 and catch rates are shown in Figure 2. Starry ray was the most abundant species in the survey catches and the abundance increased with time. Years before 1974 are unreliable, because the survey did not extend over the entire North Sea in those years. Trends in abundance for the other species are less reliable because of the low numbers caught or because specific areas were

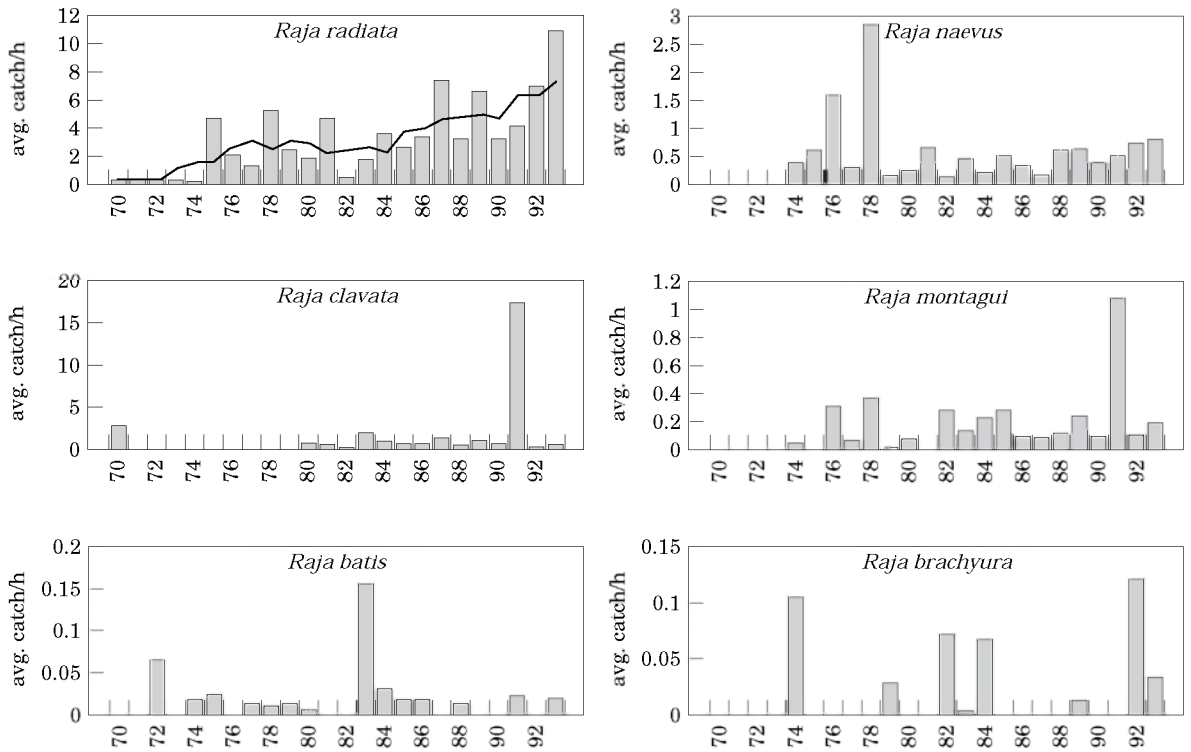

Figure 2. Average catch per hour of six ray species caught during IBTS 1970–1993. A 5-year running mean is shown for *Raja radiata*.

not very well sampled in earlier years. Moreover, there have been quite large fluctuations in catch rates. A review of the available distribution data by period is shown in Figures 3–6 for starry, thornback, spotted, and cuckoo rays, respectively. Starry ray in particular showed a marked increase in the central North Sea. Figures 4 and 6 suggest that thornback and spotted rays may also have become more abundant along the south-eastern coast of England. However, this area has only been sampled adequately from 1982 onwards and the results are therefore biased and it is impossible to draw firm conclusions for these species. Cuckoo rays were abundant off Scotland during the first and last period, but much less so in the intermediate periods. The common skate has mostly been found around the Shetlands.

Species caught during the Transect Programme and Sole Net Survey are indicated in Table 1. Thornback rays represented 95% of the catches. Since 1957, thornback rays have not been caught in the Transect Programme and only three were caught during the Sole Net Survey (Fig. 8). During the years 1951–1957, the average length steadily decreased from largely mature fish to largely immature fish (Fig. 8).

