

Killer whales (*Orcinus orca*) in British and Irish waters

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ABSTRACT

Analyses based primarily upon sightings data show that killer whales, *Orcinus orca*, are widely distributed in British and Irish waters, occurring particularly along the Atlantic seaboard and in the northern North Sea. The species is rare or absent from the southern North Sea and eastern part of the Channel. Its presence in coastal waters is seasonal, mainly between April and September, possibly associated with inshore movements of spawning Atlantic salmon and herring. This may be followed by an offshore movement associated with mating/calving in late autumn and winter. Single animals are most commonly seen, and groups usually number less than eight individuals. Single animals are mainly subadults or adult males whilst pods comprise groups of adult females and subadults, usually accompanied by a single adult male. There is little evidence for any marked change in status of killer whales in the region.

INTRODUCTION

Although cosmopolitan in its distribution, the killer whale, *Orcinus orca*, appears to be most common in polar waters (IWC 1982). This applies also in the Northeast Atlantic, but nevertheless, the species is widely distributed in British and Irish waters. This paper reviews our present knowledge of the status and distribution of the killer whale in the region, and provides some additional data on aspects of the ecology of the species.

MATERIAL AND METHODS

Information about killer whales in British and Irish waters derives from two sources: 1) records of animals beached alive or dead along the shore; and 2) records of live sightings. Killer whales are not usually hunted in the region, although takes by Norwegian and Faroese vessels have probably involved segments of those populations and have sometimes occurred in north British waters (Bulletin of International Whaling Statistics, 1960–

73). The Faroese have also taken killer whales by driving them ashore.

Most of the data presented here derive from a sightings scheme set up by the UK Mammal Society's Cetacean Group in 1973, and operating primarily within British and Irish waters. A network of about 350 observers, comprising both amateurs and professional marine zoologists, provides records on standardised forms. Identification is verified either from a description of diagnostic features or from photographs. Although killer whales are rather distinctive, it is the author's experience that untrained observers sometimes mistake Risso's dolphins, *Grampus griseus* for this species. Therefore, records without supporting documentation are not accepted.

The records obtained are coded onto a computer data base along with various environmental data such as weather conditions, water depth, sea surface temperature and salinity, the last two obtained either directly or from monthly charts showing contours of averaged

values (see Evans, Harding, Tyler and Hall 1986 for further details). All maps presented here are constructed using Mercator projection.

The great majority of the 350 individuals mentioned above are casual observers, operating particularly between June and September. They are fairly evenly spread around coastal British waters, either observing from headlands or from boats offshore. Coverage is best in the Channel, on the eastern side of the Irish Sea, west of Scotland, at the Northern Isles and east Scotland, and at northeast England. It is poorest around the coasts of Ireland. Additionally, there are about twenty observers/sites collecting sightings systematically and documenting sightings effort either by recording the number of hours or the number of days spent observing. Most of these have operated from fixed sites (for example bird observatories), mainly throughout the months April–September, but five have used vessels that cover a prescribed area by a series of cruises. These include the Department of Agriculture and Fisheries for Scotland in the northern North Sea and off Northern Scotland; Ministry of Agriculture, Fisheries and Food in the central and southern North Sea; Nature Conservancy Council's Seabirds at Sea team in the central and northern North Sea and latterly off Northwest Scotland – all operating throughout the year; occasional cruises by the Mammal Society Cetacean Group along the Atlantic seaboard of Ireland and west Scotland, and around the Northern Isles have taken place between July and October; and the Nature Conservancy Council/Royal Society for the Protection of Birds have carried out boat surveys in the Northern Isles and Cromarty/Moray Firths, mainly between April and September. Finally, the Meteorological Office operates continuously a weather station (formerly two) far west of Scotland in the mid Atlantic with relief vessels travelling between it and Oban, Highland region.

To date (October 1987), 304 records of killer whales have been collected, comprising a total of 1,454 individuals. Hammond and Lockyer (1988 — this volume) also present 87 sightings

from this region as part of their general review of killer whale distribution in the northeast Atlantic. Their sightings data from Britain and Ireland derive almost entirely from a scheme run by Denis McBrearty (University of Cambridge) using primarily merchant vessels, fishermen and yachtsmen. Twenty-three of those records (including nine of the thirteen oceanic records) exist also as part of the above-mentioned data base. For a more comprehensive picture of distribution in British and Irish waters, the two sets have been combined and are plotted in Figure 1a.

