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FRV *CLUPEA*

Cruise 0194C

REPORT

6-20 January 1994

Personnel

S P R Greenstreet	HSO (in charge)
F Armstrong	SO (6-13 January)
D S Beveridge	SO (6-13 January)
J MacMillan (Mrs)	ASO
S E B Thain (Miss)	ASO (13-20 January)
P Clark	ASO (13-20 January)

Objectives

To carry out an echo-integrator survey to determine the biomass and distribution of pelagic fish in the Moray Firth and to determine fish species and size composition through trawl sampling. To assess predatory fish abundance and distribution through demersal trawl sampling and to collect stomach samples for dietary and food consumption analysis. To determine the numbers and distribution of mammalian and avian predators using transect census methods and to record instances of seabirds carrying prey items.

Narrative

The scientific equipment was loaded onto *Clupea* on 5 January. Scientific staff joined the ship on the afternoon of 6 January at Fraserburgh. Bad weather prevented *Clupea* from sailing on the same evening, instead the ship sailed early on the morning of 7 January. Acoustic survey work started on the morning of 7 January and continued during daylight hours until deteriorating weather conditions prevented further acoustic survey during the early afternoon of 12 January. *Clupea* sailed for shelter in the Inverness Firth and then carried out acoustic survey into the Beauly Firth the following morning. Figure 1a shows the acoustic survey track covered. Concentrations of pelagic fish were sampled at positions shown in Figure 1b using an International Young Gadoid Pelagic trawl (PT154) with 10 mm mesh size cod-end fitted with a 6 mm mesh size cover. Otolith samples were collected from herring and sprats in each haul, and samples of clupeids and gadoid fish were weighed to determine length weight relationships.

While *Clupea* was carrying out acoustic survey work the density of seabirds, seals and cetaceans was assessed using standard survey methods; Figure 1c shows the sections of cruise track where these top predators surveys were undertaken. In addition to these formal surveys, all casual sightings of seals and cetaceans were noted.

Observations of seabirds carrying prey in their bills were recorded to provide dietary information.

Clupea docked in Inverness Harbour at mid-day on 13 January for the half-landing. During the afternoon the pelagic fishing gear was exchanged for demersal gear, a Jackson Rockhopper trawl (10 mm mesh cod-end), and the acoustic equipment was unloaded. F Armstrong and D S Beveridge left the ship and were replaced by P Clark and S E B Thain.

Clupea left Inverness in the early afternoon of 14 January. Sixteen demersal fishing stations (Figure 1d) were sampled over the following five and a half days. On all but one of these days some time was lost through bad weather or repairs to fishing gear. Stomach samples were collected from piscivorous fish. Fishing ceased at 1330 on 19 January and *Clupea* returned to Fraserburgh. The scientific equipment was offloaded and scientific staff left the ship on the morning of 20 January.

Results

The principal objectives of this cruise were to describe the pelagic part of the marine foodweb of the Inner Moray Firth and to quantify the flux of biomass and energy between various components of the web.

The acoustic survey data have yet to be worked up. However initial appraisal of the echo-sounder printout suggests that pelagic fish, particularly clupeids, were much more abundant than in recent winters. Fish shoals encountered were large and dense, but were mainly restricted to a limited area, consequently few pelagic fishing samples were required (see Figure 1b). All catches were dominated by clupeid species (Table 1). Sandeels were almost completely absent from the pelagic samples. The following Length-Weight relationships were obtained:

Herring	$W = 0.002577.\ L^{3.302811}$
Sprat	$W = 0.0029315 L^{3.354709}$
Whiting	$W = 0.0068393 L^{3.053007}$

The total weight of each species in each catch was calculated and the percentage contributions, by both numbers and biomass, of sprats in the clupeid fraction were determined (Table 1). In four of the five hauls sprats contributed over 95% of the clupeid biomass while in the fifth haul, taken at the eastern edge of the study area, the sprat fraction was 85%.

Initial analysis suggested that approximately 100,000 seabirds used the area on a day to day basis. Guillemots were the most abundant seabird species with a population estimated at approximately 33,000. Knowing their daily food requirements, these population size estimates suggest that approximately 10 to 15 tonnes of fish were being consumed daily by seabirds. It is likely that sandeels and small clupeids were the principal prey involved.

Whiting and haddock were the only potential predatory fish species encountered in any significant number; biomass estimates of 4,965 and 6,371 tonnes respectively were calculated for the whole study area. Assuming food consumption rates of 0.7% of body weight per day and diets consisting of 30% clupeid fish, these biomass estimates suggest

that approximately 25 tonnes of herring and sprat were eaten daily by predatory fish. Analysis of the stomach samples collected from predatory fish will allow more precise determination of their diets and their daily consumption of the clupeid resource.