Discussion

The observed decrease in landings of rays and skates cannot be related to a decline in numbers using the IBTS data because the greatest decline in landings occurred before the survey began. The revival, albeit short-lived, of good catches following World War II cannot be attributed entirely to increased effort, but was probably caused by a high degree of protection during the war years. Possibly there are strongholds where rays can avoid being caught and from where they may re-colonize previously intensively fished areas during periods of relatively low fishing activities. During the surveys, extremely large catches of thornback rays have been made, indicating that concentrations do occur. These may act as sources for other areas when conditions are favourable.

The increase in starry ray abundance will not be reflected in the catch statistics as this species is not landed for consumption. The success of this boreal species in the central North Sea might be due to enhanced food availability in the area as a result of fishing, either because of less interspecific food competition due to removal of large teleost fish or because of

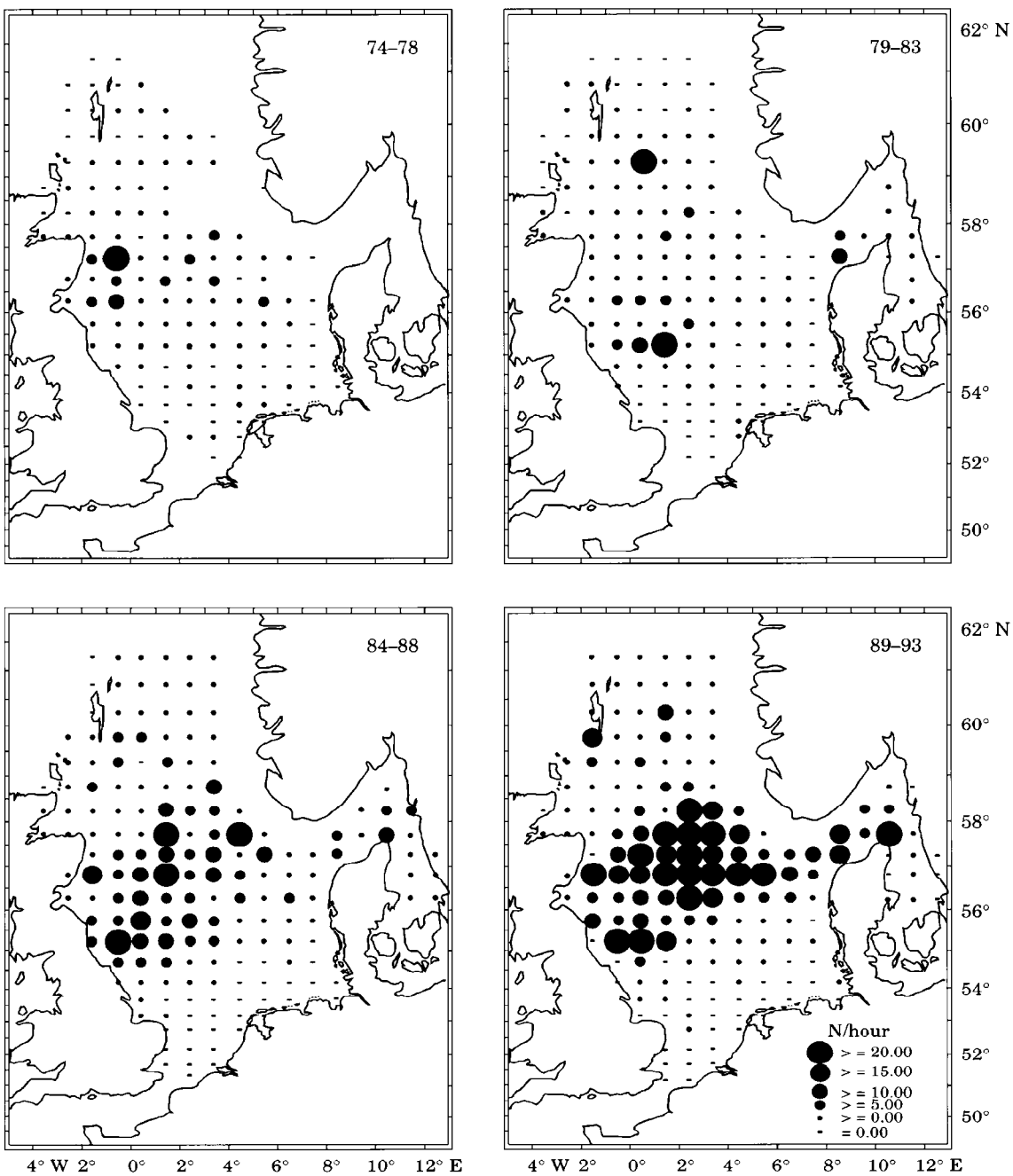

Figure 3. Distribution of starry ray (*Raja radiata*) by 5-year period (N/h; IBTS).

