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1 Summary

1. Counts of lesser black-backed gulls associated with fishing vessels in the Celtic Sea, St. George's Channel and southern Irish Sea were made prior to and during the breeding season in 1991.

2. Information on quantities of fish discarded and fishing effort (hours fished) for the Celtic Sea *Nephrops* and demersal fisheries are reviewed. Quantities of fish discarded (both total number discarded and number per hour fishing) increased throughout the 1980s in spite of an increase in mesh size. Fishing effort has also increased.

3. Numbers of lesser black-backed gulls associated with fishing vessels were low, especially during the chick-rearing period. Large proportions of the flocks behind trawlers in May and June were immature birds.

4. It is suggested that a possible reason for the low breeding success in 1991 may be due to low numbers of fishing vessels operating near the colonies during the chick-rearing period, and it is possible that this was also the case in 1989 and 1990.

2 Introduction

Skomer Island in South-West Wales holds the largest colony of lesser black-backed gulls *Larus fuscus* in the British Isles, with 15,518 pairs counted in 1991. This accounts for 20% of the British and Irish population of this species. In recent years lesser black-backed gulls have had a very low breeding success on Skomer, with less than 10% of pairs raising chicks to fledging in 1989 and 1990 (Sutcliffe 1991). During these years a high proportion of the eggs laid did not hatch, and of those which did hatch, few chicks survived. During the 1991 season, apparently more chicks survived than in 1990, the estimated number of fledglings being about 7,000 (Perrins 1992). However, the number of fledglings per nest was still low at 0.45. The reasons for this breeding failure are poorly understood, but it appeared that the chicks were not getting enough food. Adult lesser black-backed gulls feed at sea behind trawlers or in fields on the mainland where earthworms are consumed, and to a lesser extent scavenging at rubbish tips and fish docks. This report presents the results of an investigation into the availability of food behind trawlers and the number of lesser black-backed gulls exploiting this food source.

3 Methods

There were two components to this investigation: direct observations of the numbers of lesser black-backed gulls feeding at sea behind trawlers, and a review of information available on the Celtic Sea fisheries. Surveys were undertaken on board fishery protection vessels in the Celtic Sea, St. George's Channel and southern Irish Sea in February, April, May, June and July 1991. The area surveyed extended from 49°30'N to 53°N latitude with a western boundary of 8°W. North of Land's End the eastern boundary was taken as the coast of Wales, Cornwall and the Bristol Channel as far as 4°W, while south of Land's End the eastern boundary was taken as 5°30'W (Figure 1). As the fishery protection vessels approached fishing vessels working in this area, counts were made of the number of lesser black-backed gulls associated with these vessels, and each bird was classified as adult, immature or unknown. On some occasions two counts were made around the same trawler, once when the vessel was engaged in trawling and once when the nets were being hauled in. On these occasions, the larger count (usually that taken when hauling) was used in the analysis.

Many of the boats fishing in this area are French vessels, trawling for Dublin Bay prawns (Norway lobsters), *Nephrops norvegicus*. Information from this and other French fisheries in this area have been obtained and are presented below.

4 Results

4.1 Lesser black-backed gulls associated with trawlers

The highest mean number (66.3) of lesser black-backed gulls associated with trawlers was found in February (Table 1). A secondary peak occurred in May, prior to the eggs hatching. During June, when chick-feeding would have commenced, low numbers of birds were associated with fishing vessels (mean = 36.9). The difference in the number of birds behind trawlers in each month was tested using a one-way analysis of variance. This gave a value of $F = 1.41$ (degrees of freedom = 4, 38) which is not significant. The number of fishing vessels surveyed in each month was low, although this does not reflect the number of fishing vessels working in the area, as not all trawlers were approached by the fishery protection vessels.

Table 1 Number of lesser black-backed gulls associated with trawlers in the Celtic Sea and southern Irish Sea

Month	Number of lesser black-backed gulls		Number of trawlers
	Mean	Standard deviation	
February	66.3	62.3	9
April	25.2	17.4	6
May	57.5	18.9	4
June	36.9	22.3	16
July	41.6	44.7	8

In May and June many of the flocks behind trawlers contained a high proportion of immature birds, sometimes as many as 55% immatures (Table 2). In July most of the birds were adults. In February and April few birds were aged, so these months are not included in Table 2.

