

The distribution of killer whales (*Orcinus orca*) in the North Atlantic based on Norwegian catches, 1938–1981, and incidental sightings, 1967–1987

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ABSTRACT

The distribution of killer whales (*Orcinus orca*) in the Northern North Atlantic is examined from Norwegian catches of 2,435 animals, 1938–1981, and incidental sightings of 478 groups, 1967–1987. Catches occurred over a wide area but concentrated in Norwegian nearshore and coastal regions, particularly on traditional whaling grounds at Møre and Lofoten. Catches varied from 0–246 annually. Four hundred and eight and 345 were taken at Møre in 1968–1970 and Lofoten in 1971–1981, respectively. Changes in within-year peaks in catches at Lofoten from spring, prior to 1971, to winter, after 1971, may be related to depletion of Norwegian spring spawning herring (*Clupea harengus*). Within years, catches peaked in February off the Norwegian south coast, May off Finnmark, May–June in the Barents Sea and August in the Norwegian Sea, suggesting seasonal shifts in distribution/abundance. The same patterns of areal and seasonal distribution are apparent in incidental sightings records. Ninety seven groups reported incidentally contained a minimum of 1–90 individuals ($\bar{x} = 16.5$, $SD = 17.7$). Twelve groups reported by cetologists contained 1–20 ($\bar{x} = 8.9$, $SD = 6.4$). Males were significantly longer than females, in the overall sample ($n = 1463$, $\bar{x} = 20.2$ ft, $SD = 3.2$ versus $n = 933$, $\bar{x} = 17.9$ ft, $SD = 2.8$) and in most whaling areas. Mean lengths varied significantly among areas for both sexes. Males comprised 61% of the total caught.

INTRODUCTION

Christensen (1988 – this volume) describes recent attempts to map the distribution and estimate the numbers of killer whales (*Orcinus orca*) along the Norwegian coast from results of questionnaire surveys. Additional information on distribution and abundance of this species off Norway and elsewhere in the North Atlantic, is available in logbooks of Norwegian whaling vessels and in reports to the Institute of Marine Research (IMR) from various sources, of sightings of killer whales made incidental to other activities. Catch statistics and results of analysis of biological material collected during the whaling opera-

tions were published by Jonsgård and Lyshoel (1970) for the years 1938–1967, Christensen (1975) for 1938–1973, Jonsgård (1977b) for 1938–1975 and Christensen (1982) for the years 1938–1980. This paper updates information on killer whale distribution and abundance off Norway, and elsewhere in the North Atlantic, as it can be surmised from Norwegian catch statistics, 1938–1981, supplemented by sightings from various sources, 1967–1987. It also presents data, updated from Jonsgård and Lyshoel (1970), on sex composition of catches and lengths of specimens by sex and area.

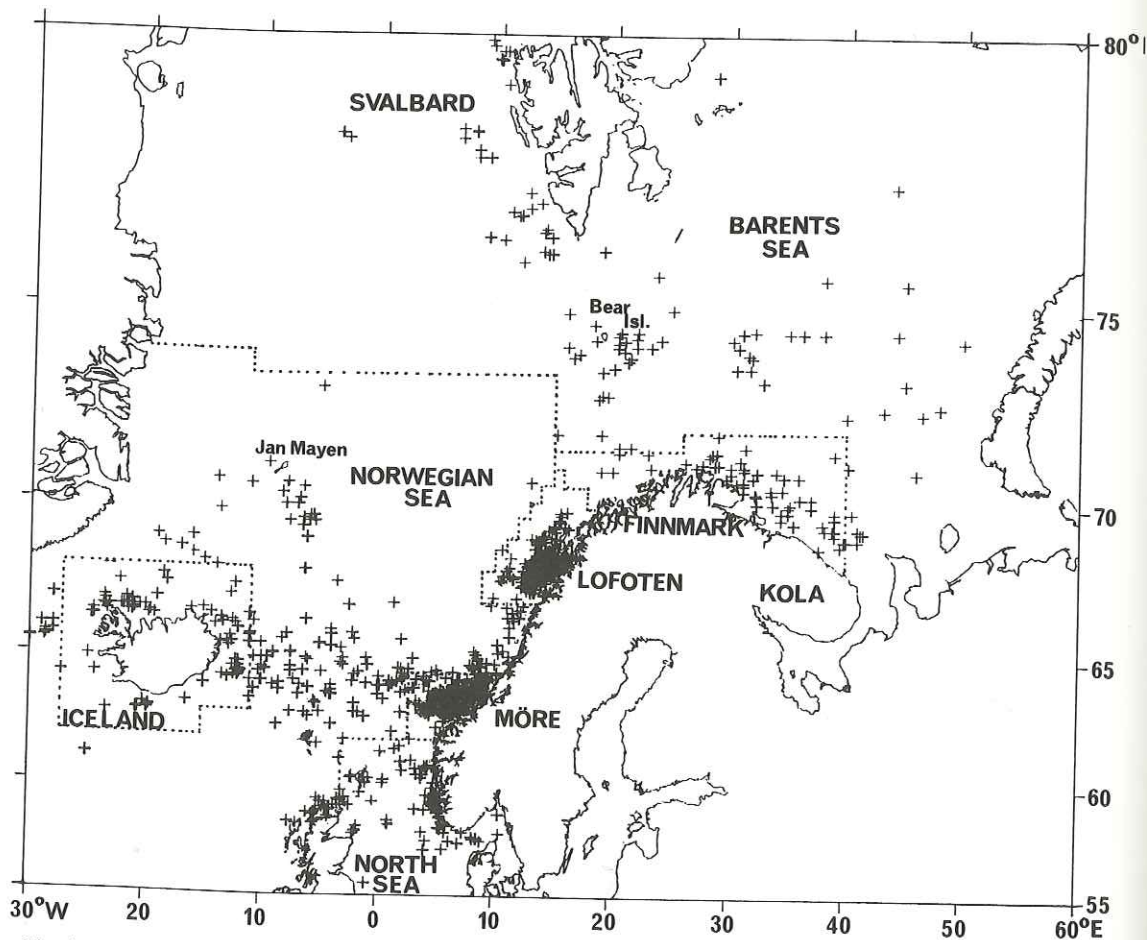


Fig. 1. Catch positions for 2,289 killer whales taken in the Northeast Atlantic by Norwegian small-type whalers, 1938-1981. Each plotted position may include more than one whale caught.

