R1/3

Not to be cited without prior reference to the Laboratory

Charter Vessels Cruise - *Zephyr* and *Monadhliath* H35

REPORT

21-26 January 1991

Personnel

S P R Greenstreet	HSO
I M Gibb	SO
B Wilson	Aberdeen University (part time)
S Reddy	Aberdeen University (part time)
D Wood	Aberdeen University (part time)

Objectives

To determine the distribution, size and species composition of clupeid shoals in the Inner Moray Firth and inner firths. To determine the distributions of top predators (seals, cetaceans, seabirds and fish) in relation to clupeids. To collect information on the diets of predatory fish.

Narrative

Scientific staff joined *Monadhliath* and *Zephyr* in Inverness at 1030 on 21 January at which time a 38 kHz echosounder and colour plotter were installed on *Monadhliath*. The boats then sailed into the Beauly Firth to set up the transducer, check the equipment and start survey work. Two hauls were made on small marks to refamiliarise the crew with working pair trawl gear. During the period 22-25 January an area west of a line north from Burghead and south of a line east from Tarbet Ness was surveyed by echosounder, the vessel returning to Inverness each evening (Figure 1A). On 25 January an excursion into the outer region of the Dornoch Firth was made. On 26 January work was restricted to the Beauly and Inverness Firths and the boats returned to Inverness by 1300. The scientific equipment was unloaded and scientific staff left Inverness for Aberdeen at 1400.

Shoals were sampled by pair trawl. Areas where concentrations of marks were detected were sampled repeatedly on successive days to examine local shoal composition variability. Seabirds, seals and cetaceans were surveyed using standard methods (Tasker *et al.* 1984, *Auk*, **101**,567-577); 15.33 hours of sea bird survey were carried out (Figure 1B). In addition to this formal survey, all "casual" sightings of seals and cetaceans were noted. The stomachs of all whiting caught were retained for dietary investigation.

Results

Fish traces were scarce throughout the area covered by the survey, an observation supported by local commercial fishermen. The echosounder printout was quantified by

partitioning the entire survey printout into 5 minute blocks and assigning a relative fish density code to each block. The survey area was partitioned into 6′ latitude by 6′ longitude rectangles (approximately 6 km by 11 km) and the mean index value in each rectangle was plotted (Figure 2A).

The largest concentrations of marks were found in the North Channel of the Inverness Firth off Avoch and at Chanonry Point. Smaller concentrations were found in the Beauly Firth and in an area approximately mid-way between Nairn and the mouth of the Cromarty Firth. A total of 10 hauls were made in these areas (Figure 2B), 8 of which caught clupeids. The largest catch (haul 5) totalled 20 baskets in volume; the rest were considerably smaller, varying between 1/5 and 4 baskets. The mean weight of 5 fish from each length class (weighed at sea) was plotted to obtain length weight relationships in the form

$$W = \alpha.L^{b}$$

Small herring (<12 cms), large herring (>16.5 cms), and sprat were treated separately, giving:

large herring	weight = $0.00209*length^{3.3889}$
small herring	weight = $0.00141*length^{3.6170}$
sprat	weight = $0.00482*length^{3.1161}$

These relationships were used to convert numbers at length to biomass at length. The clupeid composition in each catch, in terms of both numbers and biomass, is given in Table 1. Samples of otoliths from fish in each length group were retained to determine age at length.

Two hauls in the Inner Moray Firth contained catches of over 90% sprat. However, the traces on which the pair trawl was shot in this area were small, light and very localised. The catches were small (18 kg and 7 kg), and a third haul was unsuccessful. The sprats were mainly 1st winter fish, 6-8.5 cm in length; some larger 2nd winter sprats were also present. The small herring bycatch in these samples consisted entirely of 8-12 cm fish. Species composition and size distributions were consistent from day to day.