Coverage of the waters in the immediate vicinity of Skomer in June was low (Figure 2), although in all other months good coverage was obtained in this area. However, some counts were made in Cardigan Bay during June. In both February and May, all the counts were made within one $^1/_4$ ICES statistical rectangle (15' latitude x 30' longitude), whereas in other months the counts were more dispersed (Figure 3).

In addition to lesser black-backed gulls, other species were also seen associated with fishing vessels (Table 3), mostly fulmars (*Fulmarus glacialis*), herring gulls (*Larus argentatus*), gannets (*Morus bassanus*), kittiwakes (*Rissa tridactyla*) and great black-backed gulls (*Larus marinus*). Some other species not included in Table 3 were also seen around trawlers in low numbers, e.g. storm petrel (*Hydrobates pelagicus*) and common gull (*Larus canus*).

Table 2 Age composition of flocks of lesser black-backed gulls associated with fishing vessels (only includes counts where birds were aged)

Month	Flock size	%age adults	%age immature
May	45	70	30
	45	50	50
	85	45	55
June	45	55	45
	35	70	30
	55	70	30
	30	50	50
July	4	100	0
	120	97	3
	90	97	3
	49	86	14
	53	85	15
	10	90	10
	3	100	0
	4	75	25

Table 3 Mean numbers of birds observed around fishing vessels in the Celtic Sea

Species	Feb	Apr	May	Jun	Jul
Fulmar *Fulmarus glacialis*	51.2	28.3	35.0	20.2	10.0
Manx Shearwater *Puffinus puffinus*	0.0	0.0	0.3	0.0	19.8
Gannet *Morus bassanus*	19.1	1.5	28.8	5.8	24.0
Great Skua *Stercorarius skua*	0.0	0.0	0.0	0.2	0.4
Lesser Black-backed Gull *Larus fuscus*	66.3	25.2	57.5	36.9	41.6
Herring Gull *Larus argentatus*	102.9	10.0	3.5	21.4	7.8
Great Black-backed Gull *Larus marinus*	12.4	0.0	0.8	6.9	7.1
Kittiwake *Rissa tridactyla*	33.7	6.7	28.8	9.1	9.6
number of fishing vessels	9	6	4	16	8

4.2 Fisheries data for the Celtic Sea

Most trawlers working in this area are French vessels. There are also many Spanish long-liners, but these are mostly in the extreme south-west. There are two major types of French fishery in the Celtic Sea, demersal (sea-bed) and *Nephrops*. The demersal fishery covers the whole of the Celtic Sea (ICES subareas VIIf,g,h) whereas the *Nephrops* fishery is concentrated in the Smalls, Labadie and Jones grounds, of which the nearest to Skomer is the Smalls (Figure 1). Since 1983, the fishing effort for the French fishery in the Smalls area (in terms of number of hours fished) reached low levels in 1986 but has since increased again (Table 4).

Table 4 Fishing effort (no. hours) for the French fisheries in the Smalls area (ICES subarea VIIg2).

Year	*Nephrops*	Demersal
1983	131,435	39,206
1984	114,209	49,093
1985	113,282	51,807
1986	103,370	36,001
1987	121,568	42,951
1988	126,275	48,373
1989	134,928	51,109
1990	148,652	63,575

The mesh size for *Nephrops* increased during the 1980s. Before 1979 the minimum mesh size was smaller than 55mm, but it increased to 60mm in 1984 and to 70mm on 1st July 1986. In spite of these changes, discards from the *Nephrops* fishery have increased for most species (Table 5). At present, data are only available for the first two quarters of 1991, but for most species the number of discards have increased over the 1985 levels. The only species that did not show a consistent increase in the amount of discards between 1980 and 1991 were angler fish (two species), which showed a marked decrease in discards in 1985, but discards in 1991 were comparable to 1980. Of the species for which records are available, gadoids (cod, hake and whiting) have shown a dramatic increase in discards; the numbers of gadoids discarded in the first half of 1991 was greater than the total numbers discarded in 1985. This may be due to a change in fishing practice, with proportionately more *Nephrops* trawlers fishing by night towards the end of the decade than at the beginning.