SOURCES OF DATA

Licensing was introduced by the Norwegian Government to Norwegian small-type whaling for minke (*Balaenoptera acutorostrata*), Northern bottlenose (*Hyperoodon ampullatus*), killer and pilot (*Globicephala melaena*) whales in 1938 (Jonsgård 1977a). Since then, licencees have been required to submit to the authorities logbooks containing the following data for each whale caught: date and position of the catch, sex, estimated length in feet and meat and blubber yield of the whale. Occasionally logbook entries also contain information on lactation and presence and size of any

foetus found. Logbook data on a total of 2,435 killer whales caught from 1938 to 1981, representing 755 vessel seasons, have been transferred to computer files at the Institute of Marine Research in Bergen (IMR).

There is little information available on catches of small whales by Norwegian whalers prior to the introduction of logbooks in 1938. Fishing vessels fitted with harpoon guns appear to have chased killer whales during the spring herring (*Clupea harengus*) fisheries on the Norwegian coast as long ago as the early 1930's (Jonsgård 1955); catches were unreported. Since 1982 killer whales have been

protected by Norwegian whaling regulations.

Since 1967, the IMR has logged incidental sightings of marine mammals reported to it by letter or telephone from a variety of sources. From 1978, observations of marine mammals have also been logged and reported by IMR research vessels, coast guard vessels and some whaling and fishing vessels, and reports have been regularly received from inspectors dispatched to some whaling vessels during the season. These reports, entered into IMR com-

Christensen 1986). During the survey in 1987, 14 observations of killer whales were recorded, all in the Norwegian Sea west of Lofoten.

To date, whaling vessels have been the most important source of killer whale observations, providing 173 of 478 records in the IMR files. However, a considerable amount of data have been supplied through IMR's own efforts, including transect surveys, collectively providing 143 of the 478 records available (Table 1).

TABLE 1
Sources of incidental sightings of killer whales recorded by the Institute of Marine Research (IMR), 1967-1987.

Source	Number of sightings
IMR research vessels	100
IMR Sea Mammal Section, field work, including line transect surveys	43
Inspectors on whaling vessels	70
Whaling vessels	173
Fishing vessels	50
Coast guard vessels	11
Individual reports (telephone, letter, etc.)	31
Observations of killer whales, total	478

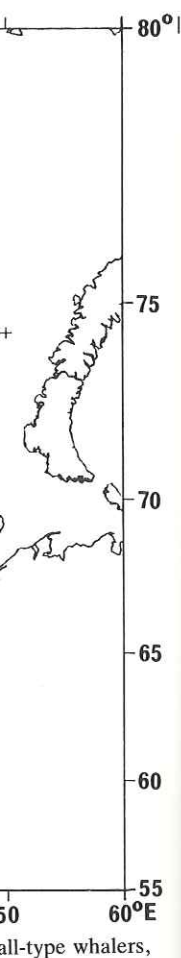
puter files and continuously updated, include all or some of the following information: observation date and position, species, estimate of numbers seen, comments on behaviour, associated birds and other animals, moving direction and sex- and size-composition. As we have no quantitative information on the effort involved in searching for marine mammals, the data from incidental sightings cannot be used for estimating trends in abundance. Nevertheless, such incidental sightings, recorded on an opportunistic basis, appear to yield useful information on distribution.

Line transect sightings surveys were conducted in the Barents Sea area (see Fig. 1) independently by IMR in June- July 1984 and May-June 1985 and as part of the international North Atlantic Sightings Survey (NASS-87) in July 1987. Minke whales were the target species but sightings of other species also were recorded. On the two first cruises no killer whales were observed in the Barents Sea or west of Spitsbergen (Øien and

RESULTS

Distribution by area and year

Between 1938 and 1981 Norwegian whalers caught a total of 2,435 killer whales (Table 2), representing 2.06% of all small whale catches recorded on IMR files for that period. For eight of the years the numbers differ from previously published statistics (cf. Christensen 1982). In all but two cases, the difference is only one animal. For 1938 there are now 49 records, while Christensen (1982) reports a catch of 46 killer whales. For 1948, however, the difference is considerable, as Christensen (1982) reports that 27 whales were caught, while the IMR records currently indicate that 43 whales were caught. There is no obvious reason for this discrepancy. Some logbook forms may have been unavailable until after 1981 or wrongly classified or filed. The catch statistics presented here are based upon all known log books supplied under the licencing system, on hand, coded and filed at IMR.



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TABLE 2

Norwegian catches of killer whales in the North Atlantic 1938–1981. Catches are given separately for areas indicated in Figure 1, starting with the Norwegian coastal waters and then in order of increasing distance from Norway. Total catch figures differing from those given by Christensen (1982) are in italics.