STATUS AND DISTRIBUTION

When interpreting results derived from both sightings and strandings records, obvious potential biases arise if there is uneven geographical coverage by observers or uneven temporal coverage in observations. With respect to strandings data, coverage is probably best in southern and eastern England and poorest in northern and western Scotland and western Ireland. Sightings coverage is best in the northern North Sea, the southern Irish Sea, the Channel and at specific localities mainly in northern and western Britain, but poorest in the northern Irish Sea and along the west coast of Ireland. In general, the coasts and inshore waters of Britain and Ireland are visited most by observers between the months of July and September and least between November and February. These biases of coverage are taken into consideration in the conclusions made from the results presented.

Sightings of killer whales recorded by the Cetacean Group's scheme have an Atlantic element, occurring usually no more than 50 km from the continental shelf edge. Sightings have been mainly from waters off northwest and northern Scotland, and in the northernmost part of the North Sea (Fig. 1). However, the poorer coverage in Ireland, particularly the Atlantic northwest coast, most likely means that it is under-represented there. Where there is regular watching, for example in the vicinity of Cape Clear Island bird ob-

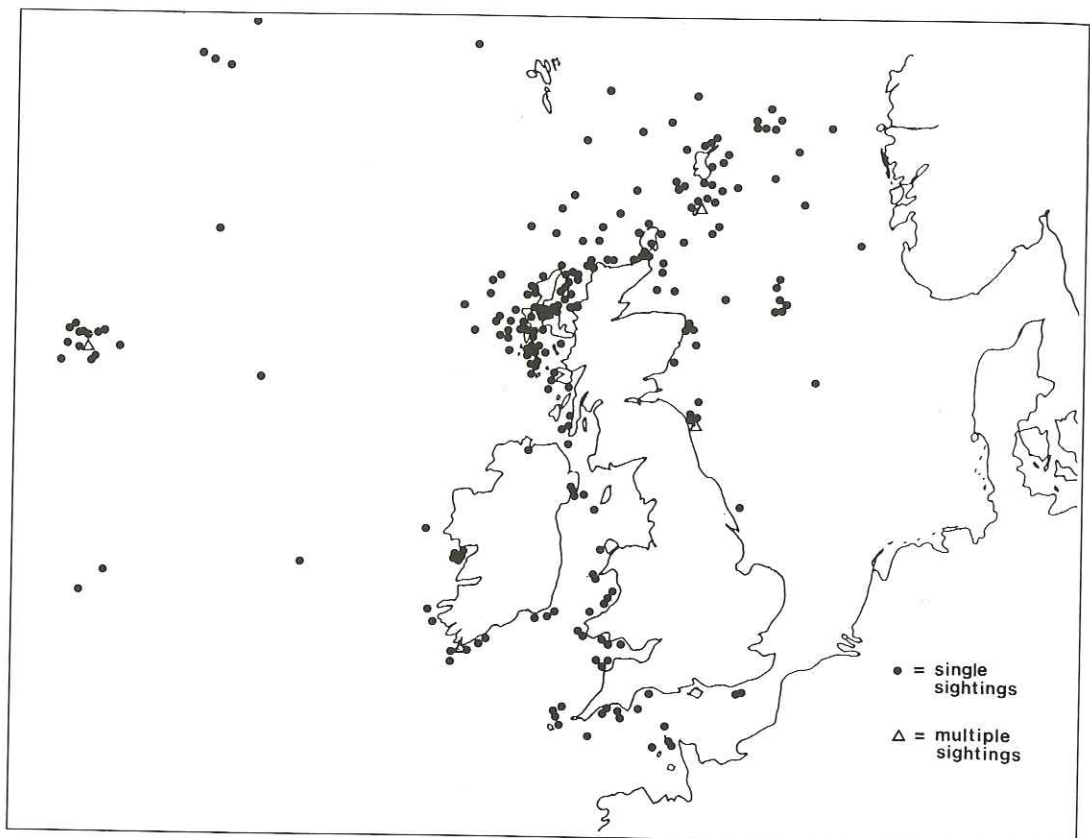


Fig. 1a. Distribution of sightings of killer whales in British and Irish waters, direct plots of sightings. Note that sightings at the same location are registered as single points. For completeness, sightings include all those from Mammal Society's Cetacean Group's scheme as well as those detailed in Hammond and Lockyer (1988 – this volume), and four records from Fairley (1981). Filled-in circles refer to single sightings; triangles refer to multiple sightings from four longterm quantified effort sites.

servatory, County Cork, killer whales are seen at least occasionally. Incidental observations along parts of the Atlantic seaboard suggest that they normally occur there as well. The species occurs also in the Irish Sea and occasionally in the English Channel. In the North Sea, killer whales regularly occur (average of 9 sightings per year since 1977) as far south as the Farne Islands in northeast England, but are rare or absent (average of less than one sighting per year since 1977) south of there. An average of 1–2 killer whale sightings per year have also been made from weather ships in the mid Atlantic (57°N, 20°W), although most sightings (Fig. 2) come from

close to the coast (most likely reflecting in part the distribution of observers).