An increase in the numbers of fish discarded each year would be expected if fishing effort increased. However, the numbers of fish discarded per hour of fishing also rose between 1980 and 1985 (Table 6), so the increase in the annual amount of discards cannot be due solely to increased fishing effort.

Table 5 Numbers of fish and *Nephrops* discarded by the French *Nephrops* fishery in the Celtic Sea.

Species	Number of discards		
	1980	1985	1991*
Angler fish	350,000	80,000	254,000
Cod	700	40,000	94,000
Dogfish	271,000	nd	nd
Hake	722,000	1,030,000	3,460,000
Lemon sole	58,900	nd	nd
Megrim	947,000	4,870,000	2,000,000
Nephrops	nd	39,300,000	69,900,000
Ray	210,000	nd	245,000+
Spurdog	91,200	nd	nd
Whiting	156,000	750,000	969,000

* data for first half of year only
+ data for females in second quarter of year only
nd = no data
(Sources: Destanque 1981, Conan 1982, Charuau 1985, Peronnet 1991)

Table 6 Numbers of fish discarded per hour fishing by the French *Nephrops* fishery in the Celtic Sea.

Species	No. discards per hour	
	1980	1985
Angler fish	1.96	0.71
Cod	nd	0.35
Dogfish	1.21	nd
Hake	4.30	9.09
Lemon sole	0.28	nd
Megrim	5.34	42.99
Nephrops	nd	346.57
Ray	0.45	nd
Spurdog	0.33	nd
Whiting	0.67	6.62

nd = no data
(Sources: Destanque 1981, Conan 1982, Charuau 1985)

The number of fish discarded by demersal fisheries also increased (Table 7). Again figures are only available for the first two quarters of 1991, but discards were greater than in 1985, with the exception of megrim. Whiting, hake and cod discards showed a marked increase, with numbers rejected in the first half of 1991 being greater than the total number rejected in 1984-5. The reasons for this increase in discards remains unknown.

Table 7 Numbers of fish discarded by the French demersal fisheries in the Celtic Sea.

Species	Number of discards	
	1984-5	1991*
Angler fish	318,000	nd
Black-bellied angler fish	219,000	171,000+
Cod	161,000	724,000
Haddock	1,330,000	1,070,000
Hake	307,000	1,300,000
Megrim	4,290,000	1,430,000
Ray	949,000*	1,120,000
Whiting	2,130,000	4,600,000

* data for first half of year only
+ data for first quarter of year only
nd = no data
(Sources: Biseau & Charuau 1989, Peronnet 1991)

5 Discussion

5.1 *History of breeding success and diet of lesser black-backed gulls on Skomer*

In 1962, lesser black-backed gulls on Skomer laid an average of 1.8 eggs per pair; of these at least 50% survived to fledging, giving an average survival rate of 0.9 chicks per pair (Harris 1964). In the mid 1980s, Todd (1987) found that survival rates were somewhat lower than this. Sutcliffe (1991) noted that some areas of the island were devoid of chicks in 1988. In 1989 and 1990 breeding success of lesser black-backed gulls on Skomer dropped dramatically (Table 8). Less than 10% of pairs raised chicks to fledging on Skomer and Skokholm, with Skomer being the worst affected (Sutcliffe 1991). In 1991 breeding success improved, with 0.45 chicks fledged per pair (Perrins 1992).

Table 8 Number of lesser black-backed gull chicks fledged per pair on Skomer

Year	No. chicks per pair	Source
1962	0.9	Harris (1964)
1982	1.19	Perrins (1992)
1983	1.24	Perrins (1992)
1984	0.84	Perrins (1992)
	0.70	Todd (1987)
1985	0.89	Todd (1987)
1986	0.63	Todd (1987)
1987	0.52*	Perrins (1992)
	0.81*	Perrins (1992)
1989	<0.10	Sutcliffe (1991)
1990	<0.10	Sutcliffe (1991)
1991	0.45	Perrins (1992)

* two estimates gave different results

Hario (1990), investigating the breeding failure of lesser black-backed gulls *Larus fuscus fuscus* in the Gulf of Finland concluded that the neglect of brood care is either a reaction to a variation in feeding conditions or a symptom of harmful physiological changes, possibly due to pollution. The failures on Skomer and Skokholm appear to be due to a shortage of food for the chicks (Sutcliffe 1991).