Approximately 1,300 common seals, 600 grey seals and 100 bottlenose dolphins feed within the confines of the Inner Moray Firth, together with small, but unknown, numbers of harbour porpoise and minke whale. Figure 2 shows the distribution of marine mammal sightings obtained during the cruise. Assuming that common seals eat 2.5 kg of fish per day, grey seals 5 kg and bottlenose dolphins 8 kg, then these population estimates suggest that these three predators consume 7 tonnes of pelagic fish prey per day. If minke whales and porpoises are allowed for, this figure might reach 10 tonnes per day.

Combining the preliminary consumption estimates of the three groups of top predators gives an estimated daily loss of some 50 tonnes of pelagic fish per day. Once the pelagic fish biomass has been estimated from the acoustic data, this figure can be put into some perspective, in terms of pelagic fish daily mortality.

S P R Greenstreet

3 March 1993

able 1: Numbers and biomass at Length in pelagic fishing samples taken in the nner Moray Firth in January 1994.

lupeids - SPRATS

	Numbers at Length					Biomass at Length (Kg)				
ength	C94/01	C94/02	C94/03	C94/04	C94/05	C94/01	C94/02	C94/03	C94/04	C94/05
4	256	246	0	0	0	.08	.08	.00	.00	.00
4.5	1504	1479	0	1860	0	.68	.67	.00	.85	.00
5	3456	5546	1200	3720	82	2.24	3.60	.78	2.41	.05
5.5	1920	8628	2400	0	82	1.71	7.70	2.14	.00	.07
6	576	8011	0	0	165	.69	9.58	.00	.00	.20
6.5	448	10846	2700	5580	247	.70	16.96	4.22	8.73	.39
7	512	8381	4200	26042	906	1.03	16.81	8.42	52.22	1.82
7.5	1250	3698	7500	44644	2964	3.16	9.35	18.96	112.83	7.49
8	1562	2465	7500	87427	5188	4.90	7.74	23.54	274.37	16.28
8.5	2916	370	12600	119050	6340	11.22	1.42	48.46	457.88	24.38
9	4634	123	20700	139511	5188	21.59	.57	96.44	649.99	24.17
9.5	1094	123	15300	57665	1812	6.11	.69	85.46	322.09	10.12
10	0	123	12648	13546	412	.00	.82	83.91	89.87	2.73
10.5	0	0	29512	24629	82	.00	.00	230.61	192.46	.64
11	0	0	73780	55414	82	.00	.00	673.90	506.15	.75
11.5	0	0	111724	80043	82	.00	.00	1184.59	848.68	.87
12	0	0	120156	94820	0	.00	.00	1469.52	1159.66	.00
12.5	0	0	111724	70191	0	.00	.00	1566.93	984.43	.00
13	0	0	71672	43100	0	.00	.00	1146.56	689.48	.00
13.5	0	0	61132	24629	0	.00	.00	1109.94	447.18	.00
14	0	0	29512	18471	0	.00	.00	605.36	378.88	.00
14.5	0	0	10540	6157	0	.00	.00	243.21	142.07	.00
OTAL	20128	50039	706500	916499	23632	54.11	75.97	8602.95	7320.22	89.97

lupeids - HERRING

ength	C94/01	C94/02	C94/03	C94/04	C94/05	C94/01	C94/02	C94/03	C94/04	C94/05
9.5	1	3	0	0	0	.00	.01	.00	.00	.00
10	7	30	0	0	0	.04	.17	.00	.00	.00
10.5	11	41	0	188	0	.07	.27	.00	1.22	.00
11	10	29	0	188	46	.08	.22	.00	1.43	.35
11.5	13	19	0	250	170	.11	.17	.00	2.20	1.49
12	15	5	0	750	268	.15	.05	.00	7.58	2.71
12.5	11	2	0	1062	366	.13	.02	.00	12.29	4.24
13	11	0	0	1125	268	.14	.00	.00	14.82	3.53
13.5	9	2	0	2562	144	.13	.03	.00	38.23	2.15
14	0	4	0	3938	41	.00	.07	.00	66.26	.69
14.5	0	2	0	3438	15	.00	.04	.00	64.96	.28
15	0	0	0	1875	5	.00	.00	.00	39.62	.11
15.5	0	0	0	500	0	.00	.00	.00	11.77	.00
16	0	0	0	62	0	.00	.00	.00	1.62	.00
16.5	0	0	0	62	0	.00	.00	.00	1.79	.00
17	0	0	0	62	0	.00	.00	.00	1.98	.00
17.5	0	0	0	62	0	.00	.00	.00	2.18	.00
18	0	0	0	0	0	.00	.00	.00	.00	.00
18.5	0	0	0	188	0	.00	.00	.00	7.94	.00
19	0	0	0	125	0	.00	.00	.00	5.77	.00
TOTAL	88	137	0	16437	1323	.86	1.04	.00	281.68	15.55
CLUPS	20216	50176	706500	932936	24955	54.98	77.02	8602.95	7601.90	105.51
%Sprat	99.565	99.727	100	98.238	94.698	98.43	98.65	100.00	96.29	85.27