One other catch containing over 90% sprat was made off Chanonry Point, but it was small (3 kg) and again consisted almost entirely of 4-8.5 cm, 1st winter fish. A previous, larger catch (33 kg), at this site had consisted of only 40% sprat; most were 5-8.5 cm 1st winter fish, but the smaller number of 9-13 cm, 2nd winter fish, made up 75% of the sprat biomass. On this occasion the herring bycatch consisted mainly of 14-20 cm 2nd winter fish.

The three largest catches (713 kg, 105 kg, and 98 kg) were made in the north channel of the Inverness Firth off Avoch where the largest and densest traces observed during the survey were located. Species composition and age/length distributions in these samples were consistent, comprising almost entirely of 2nd winter herring, 16-22 cm in length.

The only successful Beauly Firth haul was small (5 kg) and consisted mainly of small, 7-14 cm herring. The few sprats caught were also very small, 4-6 cm.

The stomach contents of 13 whiting have still to be examined.

The distribution of auks, divers and shag are shown in Figure 3. Rectangles (6′ latitude by 6′ longitude) with a higher average relative fish density supported significantly higher densities of auks ($r = 0.44$; $p<0.05$). If the rectangle immediately south of Tarbet Ness was excluded from the analysis, then this correlation was improved ($r = 0.62$; $p<0.01$) and the correlation for guillemots was also significant ($r = 0.56$; $p<0.01$) (Figure 4). Strong surface currents were observed around Tarbet Ness as the water swept around the headland and over a large reef. The resulting mixing of the water column probably enhanced the attraction of this rectangle to foraging seabirds. Shag, divers and seaduck were also numerous in this region. Water depth had no apparent significant influence on auk distributions.

The numbers and positions of all seals and dolphins sighted during the cruise are shown in Figure 5. Seals were most frequently encountered at sea in the Inverness Firth north channel and around Chanonry Point where clupeids appeared to be most abundant. Dolphin sightings were more widely distributed and appeared to be less restricted to areas of higher fish density.

S P R Greenstreet
7 November 1991

Table 1: Numbers at length, total catch and total biomass, and catch composition by number and weight, of herring and sprat in each haul.