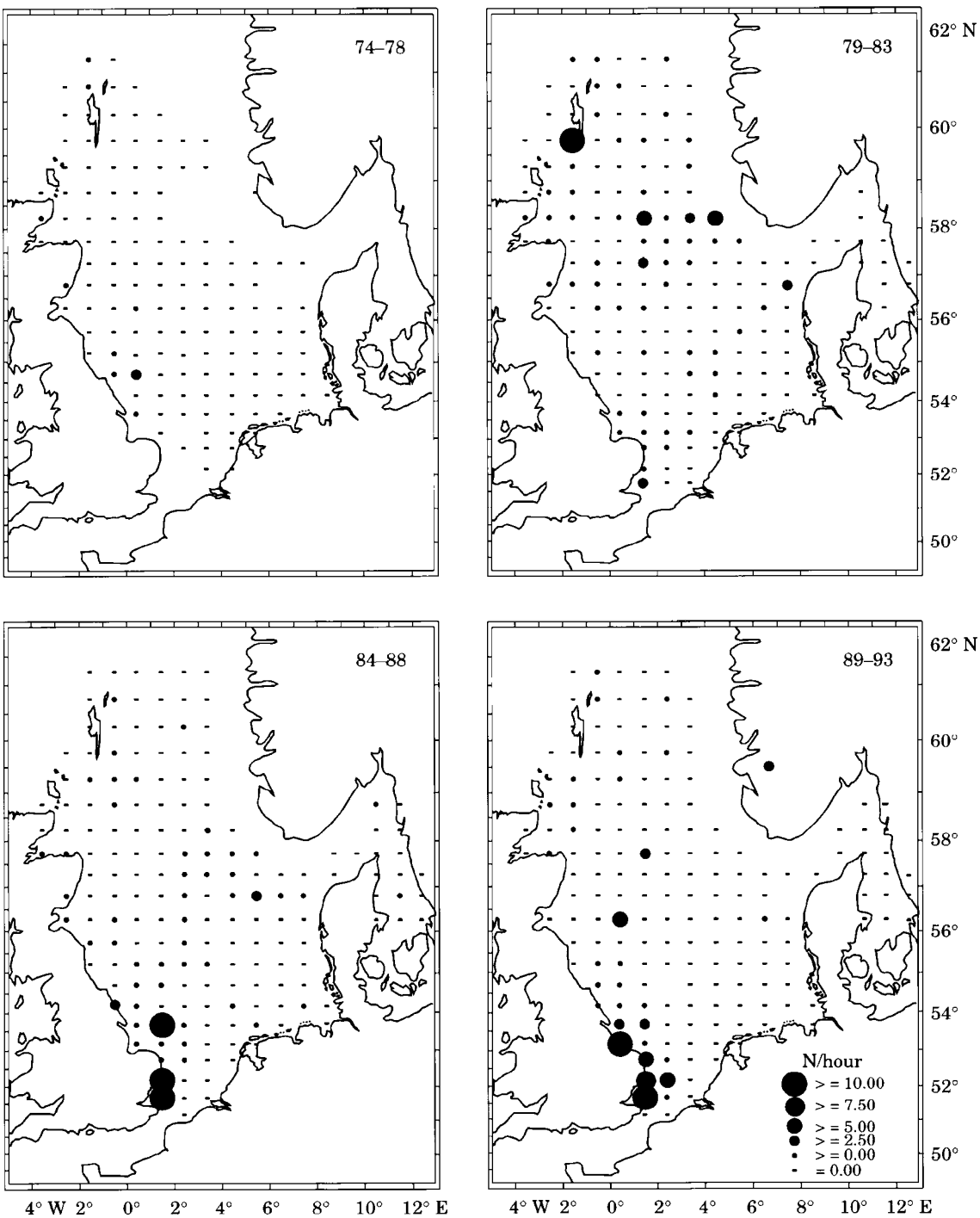

Figure 4. Distribution of thornback ray (*Raja clavata*) by 5-year period (N/h; IBTS).