Gadoids - WHITING

	Numbers at Length									
Length	C94/01	C94/02	C94/03	C94/04	C94/05	C94/01	C94/02	C94/03	C94/04	C94/05
7	0	0	0	0	5	.00	.00	.00	.00	.01
8	0	2	0	0	11	.00	.01	.00	.00	.04
9	0	1	0	62	22	.00	.01	.00	.35	.12
10	0	5	0	0	12	.00	.04	.00	.00	.09
11	6	16	0	0	15	.06	.17	.00	.00	.16
12	10	24	0	0	20	.13	.32	.00	.00	.27
13	18	32	0	0	24	.31	.55	.00	.00	.41
14	26	28	0	62	28	.56	.60	.00	1.34	.60
15	24	26	0	62	12	.64	.69	.00	1.65	.32
16	15	17	0	0	12	.49	.55	.00	.00	.39
17	7	14	0	0	2	.27	.55	.00	.00	.08
18	3	4	0	0	1	.14	.19	.00	.00	.05
19	0	2	0	0	1	.00	.11	.00	.00	.05
20	1	0	0	0	0	.06	.00	.00	.00	.00
21	0	0	0	62	0	.00	.00	.00	4.61	.00
22	0	0	0	0	0	.00	.00	.00	.00	.00
23	0	1	0	0	0	.00	.10	.00	.00	.00
24	0	0	0	0	0	.00	.00	.00	.00	.00
25	0	0	0	0	0	.00	.00	.00	.00	.00
26	0	1	0	0	0	.00	.14	.00	.00	.00
TOTAL	110	173	0	248	165	2.67	4.02	.00	7.95	2.60

Gadoids - NORWAY POUT

	Numbers at Length									
Length	C94/01	C94/02	C94/03	C94/04	C94/05	C94/01	C94/02	C94/03	C94/04	C94/05
10	1	0	0	0	1	.01	.00	.00	.00	.01
11	8	0	0	0	13	.07	.00	.00	.00	.12
12	5	0	0	0	6	.06	.00	.00	.00	.07
13	1	0	0	0	0	.02	.00	.00	.00	.00
TOTAL	15	0	0	0	20	.16	.00	.00	.00	.20

Figure 1A: Acoustic survey track; January 1994

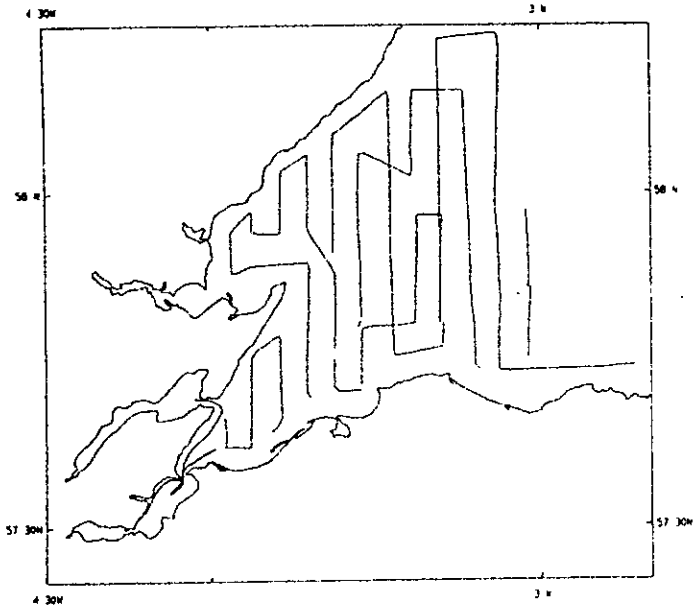

Figure 1B: Pelagic haul sampling sites; January 1994.