Harris (1964) noted that predation and cannabilism were the main reasons for the loss of chicks in 1962, with parasites, lack of food and disease being unimportant. Fish were an important component of the diet of lesser black-backed gulls on Skomer in the 1960-1962 breeding seasons, with sixteen out of 55 adult birds having fish in their stomachs (Harris 1965). In 1980 the main component of lesser black-backed gull chicks' diet was bony fish between 15 cm and 30 cm long (Alexander & Perrins 1980), with the remains of other larger fish also present. These fish were probably discarded by fishermen. This conclusion was supported by the seventeen fish skulls which could be identified in the samples. These skulls were from blue whiting (10), poor cod (6) and whiting (1). These fish are not usually available to surface-feeding birds. Fish were important in the diet of gulls from Skokholm in 1981 and 1982; regurgitates contained 75.5% fish/squid in 1981 and 54.5% fish in 1982 (Sutcliffe 1991). In 1984-1986 nest remains and regurgitates showed that the diet of gulls was mainly small fish (blue whiting and poor cod) probably from trawler discards (Todd 1987).

In recent years earthworms seem to have become a more important part of the diet than previously. Harris (1965) found only one bird had eaten earthworms. Earthworms were eaten in 1980 (Alexander & Perrins 1980), while Sutcliffe (1991) noted that regurgitates on Skokholm contained 20.8% earthworms in 1981. In 1990 all regurgitates from thirteen chicks contained earthworms (Perrins 1991), with only two containing any evidence of fish in the diet. In 1991 earthworms again formed a major constituent (60-65%) of the chicks' diet (Perrins 1992).

The growth rate of chicks in 1991 was poor (Perrins 1992) and it seems likely that the main cause of death was starvation. Earthworms may not be an adequate food for the chicks. The lack of fish in the diet indicates that either the adult gulls were not searching for fish, or that they are searching for fish but not finding them.

5.2 *Are lesser black-backed gulls still feeding at sea?*

Flight directions indicated that the birds were feeding at sea in 1984-1986 (Todd 1987), and in June 1981 most birds left Skokholm in a westerly (seaward) direction (Sutcliffe 1991). In June 1990, 45% of lesser black-backed gulls seen flying at sea within 45 km of Skomer between dawn and mid afternoon were heading in a south-west direction and a further 19% were heading west (Stone *et*

al. 1992). On 3 July 1990, 73% of birds departed from Skomer in a westerly direction (Orsman & Sutcliffe 1990) between 0500 and 1900 GMT. Most westward movement took place in mid-morning and late afternoon/early evening. However, Perrins (1991) found that on 6 June 1990 most lesser black-backed gulls flew to the mainland, and only twenty birds flew out to sea between 0500 and 0900 GMT. Perrins (1992) again reported a daily exodus of adult gulls to the mainland in 1991. Similarly, Donovan (1991) reported small flights of birds towards Llysfran reservoir on the mainland at dawn and afterwards, with return flights in the late evening, and concluded that the birds fed inland during the day. Perrins (1991) suggested that most birds going to the mainland do so before dawn.

It is clear that although most gulls may be feeding on the mainland, some birds still go to sea in search of food (Orsman & Sutcliffe 1990, Stone *et al.* 1992). More comprehensive studies of departures of gulls from the island, during the pre-breeding and breeding seasons, would give a better picture of the proportion of birds feeding at sea or on the mainland.

Lesser black-backed gulls at sea were concentrated around fishing vessels; densities of gulls away from trawlers were low (mostly less than 1 bird/km^2). Numbers of lesser black-backed gulls associated with trawlers were not as large as might be expected given the numbers of birds that breed on Skomer and Skokholm. Relatively low numbers (mean flock size = 36.9) were observed behind trawlers in the chick-rearing period in June, and many of these birds were immatures. However, the number of lesser black-backed gulls associated with fishing vessels in the Celtic Sea is high when compared to numbers behind trawlers in the Irish Sea, where in surveys conducted to the west of the Isle of Man in 1972-1975 the mean number reached a maximum of 3.3 birds in May (Watson 1981). The highest number observed in 1991 (mean flock size = 66.3) was in February.