Haul	1		2		3		4		5		6		7		8		9		10	
Date	21/01/91		21/01/91		22/01/91		22/01/91		23/01/91		23/01/91		24/01/91		24/01/91		25/01/91		26/01/91	
Time shot	14.45		16.23		08.47		10.45		08.39		11.26		08.35		16.45		10.11		10.05	
Duration	15		17		13		12		13		15		14		30		33		24	
Region	Beauly		Avoch		Beauly		Chanonry		Avoch		Inner Fth		Avoch		Inner Fth		Inner Fth		Chanonry	
Latitude	57:30.14		57:34.22		57:29.48		57:34.51		57:34.53		57:42.32		57:34.35		57:39.87		57:39.48		57:34.43	
Longtitude	04:18.81		04:08.31		04:18.33		04:06.51		04:07.96		03:49.19		04:07.78		03:51.41		03:50.68		04:05.08	
	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H	S	H
3.5	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	5	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
4.5	-	-	12	-	9	-	16	-	-	-	-	-	3	-	-	-	-	-	4	-
5	-	-	28	-	42	-	55	-	-	-	-	-	3	-	-	-	-	-	4	-
5.5	-	-	60	-	42	-	79	-	40	-	-	-	21	-	9	-	20	-	11	-
6	-	-	64	-	15	-	316	-	40	-	-	-	30	-	18	-	20	-	157	-
6.5	-	-	44	-	6	-	276	-	40	-	-	-	42	-	172	-	157	-	179	-
7	-	-	52	-	1	25	419	-	-	-	-	-	75	-	508	-	648	-	241	-
7.5	-	-	40	-	3	260	245	-	40	-	-	-	60	-	726	-	1825	-	226	-
8	-	-	36	-	1	285	103	-	20	-	-	-	24	-	581	-	1531	-	139	-
8.5	-	-	12	-	4	227	63	-	60	-	-	-	42	-	218	1	805	4	69	-
9	-	-	72	-	17	157	158	-	200	-	-	-	114	-	63	3	275	4	36	1
9.5	-	-	28	-	9	87	63	-	180	-	-	-	99	-	9	8	20	18	4	-
10	-	-	24	-	1	45	87	-	60	-	-	-	30	-	-	11	-	50	-	-
10.5	-	-	40	-	2	50	87	-	100	-	-	-	18	-	-	25	39	76	-	-
11	-	-	52	-	-	4	190	5	100	-	-	-	63	-	-	19	78	38	4	-
11.5	-	-	36	-	3	1	182	-	100	-	-	-	39	-	18	10	-	18	3	-
12	-	-	20	-	-	2	166	5	100	-	-	-	54	-	-	5	-	2	-	-
12.5	-	-	12	-	-	1	87	-	-	-	-	-	6	-	-	4	-	2	-	-
13	-	-	16	-	-	7	55	-	-	-	-	-	9	-	-	-	-	-	-	1
13.5	-	-	4	-	1	6	24	5	-	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	8	-	10	-	-	-	-	-	32	-	-	-	-	-	-
14.5	-	-	-	-	-	2	-	5	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	2	-	-
15.5	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-
16	-	-	-	10	-	1	-	5	-	68	-	-	-	21	-	-	-	-	-	-
16.5	-	-	-	21	-	-	-	15	-	136	-	-	-	84	-	-	-	-	-	-
17	-	-	-	207	-	6	-	40	-	1355	-	-	-	369	-	-	-	2	-	-
17.5	-	-	-	414	-	1	-	80	-	1965	-	-	-	537	-	-	-	-	-	-
18	-	-	-	684	-	8	-	105	-	4473	-	-	-	663	-	-	-	-	-	-
18.5	-	-	-	580	-	5	-	100	-	3728	-	-	-	411	-	-	-	-	-	-
19	-	-	-	414	-	2	-	95	-	3369	-	-	-	221	-	-	-	-	-	-
19.5	-	-	-	145	-	-	-	30	-	881	-	-	-	105	-	-	-	-	-	-
20	-	-	-	52	-	1	-	5	-	610	-	-	-	32	-	-	-	-	-	-
20.5	-	-	-	21	-	2	-	5	-	542	-	-	-	42	-	-	-	-	-	-
21	-	-	-	10	-	-	-	-	-	203	-	-	-	-	-	-	-	-	-	-
21.5	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	10	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total N.	-	-	652	2578	162	1195	2671	520	1080	17350	-	-	735	2528	2322	86	5418	216	1077	2
%N Sprat	-		20.2		11.9		83.7		5.9		-		22.5		96.4		96.2		99.8	
Total Kg	-	-	3	102	.3	5	13	20	6	707	-	-	4	94	6	.7	16	2	3	.02
%Kg Sprat	-		2.8		5.7		39.5		0.9		-		3.[redacted]		90.7		91.3		99.3	