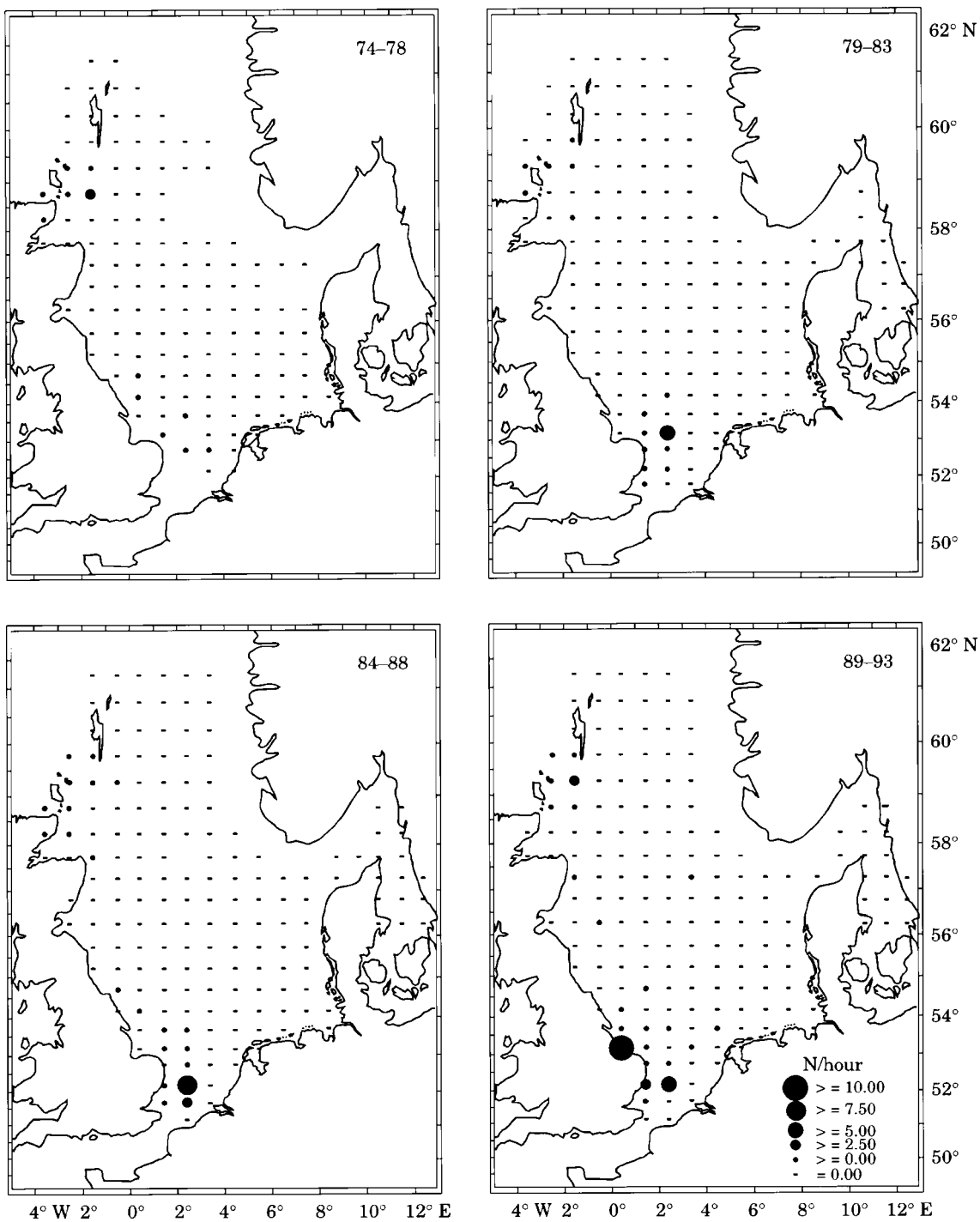

Figure 5. Distribution of the spotted ray (*Raja montagui*) by 5-year period (N/h; IBTS).