5.3 *Are fish available for lesser black-backed gulls feeding at sea?*

Small fish may be caught by the gulls at the sea surface, but the species found in regurgitates fed to chicks were demersal species, thus most likely to have been discarded from trawlers. The increase in mesh size during the 1980's might have been expected to result in a decrease in the amount of fish discarded per fishing

vessel. However, discards of most species increased, in particular those of whiting. Perrins (1992) found no evidence of a food shortage for gulls prior to egg-laying. It appears that gulls were either choosing not to use trawler discards during the chick-rearing period, or that there were insufficient discards available at this time in 1989 and 1990. The data that is available on discards from the French Celtic Sea fisheries cannot be sub-divided to show amounts discarded in each month, and there is no data available for domestic boats working in this area.

Smaller birds such as lesser black-backed gulls were found to be unable to compete successfully for discards with larger species (gannets and great black-backed gulls) behind whitefish trawlers around Shetland (Furness, Hudson & Ensor 1988, Hudson & Furness 1988a,b). Discards from whitefish trawlers are larger than discards from *Nephrops* trawlers, and lesser black-backed gulls have been found to be more successful in feeding behind *Nephrops* trawlers in the Clyde (Furness, Hudson & Ensor 1988). The increase in mesh size of the Celtic Sea *Nephrops* trawlers may have resulted in an increase in the size of fish discarded, giving larger birds an advantage. There were always fewer gannets than lesser black-backed gulls, and great black-backed gulls were in low numbers, so competition is unlikely to be a contributing factor.

The method of discarding fish may affect the value of this food source. Continuous flushing of small numbers of fish feeds more birds than if large amounts are discarded in one go, when many discards sink (Hudson 1986). It is not known whether there has been a change in the way fish are discarded in recent years.

5.4 *Are fishing vessels working close enough to Skomer and Skokholm?*

Given that the fisheries are still producing large quantites of discarded fish, reasons why lesser black-backed gulls are not exploiting this food source are unclear. Possibly fishing vessels were not working close enough to Skomer and Skokholm during the crucial chick-rearing period. Pearson (1968) considered that the average potential feeding range of lesser black-backed gulls on the Farne Islands lay within 30 miles. In 1991, the majority of observations around fishing vessels were to the west and north of the Isles of Scilly, with a few observations in Cardigan Bay. Some of the gulls observed behind trawlers in the vicinity of the

Isles of Scilly were probably from colonies on these islands. More detailed fishery statistics would be needed to determine the intensity of fishing activity near Skomer and Skokholm during the chick-rearing period. The statistics available cover the whole of the Celtic Sea and cannot be sub-divided by area. More coverage in waters closer to the islands may give some indication of the intensity of fishing effort in this area.

Hatching success has been low on Skomer in the last three years (Perrins 1992, Sutcliffe 1991), apparently mainly due to intra-specific predation. This may reflect the increased amount of time that the nest is left unguarded while the adults are searching for food. More birds were observed behind trawlers in May than in June, although many of these birds were immatures. Although these observations were made over 250 km from the colonies, coverage of waters closer to the colonies was obtained during May. It may be that the gulls were having to travel long distances before encountering fishing vessels, thus leaving their nests unguarded for long periods.

6 Conclusions

Although large numbers of lesser black-backed gulls are feeding on the mainland, some are still heading out to sea to feed behind trawlers. The amount of fish discarded by the Celtic Sea fisheries has increased in recent years. However, fishing vessels may not be working in the immediate vicinity of Skomer and Skokholm and this may limit the value of this food source. Further surveys around fishing vessels in 1992, with increased coverage closer to the colonies, could shed more light on the situation.