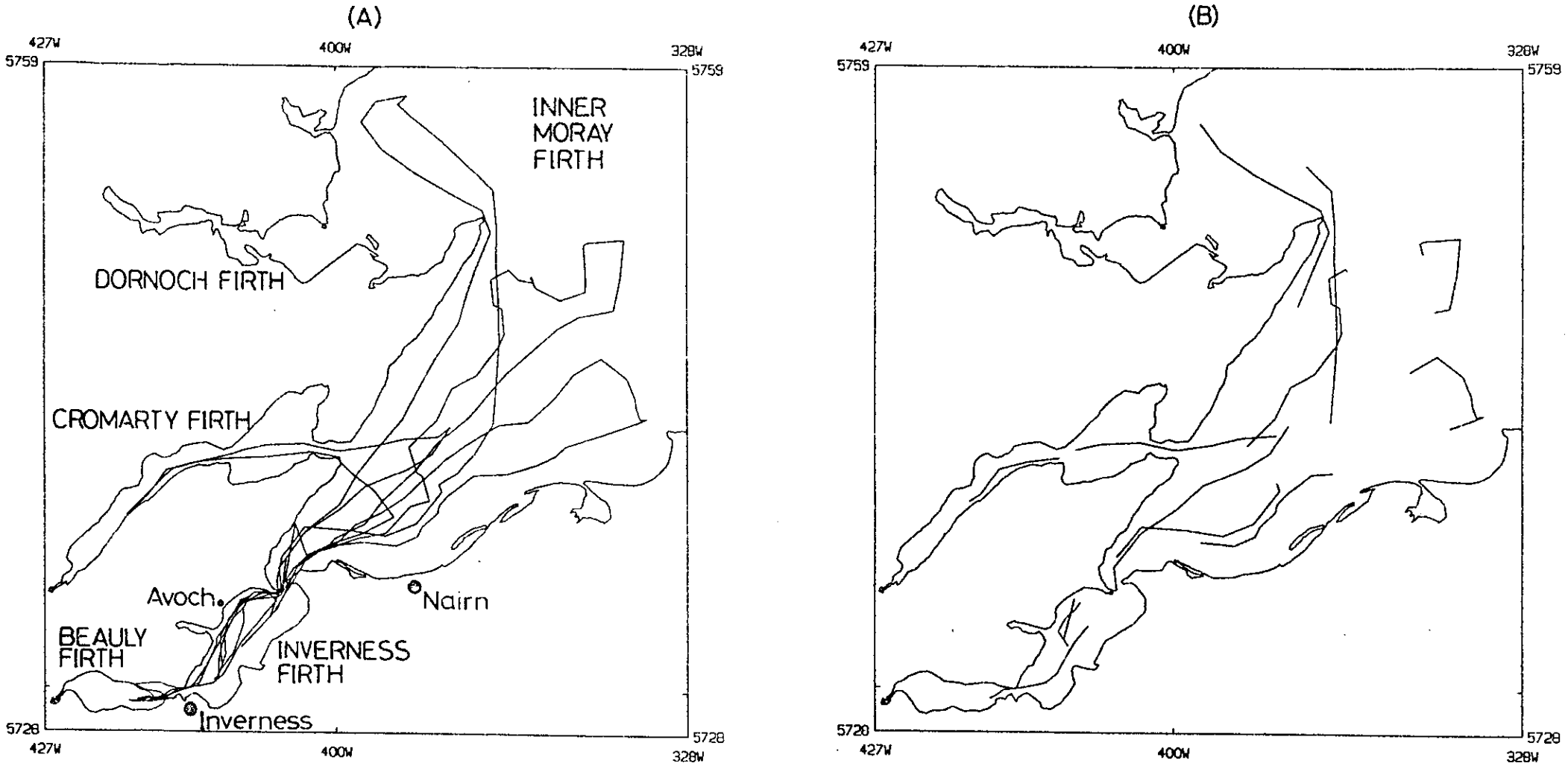

Figure 1. Acoustic survey tract (A) and seabird survey track (B), Moray Firth, 21-26 January 1991.