Season	Finnmark & Kola	Lofoten	Møre	North Sea	Barents Sea & Svalbard	Norwegian Sea	Iceland	East Greenland	West of Cape Farewell	Total
1938	1	12	15	11	5	5	—	—	—	49
1939	—	13	1	7	—	2	—	—	—	23
1940	—	—	—	5	—	2	—	—	—	7
1941	—	4	6	4	—	—	—	—	—	14
1942	—	29	10	17	—	1	—	—	—	57
1943	—	7	2	3	1	—	—	—	—	13
1944	—	2	14	8	—	4	—	—	—	28
1945	—	5	2	1	—	4	—	—	—	12
1946	2	12	6	6	5	1	—	—	—	32
1947	3	10	1	9	1	5	—	—	—	29
1948	—	11	5	9	11	4	3	—	—	43
1949	—	12	2	5	12	3	—	—	—	34
1950	—	2	—	6	—	4	—	—	—	12
1951	2	15	2	—	4	1	—	—	—	24
1952	6	3	2	—	—	2	—	—	—	13
1953	—	5	2	—	1	1	—	—	—	9
1954	3	4	6	—	—	—	—	—	—	13
1955	—	3	5	—	1	14	3	—	—	26
1956	7	6	1	1	2	23	—	—	—	40
1957	—	15	14	3	2	7	7	—	—	48
1958	13	10	7	—	3	6	—	—	—	39
1959	3	1	4	1	24	12	16	8	—	69
1960	1	12	17	3	16	15	4	14	—	82
1961	2	3	41	17	10	13	18	8	—	112
1962	7	3	16	5	8	49	29	7	—	124
1963	14	3	16	5	13	30	6	3	—	90
1964	6	8	9	2	—	37	14	1	—	77
1965	3	1	12	—	7	63	18	—	—	104
1966	9	47	4	—	4	61	6	31	—	162
1967	—	7	1	—	—	15	7	6	—	36
1968	—	4	33	—	2	26	8	7	6	86
1969	—	7	170	—	4	16	8	4	22	231
1970	—	17	205	4	3	5	3	9	—	246
1971	—	3	—	6	1	10	3	34	—	57
1972	—	7	—	—	—	—	—	4	17	28
1973	—	1	—	—	—	—	—	—	—	1
1974	—	5	—	1	—	—	—	—	—	6
1975	—	1	—	—	—	1	—	—	—	2
1976	—	—	—	—	—	—	—	—	—	0
1977	—	7	—	—	—	—	—	—	—	7
1978	—	63	—	—	1	—	—	—	—	64
1979	—	219	2	—	—	—	—	—	—	221
1980	—	52	—	—	—	—	—	—	—	52
1981	—	11	1	1	—	—	—	—	—	13
1938–81	82	662	634	140	141	442	153	136	45	2,435

Areas indicated in
away. Total catch

Area	Total
—	49
—	23
—	7
—	14
—	57
—	13
—	28
—	12
—	32
—	29
—	43
—	34
—	12
—	24
—	13
—	9
—	13
—	26
—	40
—	48
—	39
—	69
—	82
—	112
—	124
—	90
—	77
—	104
—	162
—	36
6	86
22	231
—	246
—	57
17	28
—	1
—	6
—	2
—	0
—	7
—	64
—	221
—	52
—	13
2,435	

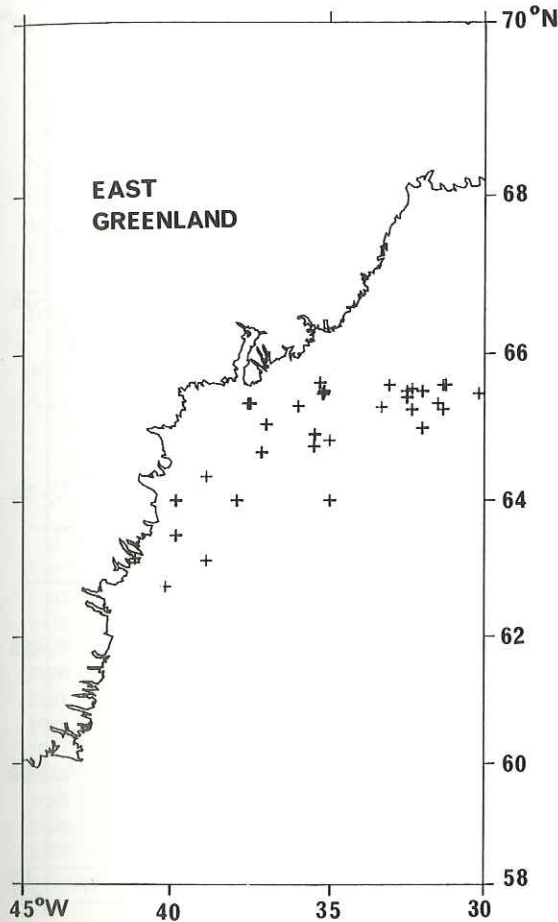


Fig. 2. Catch positions for 101 killer whales taken by Norwegian whalers off East Greenland, west of 30°W. Each plotted position may include more than one whale caught.

Killer whales were caught over a wide area of the North Atlantic (see Fig. 1 for catches east of 30°W, Fig. 2 for catches off East Greenland and Fig. 3 for catches west of Cape Farewell, Greenland [44°W]).

The majority of catches in the Northeast Atlantic were in coastal or nearshore waters. Along the Norwegian coast, the most important areas were the traditional whaling grounds off Lofoten and Møre. Other important grounds were along the western and southwestern coasts, along the coasts of Finnmark and the Kola Peninsula thence

northeastwards into the southern Barents Sea. Also, many killer whales were caught in the Norwegian Sea between Norway and Iceland and around Iceland. Smaller numbers were taken north of Scotland. In the far north, killer whales were caught at widely scattered locations over a large area of the relatively shallow Barents Sea and northwards to about 80°N off the west coast of Svalbard. Catches also were made around Bear Island and Jan Mayen.

For convenience, the catches presented by year in Table 1 are specified by the areas named and shown in Figure 1. Catches labelled "Norwegian Sea" include those from northwest of Scotland, Jan Mayen and near-shore waters between Lofoten and Møre, representing 25% of whales listed under Norwegian Sea in Table 2.