7 Acknowledgements

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Appendix 1

Scientific names of fish species referred to in text and tables:

Common name	Scientific name
Angler fish	*Lophius piscatorius*
Black-bellied angler fish	*Lophius budegassa*
Cod	*Gadus morhua*
Dogfish	*Scylliorhinus canicula*
Haddock	*Gadus aeglefinus*
Hake	*Merluccius merluccius*
Lemon sole	*Microstomus kitt*
Megrim	*Lepidorhombus whiffiagonis*
Ray	*Raja* spp.
Spurdog	*Squalus acanthius*
Whiting	*Merlangus merlangus*

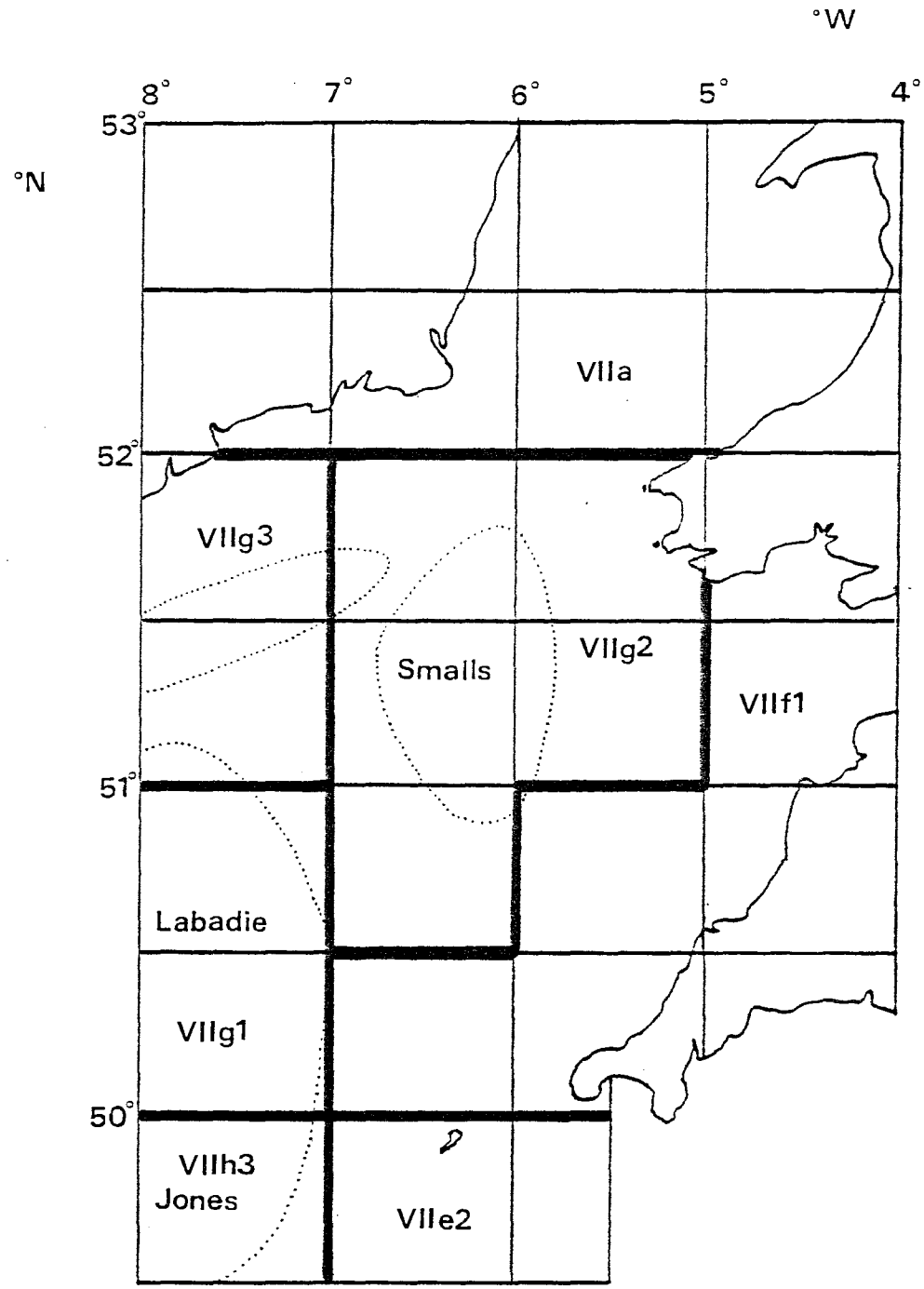

Figure 1 Area surveyed, showing ICES sub-areas and Celtic Sea *Nephrops* fishing grounds