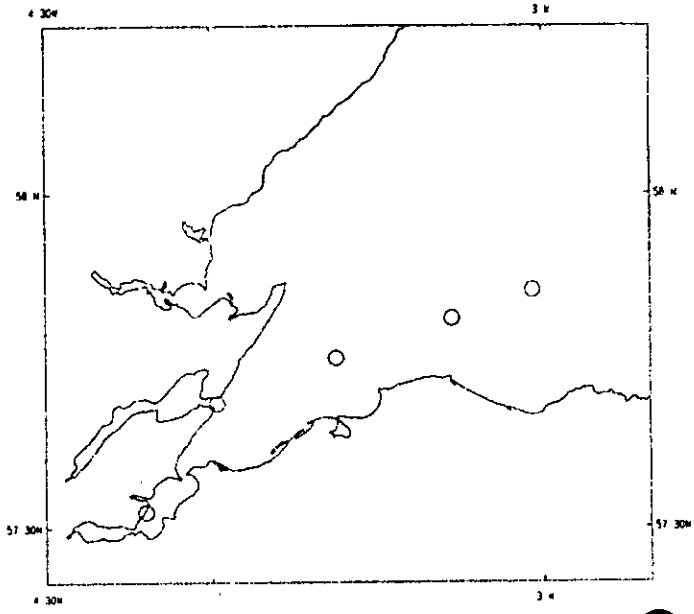

Figure 1C: Seabird survey track; January 1994

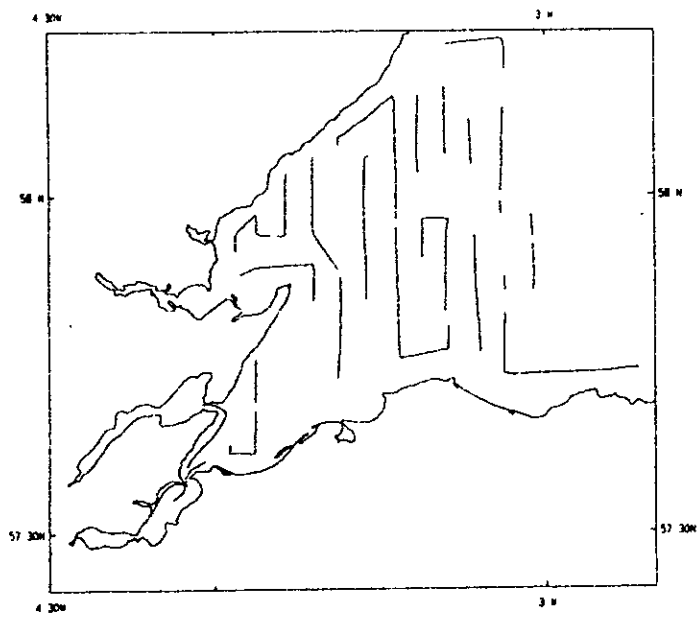

Figure 1D: Demersal haul sampling sites; January 1994.

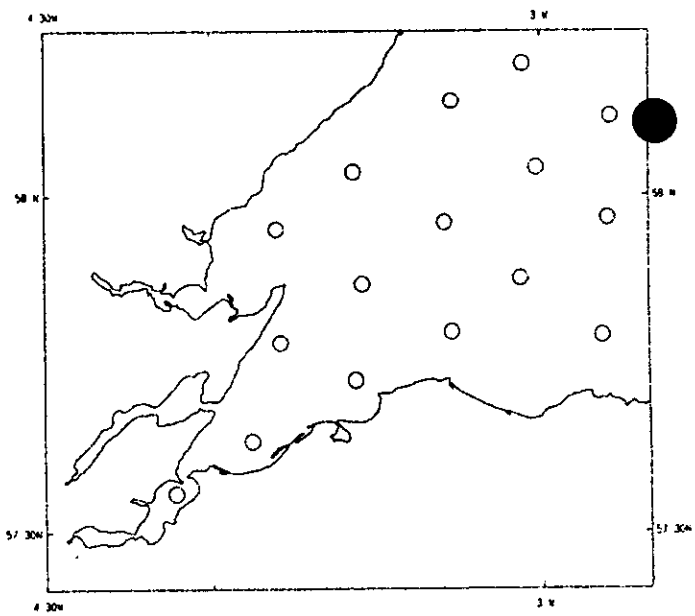

Figure 2: Marine mammal sightings: January 1994.

(Circle area is proportional to animal numbers at each location.
Filled - common seal; diagonal hatch - minke whale; cross hatch - porpoise;
spots - bottlenose dolphin.)