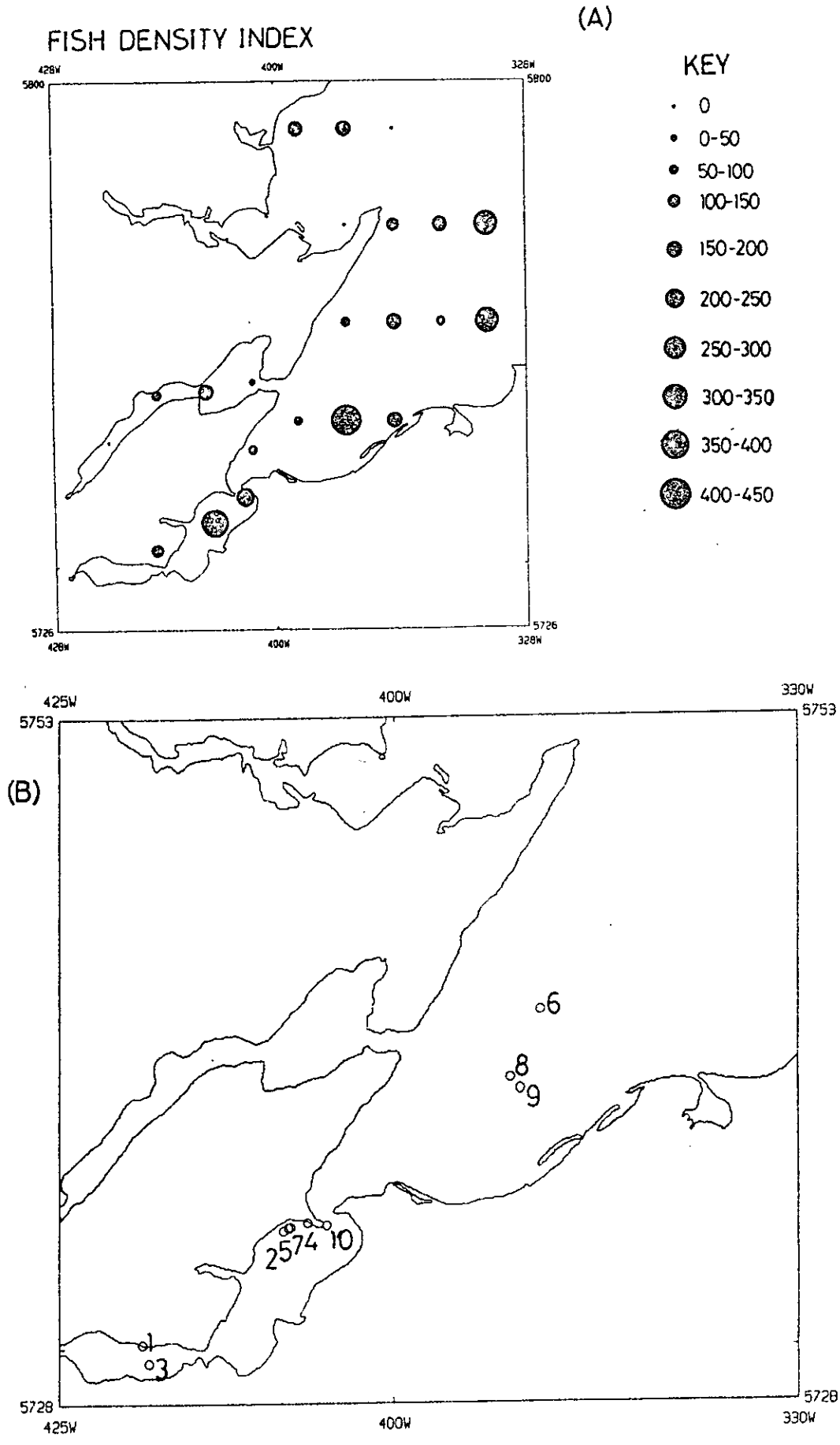

Figure 2. Mean "Relative Fish Density Index" in 6′ longitude x 6′ latitude rectangles (A) and position of 10 hauls (B).