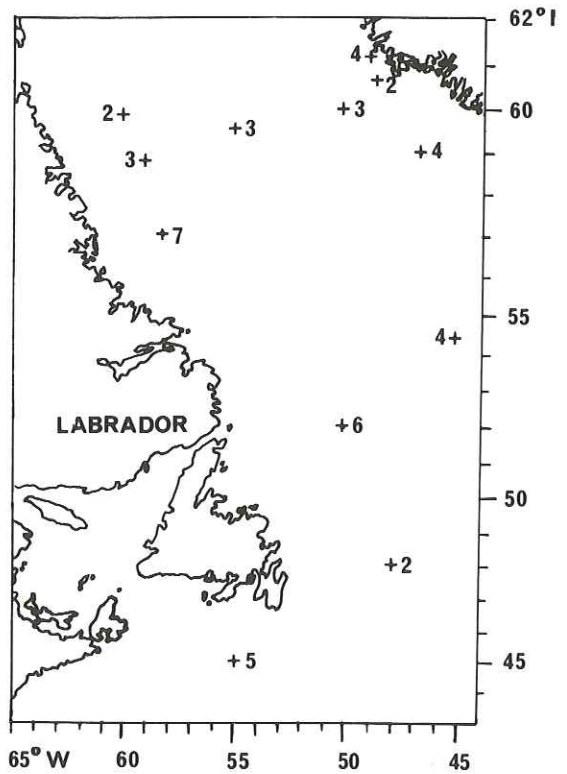


Fig. 3. Catch positions for 45 killer whales taken by Norwegian whalers west of Cape Farewell (longitude 44°W), 1968-1972. Figures indicate the number of animals caught at that position.

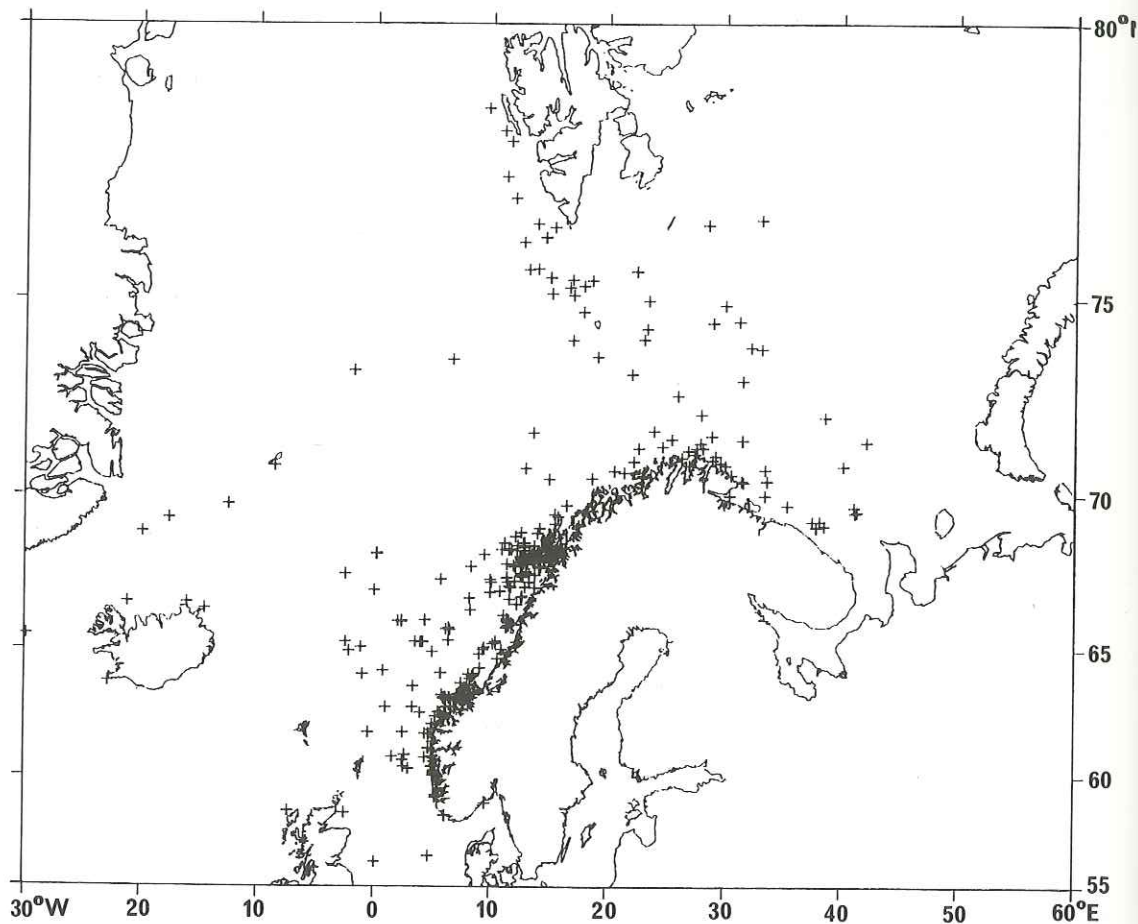


Fig. 4. Distribution of 445 incidental sightings of killer whales reported to IMR, 1967-1987. See Figure 1 for information on place names.

The average annual Norwegian catch of killer whales from 1938 through 1981 was about 55 animals. An average of 37 whales per year was taken from Norwegian coastal areas, alone (including Finnmark, Lofoten, the coastal areas of the Norwegian Sea, Møre and the North Sea). However, the fishery was characterized by large variations among years in the numbers caught and the areas of greatest fishing success (Table 2). In fact, annual catches ranged from 0 to 246 whales; so, the history of the Norwegian killer whale fishery is poorly characterized by the annual average catch alone. Of the total catches, 1938-1981, 52% of those at Lofoten were taken in the years

1978-1981 and 64% of those at Møre were taken in the years 1968-1970.

From about 1960 through about 1970, the killer whale fishery expanded from the traditional grounds near Norway to cover also distant grounds in the Norwegian Sea and the coastal waters off Iceland and East Greenland. A total of 45 killer whales was taken west of Cape Farewell, 6 in 1968, 22 in 1969 and 17 in 1972. Norwegian catches of killer whales dropped to nearly zero after 1972, with the exception of the catches at Lofoten 1978-1981.