Since the British Museum's strandings scheme was initiated in 1913, there have been 62 recorded strandings of killer whales in Britain and Ireland (Sheldrick 1979, pers. comm.). These have been distributed throughout the region although there have been somewhat more records from the Northern Isles than elsewhere as shown by Fraser (1974). He noted that of twenty-three counties of Britain and Ireland with strandings records, only the Shetland Islands had more than two records. Unlike sightings records, strandings have been reported no less fre-

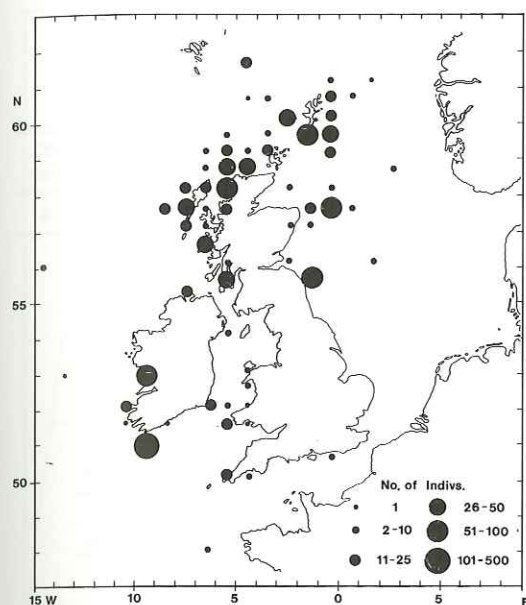


Fig. 1b. Distribution of sightings of killer whales in British and Irish waters, numbers of individuals by ICES grid plots.

quently from southeast England than from elsewhere. However, since cetaceans may drift some distance after death, the localities at which stranded animals occur do not necessarily reflect their true distribution. Currents move southwards into the North Sea and eastwards up the English Channel. Strandings in eastern and southern England may therefore derive from animals that died north or west of there.

CHANGES IN STATUS

With a relatively small number of records upon which to base conclusions, any apparent status changes should be regarded as tentative. Three methods are here used to examine possible changes in numbers: 1) strandings records for different time periods since 1913 (where effort, although not constant, has not changed in any obvious manner over time); 2) the number of killer whale sightings (and numbers of individuals) as a proportion of the total number of all cetaceans sighted, for different time periods since 1958; and 3) an index

of numbers of sightings and individuals, corrected for effort (i.e. adjusted for the number of recorded hours of observation), at sites where regular watching has occurred and effort has been quantified. Although coverage has increased in the last twenty years, there is no evidence from sightings data that this trend has been biased in favour of particular cetacean species. A comparison of the proportion of killer whales seen out of the total number of all cetacean species recorded should therefore reflect changes in the numbers of that species relative to others in the region.

The results of the above three methods are presented in Table 1. Over the last 75 years, there is no evidence of any marked change in status of the species, although sample sizes are small for such a comparison. Within the last 25 years, there is some indication of a decline in numbers, but such fluctuations have occurred in the longer term data, and low numbers were stranded, for example, between 1958 and 1962, with none in the period ten years previous. Since 1958, the proportion of sight-

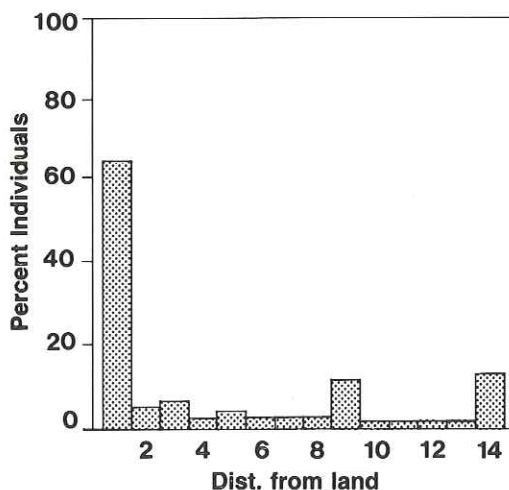


Fig. 2. Percentage of the total number of killer whale individuals recorded at different distances from land. Total number for which distances from land were recorded is 1,324. The distance categories are as follows: 1: 1-5 km; 2: 6-10 km; 3: 11-20 km; 4: 21-30 km; 5: 31-40 km; 6: 41-50 km; 7: 51-75 km; 8: 76-100 km; 9: 101-150 km; 10: 151-200 km; 11: 201-300 km; 12: 301-400 km; 13: 401-500 km; 14: 501+ km.