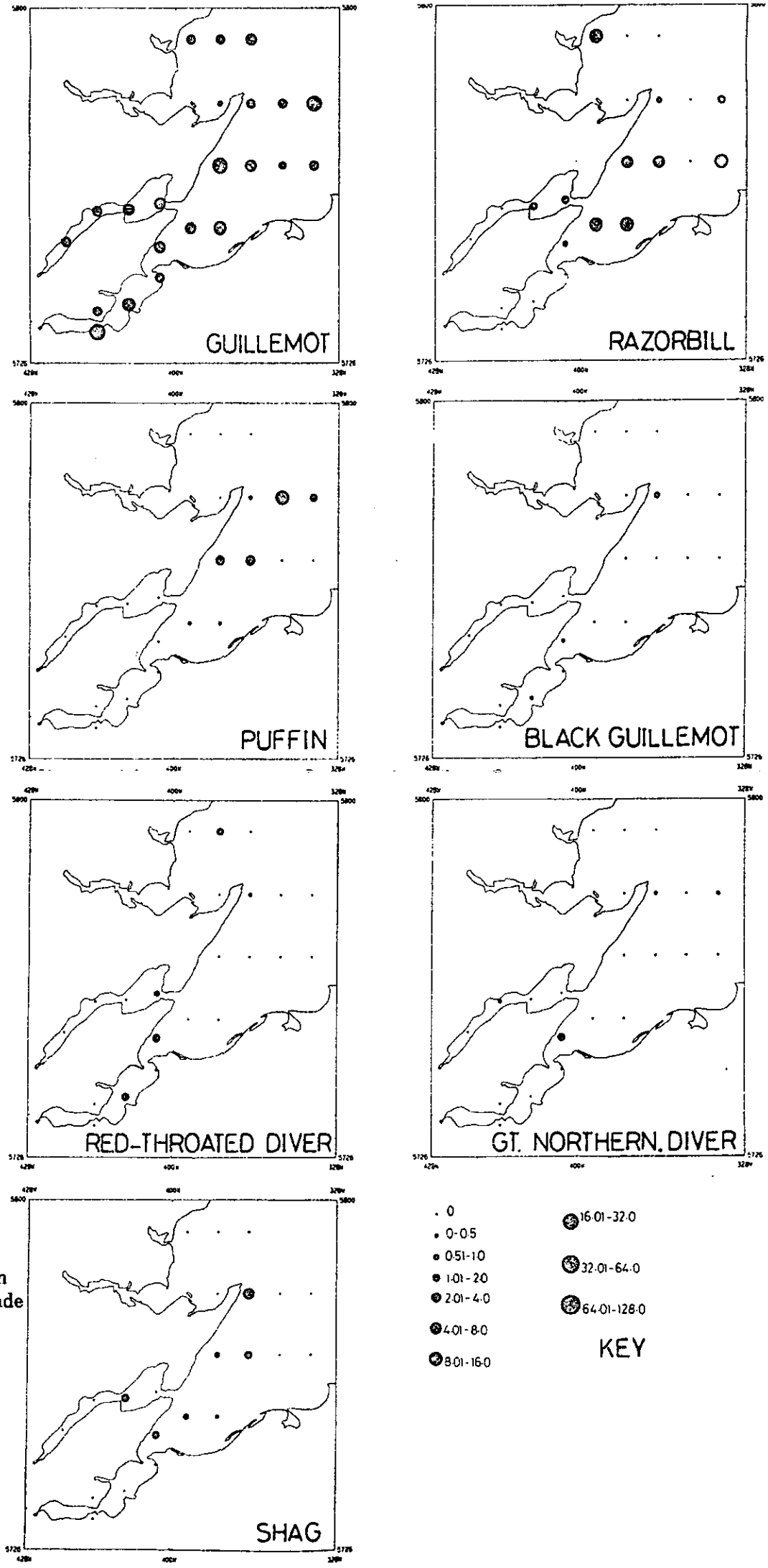

Figure 3. Seabird densities (birds/km^2) in 6′ longitude x 6′ latitude rectangles.