Incidental sightings are summarized by year and area in Table 3 and plotted in Figure 4.

The number of observations reported for each area has varied from year to year; variations also occur between areas. A particularly large proportion of the observations have been reported from the Lofoten area and from the Norwegian Sea. Overall, these sightings show the same distribution pattern for killer whales as does the distribution of the catches (cf. Fig. 1).

Seasonal distribution

Norwegian whalers have taken killer whales throughout the year, with peaks in May and August (Table 4). In fact, however, Lofoten is

the only area in which killer whales have been caught year-round. In this area, peaks in catches occur in January and April–May, and whaling was distinguished by a few years of exceptionally high catches (1978 to 1981) after 40 years of moderate to very low catches (Table 2).

The Norwegian spring-spawning herring stock collapsed around 1970 (Dragesund and Ulltang 1978; Dragesund *et al.* 1980). The effects of this collapse on killer whale catches in the Lofoten area are illustrated by examining separately the catches prior to 1970 and those from 1971–1981 (Table 5). Peak catches ap-

TABLE 3
Number of incidental sightings of killer whales, 1967–1987, by whaling area (see Fig. 1, Table 2).

Year(s)	Finnmark & Kola	Lofoten	Møre	North Sea	Barents Sea & Svalbard	Norwegian Sea	Iceland	East Greenland	West of Cape Farewell	Total
1967–77	11	1	3	2	10	10	4	8	7	56
1978	—	26	7	3	—	22	—	—	—	58
1979	4	73	17	2	2	19	—	1	—	118
1980	4	28	2	—	2	1	—	—	2	39
1981	3	4	—	2	2	1	—	1	—	13
1982	1	14	—	1	4	4	—	1	1	26
1983	4	7	—	—	5	7	—	—	3	26
1984	3	11	11	—	11	4	—	—	1	41
1985	3	13	13	1	1	13	—	—	—	44
1986	1	13	1	1	6	2	—	—	—	24
1987	2	6	3	1	4	17	—	—	—	33
1967–87	36	196	57	13	47	100	4	11	14	478

TABLE 4
Distribution (number of animals) by month and whaling area (Fig. 1) of all Norwegian catches of killer whales, 1938–1981.

Month	Finnmark & Kola	Lofoten	Møre	North Sea	Barents Sea & Svalbard	Norwegian Sea	Iceland	East Greenland	West of Cape Farewell	Total
January	—	163	3	2	—	11	—	—	—	179
February	—	13	162	51	—	3	—	—	—	229
March	—	13	280	10	—	24	—	—	—	327
April	6	104	57	2	18	40	3	4	12	246
May	57	157	80	7	48	91	4	4	5	453
June	13	38	21	23	54	87	5	10	—	251
July	4	15	16	12	16	57	36	11	—	167
August	2	10	14	23	5	102	90	107	28	381
September	—	12	1	8	—	26	15	—	—	62
October	—	46	—	1	—	—	—	—	—	47
November	—	61	—	1	—	1	—	—	—	63
December	—	30	—	—	—	—	—	—	—	30
1938–81	82	662	634	140	141	442	153	136	45	2,435

pear to have shifted from spring (April–May) prior to 1971, to late autumn and winter (October–January) in later years.

The within-year distribution of catches in each area (Table 4) refer to the years up to around 1970, with the exception of Lofoten which is the only area where significant catches occurred in later years (Table 2). Peak catches occurred at different times in different areas: in the North Sea in February; off Møre in February–March; off Lofoten in April–May (Table 5); along the Finnmark coast in May; in the Barents Sea in May–June; and in the Norwegian Sea in August, with high catches

also in May and June. Peak catches in the distant areas, off Iceland and East Greenland, were in August.

The movement pattern surmised from incidental sightings (Table 6) is the same as that apparent from whaling records. Killer whales are found in the Lofoten area throughout the year with peaks in late autumn and winter. They are reported most frequently off Møre in February–March, off Finnmark in May, in the Barents Sea in May–June and in the Norwegian Sea in summer (May–July).

Herd size

A few estimates of group size are included in reports of incidental sightings. From comments accompanying those records, it often is clear that such estimates should not be used in quantitative analyses. For example, many estimates apply to the numbers of whales seen in an area rather than to the numbers in separate groups; some reports present a range of numbers rather than a single figure; and many estimates appear to contain rounding errors, revealed by peaks at five and ten individuals for smaller groups and at multiples of ten for larger groups.

Reported sightings involved 1 to 270 whales. The best available minimum estimates ($n = 97$), however, were 1 to 90 individuals ($\bar{x} = 16.5$, $SD = 17.7$). The best estimates of

TABLE 5
Catches of killer whales in the Lofoten area by month, 1938–70 and 1971–1981. Percentages in parentheses.

Month	1938–70	1971–81
January	1 (0.3)	162 (43.9)
February	—	13 (3.5)
March	10 (3.4)	3 (0.8)
April	92 (31.4)	12 (3.3)
May	135 (46.1)	22 (6.0)
June	28 (9.6)	10 (2.7)
July	15 (5.1)	—
August	7 (2.4)	3 (0.8)
September	5 (1.7)	7 (1.9)
October	—	46 (12.5)
November	—	61 (16.5)
December	—	30 (8.1)
	293	369

TABLE 6
Incidental sightings of killer whales by month and whaling area (see Fig. 1, Table 2).