TABLE 1
Status changes of killer whales in British and Irish waters.

a) Numbers of strandings between 1913 and 1985.

| 1913- 1917 | 1918- 1922 | 1923- 1927 | 1928- 1932 | 1933- 1937 | 1938- 1942 | 1943- 1947 | 1948- 1952 | 1953- 1957 | 1958- 1962 | 1963- 1967 | 1968- 1972 | 1973- 1977 | 1978- 1982 | 1983- 1985 |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
| 1 | 3 | 6 | 2 | 2 | 5 | 7 | 0 | 3 | 2 | 7 | 6 | 8 | 6 | 4 |

b) Numbers of sightings/numbers of individuals as percentage of total of all cetaceans recorded, 1958-86.

| | 1958-72 | 1973-79 | 1980-86 |
|-------------------------|---------|---------|---------|
| % sightings | 7.6 | 6.2 | 2.7 |
| % individuals | 2.3 | 1.8 | 2.0 |

c) Sighting indices (corrected for effort¹) for four longterm monitoring sites between 1963 and 1986.

| Site | Sightings | | | | |
|------------------------|-----------|---------|---------|---------|---------|
| | 1963-67 | 1968-72 | 1973-77 | 1978-82 | 1983-86 |
| Weather ship | — | — | 4 | 9 | 10 |
| Fair Isle | — | 2 | 2 | 6 | 12.5 |
| Farne Is. | 5 | 1 | 1 | 6 | 2 |
| Cape Clear | 6 | 6 | 5 | 18 | 1 |

| Site | Individuals | | | | |
|------------------------|-------------|---------|---------|---------|---------|
| | 1963-67 | 1968-72 | 1973-77 | 1978-82 | 1983-86 |
| Weather ship | — | — | 31 | 82 | 89 |
| Fair Isle | — | 8 | 17 | 29 | 34 |
| Farne Is. | 25 | 5 | 5 | 23 | 2 |
| Cape Clear | 28 | 16 | 8 | 50 | 3 |

¹ Comparisons of abundance indices should only be made between years within sites, since they are calculated in different ways — effort corrections use number of hours of observation for Cape Clear but number of days watching for the remainder. Although there are seasonal biases of coverage for all but the Weather ship (watching concentrated between April–September), these are consistent between years and so do not affect the above comparisons.

ings has also declined, although that of individuals has remained the same (see Table 1b). There are only four sites with long-term observations at which effort has been quantified and where killer whales have been recorded sufficiently regularly for analysis. These are Fair Isle in the Shetland Islands and the weather ship in the mid Atlantic (57°N, 20°W) in the north, the Farne Islands off the Northumberland coast, and Cape Clear off the south coast of County Cork. Since 1968, numbers of sightings and of individuals (corrected for effort) show no obvious trend (except possibly in the last four years) for either the Farne Islands or Cape Clear whilst the two more

northerly sites (Fair Isle and the mid Atlantic weather ship) show steady increases (Table 1c). These results present little evidence for any consistent change in status of killer whales in the region.

SEASONAL DISTRIBUTION AND MOVEMENTS

Sightings occur in all months of the year in all regions, but particularly between April and October (Figs. 3 and 4). Most sightings are from June, July and August, although effort is greater at this time, particularly in the latter two months. There is some evidence that indi-

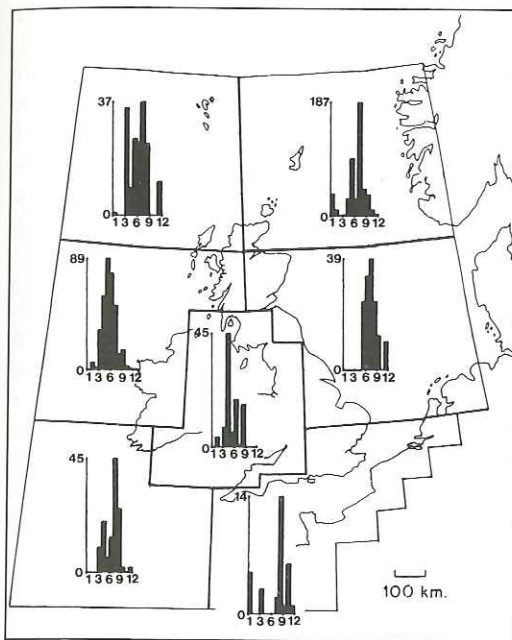


Fig. 3. Seasonal distribution of killer whales by major sea area within British and Irish waters. Vertical axis denotes number of individuals, horizontal axis month, where 1 is January, 2 February, . . . and 12 December.