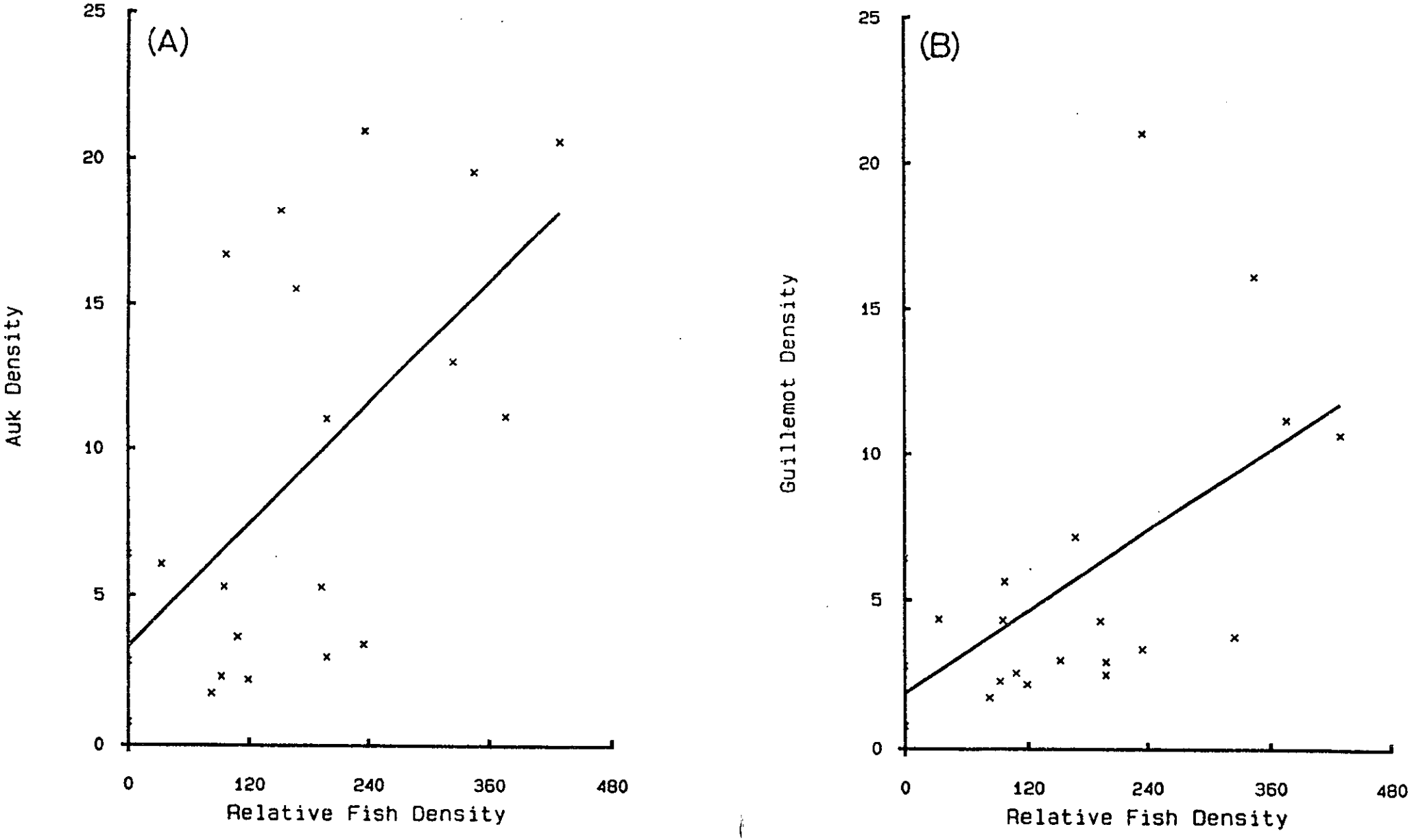

Figure 4. Relationship between the density of all auks (birds/km^2) (A), and the density of guillemots (birds/km^2) only (B), with mean relative fish density index (excluding the Tarbet Ness rectangle, see text).