Month	Finnmark & Kola	Lofoten	Møre	North Sea	Barents Sea & Svalbard	Norwegian Sea	Iceland	East Greenland	West of Cape Farewell	Total
January	—	28	4	—	—	—	—	—	—	32
February	1	6	10	—	—	5	—	—	—	22
March	—	6	19	—	—	7	—	—	—	32
April	2	15	5	2	5	9	—	—	—	39
May	24	21	5	4	15	21	1	4	—	95
June	7	17	4	3	11	24	1	—	5	72
July	2	15	1	1	5	20	2	3	7	56
August	—	4	6	2	6	5	—	3	1	27
September	—	11	—	1	4	5	—	1	—	22
October	—	35	3	—	—	1	—	—	—	39
November	—	29	—	—	1	2	—	—	—	32
December	—	9	—	—	—	—	—	—	—	9
	36	196	57	13	47	99	4	11	14	477

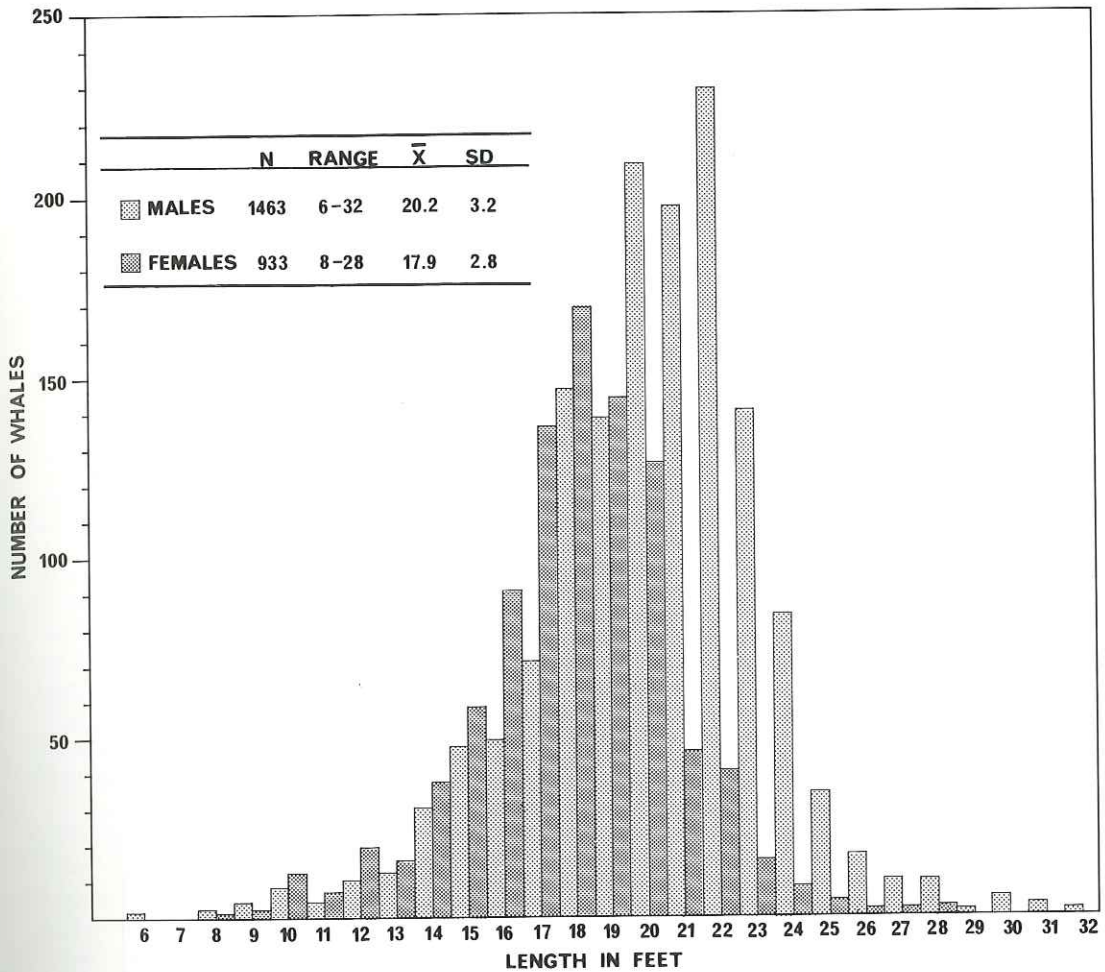


Fig. 5. Length distributions of killer whales caught in the North Atlantic by Norwegian small-type whalers, 1938-1981.

group sizes are those by professional biologists in 12 observations from the NASS-87 survey; these groups contained from 1 to 20 individuals ($\bar{x} = 8.9$, $SD = 6.4$).

Length- and sex-distributions

Whaling logbooks usually contain information on the length and sex of individual whales taken. Jønsgård and Lyshoel (1970) recognized some problems with such information. By comparison to their own measurements, most lengths estimated by whalers were correct or nearly correct, although some deviated from the scientists' measurements by up to \pm

2 feet. Many of the whalers' determinations of sex, particularly for small whales, were incorrect. These authors did not state the size range of "small whales". Even so, the large number of samples should yield some descriptive information on size ranges by sex, even if imprecise estimates of length and occasional misidentifications of sex make the data unsatisfactory for in-depth analysis.

Length distributions are plotted by sex for all catches by Norwegian whalers, 1938-1981 (Fig. 5), and for catches in each area (Fig. 6). Sex compositions and mean lengths, with standard deviations of samples, for this latter

2).