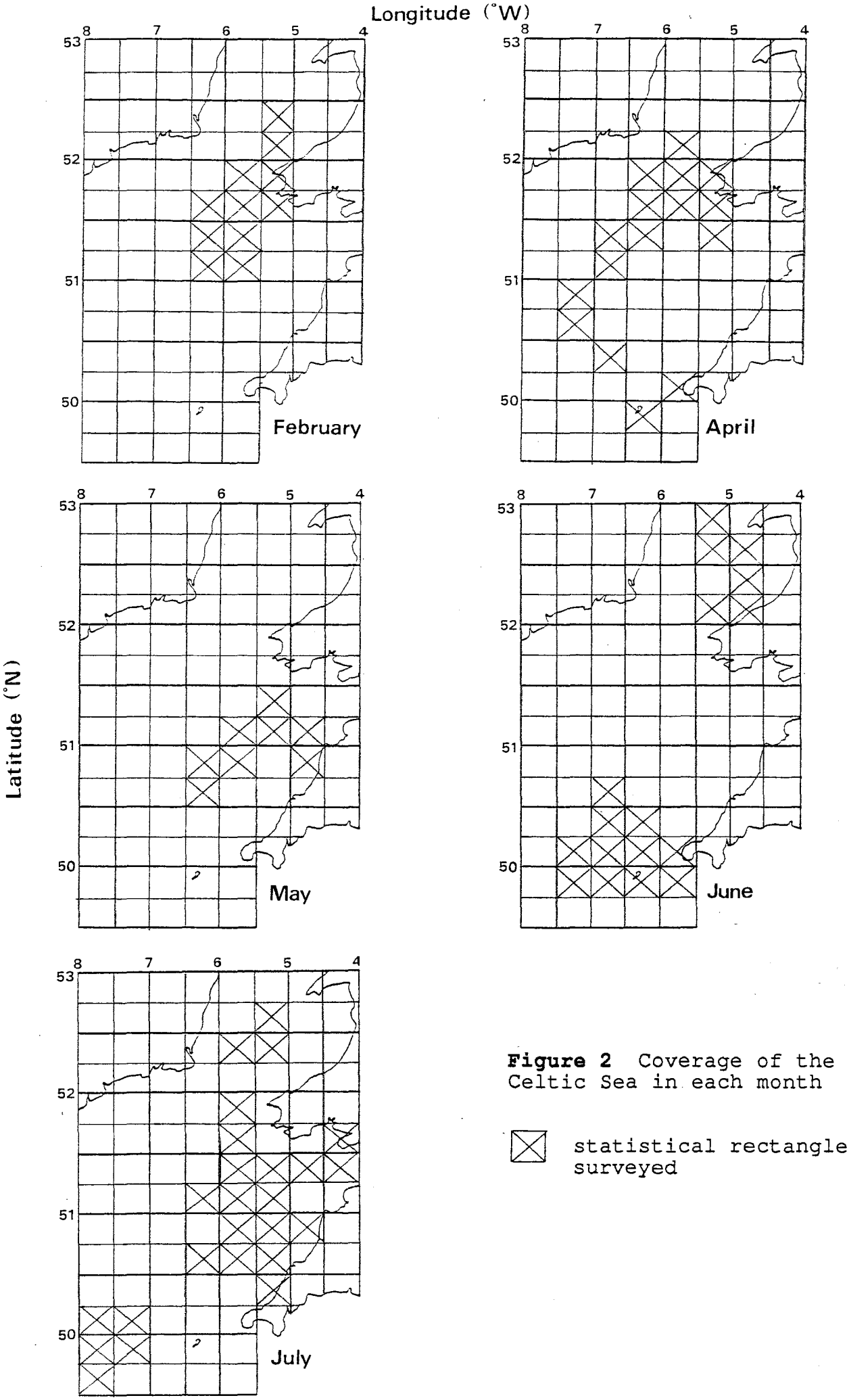

Figure 2 Coverage of the Celtic Sea in each month

statistical rectangle surveyed

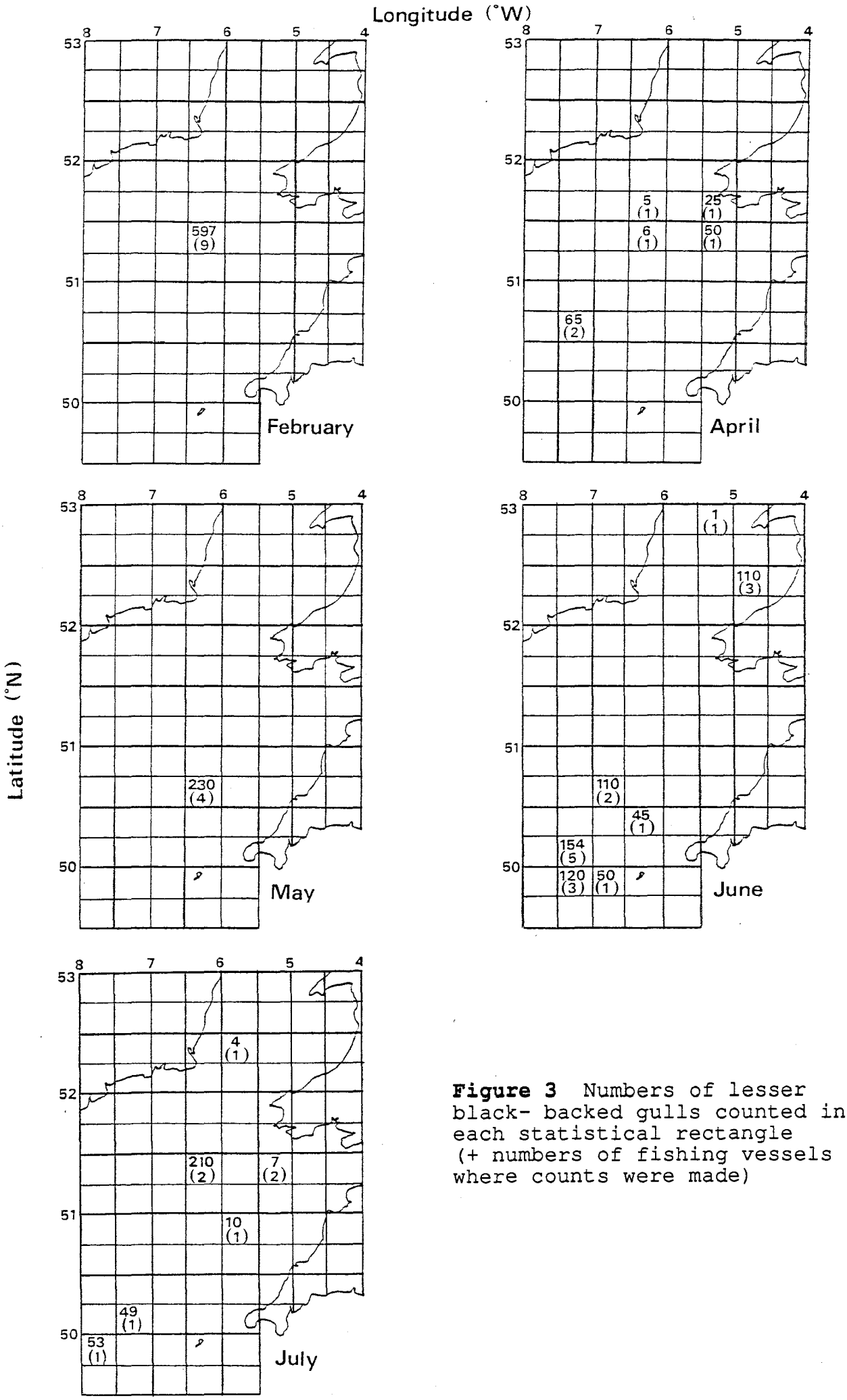

Figure 3 Numbers of lesser black- backed gulls counted in each statistical rectangle (+ numbers of fishing vessels where counts were made)