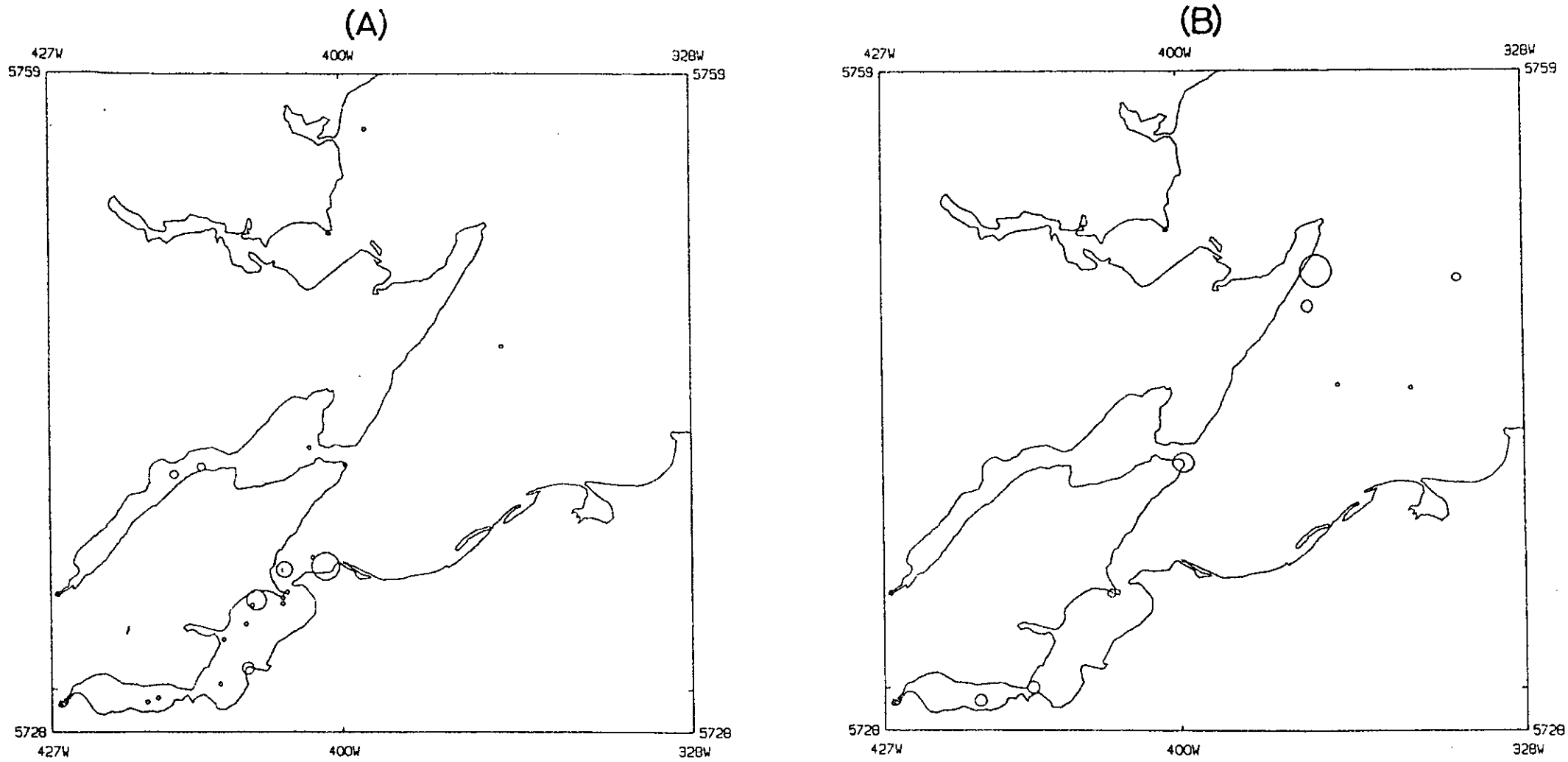

Figure 5. Distribution of seal (A) and dolphin (B) sightings. Circle diameter is proportional to number of animals sighted at each location; maximum number of seals - 7, maximum number of dolphins - 8.