West of Cape Farewell	Total
—	32
—	22
—	32
1	39
—	95
5	72
7	56
1	27
—	22
—	39
—	32
—	9
14	477

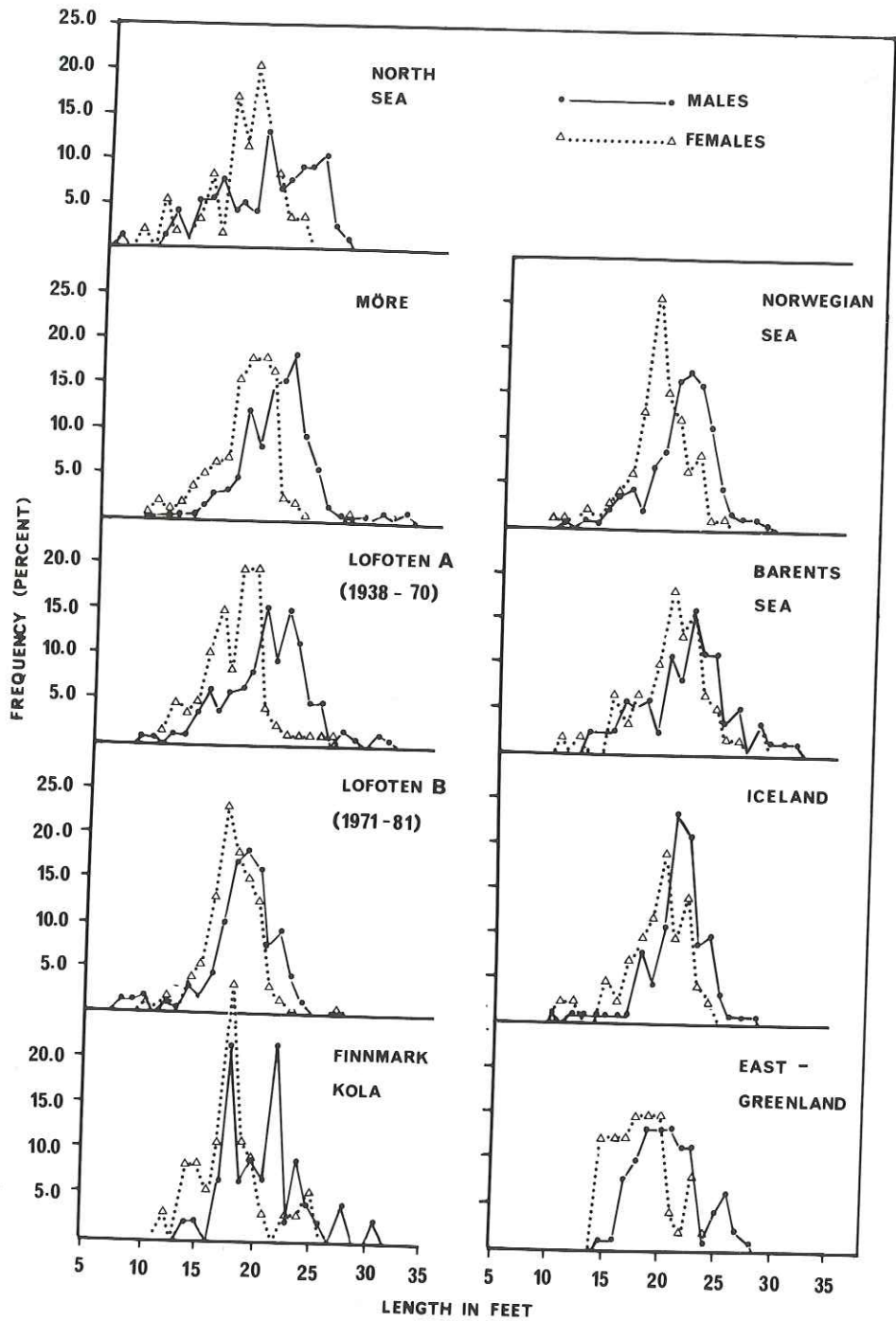


Fig. 6. Length distributions of killer whales caught by Norwegian small-type whalers in different areas of the North Atlantic, 1938-1981. The data from the Lofoten area are given separately for the years 1938-1970 and 1971-1981. Sample sizes and statistics for each area are given in Table 7.

TABLE 7

Mean lengths and sex compositions of killer whales in Norwegian catches by whaling area (Fig. 1). Catches in the Lofoten-Vesterålen area are given separately for the periods 1938–1970 (A) and 1971–1981 (B).

	Barents Sea & Svalbard	Finnmark & Kola	Lofoten		Møre	North Sea	Norwegian Sea	Iceland	East Greenland	West of Cape Farewell	Total
			A	B							
<i>Males:</i>											
Mean L	21.4	20.9	20.1	18.5	20.3	18.8	20.4	21.1	21.0	21.2	20.2
SD	3.8	3.4	3.6	3.1	2.8	4.3	2.8	2.8	2.8	2.1	3.2
n	81	46	193	159	385	77	293	110	88	31	1,463
<i>Females:</i>											
Mean L	20.2	18.1	17.4	17.5	17.6	16.8	18.2	19.4	18.4	17.3	17.9
SD	3.4	3.0	2.8	2.3	2.6	3.0	2.5	2.7	2.4	2.7	2.8
n	58	35	88	201	242	60	146	42	47	14	933
% females	42	43	31	56	39	44	33	28	35	31	39

grouping are shown in Table 7. Data from the Lofoten area are given separately for 1938–1970 and 1971–1981. Mean lengths of the two sexes are significantly different in all areas except for the samples from Lofoten (1971–1981), the North Sea, Iceland and the area west of Cape Farewell (Games and Howell test of equality of means [Sokal and Rohlf 1981] with $\alpha = 0.05$). In addition, males taken off Lofoten after 1971 differ from males in all other samples except those from Finnmark, Lofoten 1938–1970 and the North Sea. The mean of the Barents Sea female sample differed from those from Lofoten 1971–1981, Møre and the North Sea ($\alpha = 0.05$).

DISCUSSION

Norwegian annual catches of killer whales were relatively stable until about 1960. Thereafter they increased, probably as part of the general expansion of Norwegian small-type whaling westwards through the Norwegian Sea to areas off Iceland and East Greenland (Christensen 1975; Øien and Christensen 1985). The target species of this expansion was the minke whale, but toothed whales like northern bottlenose, killer and pilot whales, already part of the Norwegian whaling traditions, were taken when encountered. It is most appropriate, however, to consider

catches of killer whales (and other toothed whales) as by-catches of relatively minor importance to the whalers. As evidence, Øien (1987) found only four occasions when any of the 105–352 Norwegian small-type whaling vessels annually involved in this fishery, 1938–1971, had taken only killer whales during a whaling season.