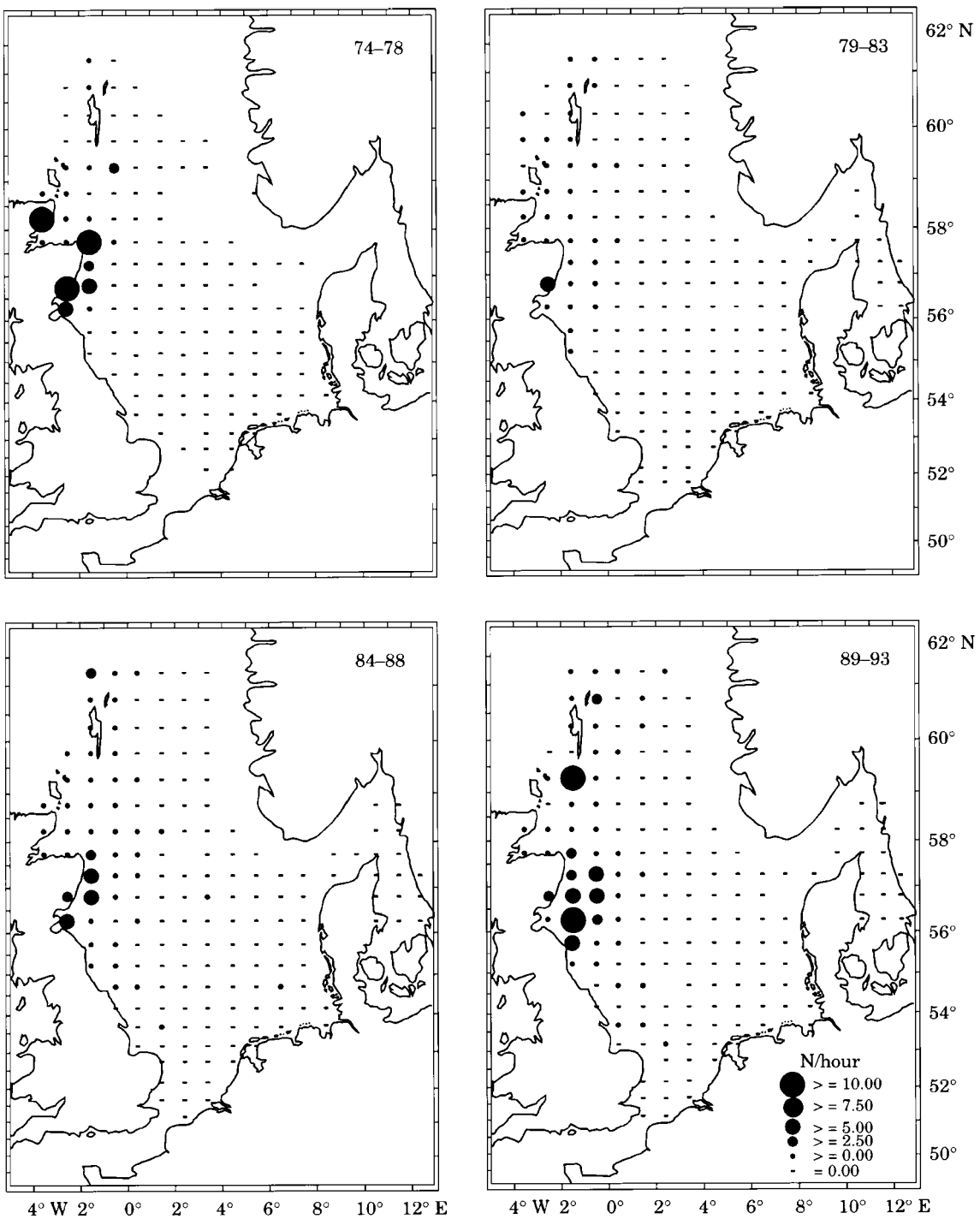

Figure 6. Distribution of the cuckoo ray (*Raja naevus*) by 5-year period (N/h; IBTS).