The increase in catches after 1960 was not related to an increase in killer whale abundance but rather to expansion of whaling area. Conversely, the drop in catches after 1971 was not caused by reduced abundance of killer whales but rather by a significant economic factor. Meat from toothed whales was used only as food for pets and fur animals. After 1971 the feed markets were much reduced (Jonsgård 1977c). A similar reduction occurred in the Norwegian catches of bottlenose whales, which dropped to low levels after the 1971 season, but depletion probably also contributed to these reduced catches (Christensen 1975).

On some occasions, the catches of killer whales appear to have been related to high local abundances, as in the Møre area in 1968–1970 and off Lofoten in 1978–1981. At least the hunt in Lofoten was initiated by complaints from fishermen that killer whales were interfering with the recovery of the depleted herring stock, which at that time was showing

an increasing trend. The decline in the Norwegian spring spawning herring stock was accompanied by a change in distribution pattern and migration, resulting in a shrinkage of spawning areas in the late 1960's to the Møre-Trøndelag area (Dragesund *et al.* 1980). This is probably a cause of the high local abundance of killer whales at Møre as revealed by the high catches during the winter months of 1968–1970 (Tables 2 and 4). The possible relationship between abundance and migrations of herring and distribution and migrations of killer whales is further discussed by Jonsgård and Lyshoel (1970) and Christensen (1988 – this volume).

The distribution of killer whale catches (Fig. 1) is strikingly similar to the distribution of minke whale catches (Figs. 2 to 4 in Øien *et al.* 1987), although the densities of catches of minke whales are greater. The main concentrations of minke whale catches were on the coast of Møre, at Lofoten and in the Barents Sea-Svalbard area. Only a minor fraction of the killer whales were caught in this latter area. On the other hand, many killer whales were caught in offshore areas of the Norwegian Sea, between the Møre coast and Iceland, in an area where minke whales were caught only occasionally. This indicates that killer whales are fairly abundant there. It is probable that many of the killer whales caught in this area were taken by vessels transiting to the minke whale grounds off Iceland and East Greenland. This assumption is further strengthened by the fact that the peak catches of both killer and minke whales in these areas were in August (Øien and Christensen 1985).

The distribution of catches is also affected by catch regulations. Before licensing was introduced in small-type whaling in 1938, there was no regulation of quotas or seasons. In 1950, a summer closure from 1 to 21 July was introduced. In 1952, a six month season was set from 15 March to 14 September (Jonsgård 1977a; Øien *et al.* 1987). In most years since 1952 such closures have precluded catches in late autumn and winter, although whaling of killer whales outside the season was permitted by exception at both Møre and Lofoten in the

years of high catches around 1970 and 1980, respectively.

The incidental sightings from the main sources (IMR research vessels, whaling and fishing vessels) may be biased as activities of these vessels in many respects depend on seasonal local abundances of fishes and whales. The high numbers of sightings in the Lofoten area and in the Norwegian Sea (Table 4) are more likely results of proportionally greater fishing effort rather than greater killer whale abundance in those areas. As is also seen from Table 4, there were especially many sightings from the Lofoten area in 1978–1980, with a sharp peak in 1979. This pattern coincides with the patterns of catches at Lofoten (Table 2).

Despite these possible biases, the distributions of killer whales indicated by catches and incidental sightings are similar. Although the successions are different, the peak months in Lofoten, both in catches 1971–1981 and in observations, are October, November and January. On the Møre coast, both the catches and observations peaked in February and March; in the Barents Sea and near Svalbard both catches and observations peaked in May–June. For the Norwegian Sea the two data sets coincide for May to July, but an August peak in catches is not matched by a peak in the sightings, which mainly cover the period after 1977. If the sightings are representative, the differences noted may indicate that a change in abundance of killer whales has taken place in this area. On the other hand, McBrearty *et al.* (1986), who reported on sightings of killer whales around the British Isles and in the Norwegian Sea, found that most of their observations around the British Isles were from June to September with concentrations to the north and west of Scotland in early summer, while later in the year sightings were more widespread over the sea.

The mean group size in the most reliable estimates available for Norwegian waters ($n = 12$, $\bar{x} = 8.9$, $SD = 6.4$) were comparable to those from other areas: British Columbia, $n = 30$, $\bar{x} = 8.7$ (computed from data in Bigg 1982), temperate and tropical eastern Pacific,

$n = 508$, $\bar{x} = 5.3$, $SD = 6.5$ (Dahlheim *et al.* 1982) and southern Alaska, with means of 4 to 6 depending on area (Leatherwood *et al.* 1984a).

The mean lengths of catches are, alone, poor statistics for comparing different samples. Although there are few unexpected statistically significant dissimilarities of means, there are apparent differences in ranges and relative frequencies. It is, however, probable that the length distributions also reflect catch strategies. Males are grossly over-represented in the catches, probably indicating the whalers' preference for bigger individuals. Fraser (1974) found a preponderance of males among stranded animals on the British coast, suggesting that males are more numerous in these waters than females. However, in recent studies off Iceland killer whale pods have contained an average of 18–24% adult males (Sigurjónsson *et al.* 1988 – this volume), percentages comparable to those observed off British Columbia (23%, Bigg 1982) and Southern Alaska (18.6%, Leatherwood *et al.* 1984b; 30.4%, Ellis *et al.* in press).

ACKNOWLEDGEMENTS

This study was partly funded by Hubbs Marine Research Center, San Diego, California, through contract No. 3244. S. Hartvedt coded and transferred to computer files reports on killer whale catches and incidental sightings. A. Sæverud helped with the drawings. T. Øritsland, Institute of Marine Research, Bergen, edited the manuscript. The comments and suggestions from three anonymous referees greatly improved both language and contents of this paper.

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