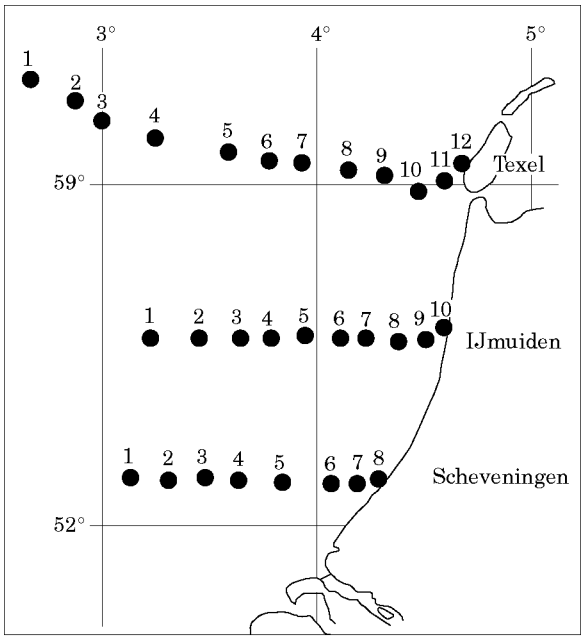

Figure 7. Positions of three transects sampled by The Netherlands Institute for Fisheries Research between 1950 and 1967 and between 1969 and 1994.

access to large quantities of discards. Starry rays are known to be scavengers (Templeman, 1982) and are less susceptible to fishing mortality than the thornback ray and common skate, because of a low length at first maturity. Moreover, this species is distributed outside the major beam trawling areas in the southern and south-eastern North Sea.

The decline in average length and in numbers of mature thornback rays seen off the Dutch coast during the 1950s represents signs of over-exploitation. However, it is not quite clear why this species disappeared from the area within almost a year. The effect is apparently confined to the Dutch coast, as this species is still present in fair numbers on the western side of the Southern Bight.

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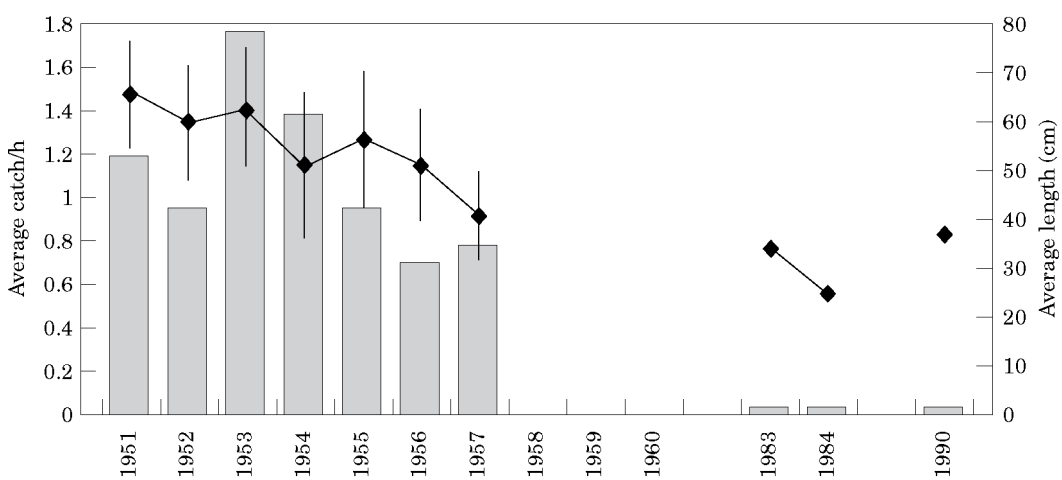

Figure 8. Average catch per hour (all transects; bars) and average length (Scheveningen and IJmuiden; diamonds, ± s.e.) of *Raja clavata* in the Dutch coastal area.

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