viduals may undergo an inshore movement in summer, moving offshore again at the end of the year (Fig. 5), although some individuals may be found in coastal waters at that time, mainly in the Channel and in the southern Irish Sea. For this analysis, data were included from Atlantic weather ships up to 800 km from land, since there is a uniform effort throughout the year (although viewing conditions will be reduced by less favourable weather during winter). Although outside British and Irish waters, data from these observation platforms serve as a useful direct comparison of the seasonal presence of killer whales in offshore versus coastal waters. Sixteen out of twenty-one sightings (76%) from the weather ships occurred in the first six months of the year (particularly March–June). Differences between the results presented here and those of Hammond and Lockyer (1988 – this volume) appear to be due primarily to our larger data set from offshore waters

in the present study (both from mid Atlantic and at intermediate distances). Interestingly, most of their sightings in January and February also were from the Channel and the southern Irish Sea.

Whereas other cetacean species may be seen repeatedly in a localised area during the short term, sightings of killer whales rarely occur in the same area more than once a month. This, together with the re-sighting in the Northern Isles of an individual identified by a kink towards the top of its dorsal fin and a particularly pale dorsal saddle (putatively with the same pod) more than 100 km away two weeks later, suggest that killer whales in British and Irish waters range over comparatively large areas. There is no evidence for the presence of sedentary resident pods as reported, for example, off British Columbia (Balcomb *et al.* 1982; Bigg 1982; Ford and Fisher 1983), and which may also apply around the Lofoten Islands in Northwest Norway (Jonsgård and Lyshoel 1970; Christensen 1982, 1984; Lyrholm 1988 – this volume) and east of Iceland (Sigurjónsson *et al.* 1988 – this volume).

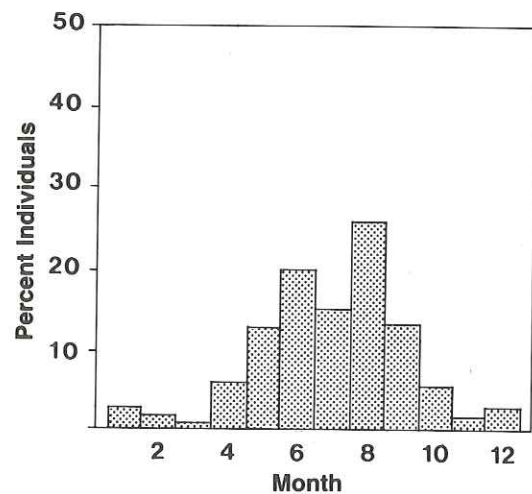


Fig. 4. Seasonal distribution of killer whales in British and Irish waters (all areas combined). Vertical axis denotes percentage of total number of individuals, horizontal axis month, where 1 is January, 2 February . . . 12 December.

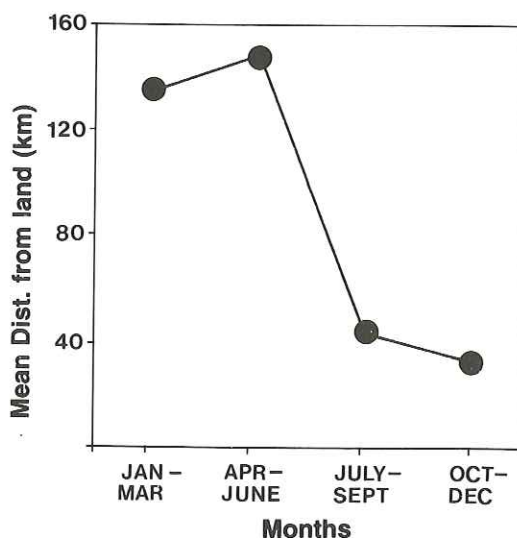


Fig. 5. Mean distance from land (km) that killer whales have been recorded for the periods January-March, April-June, July-September, and October-December.

DIET AND FEEDING ECOLOGY

Since the stomach contents of killer whales have not been examined in British and Irish waters, information on diet has to be inferred from associations with known food prey and from observations of direct capture of food items.

Studies of killer whales elsewhere (Nishiwaki and Handa 1958; Hancock 1965; Tomilin 1967; Condry *et al.* 1978; Lopez and Lopez 1985; Whitehead and Glass 1985; Heimlich-Boran 1986) show that the species has a catholic diet which includes a range of fish species (notably Pacific and Atlantic salmon (*Salmo spp.*) and herring (*Clupea harengus*), but also mackerel (*Scomber scombrus*) and cod (*Gadus morhua*) in the northern hemisphere), squid, and marine mammals (seals and cetaceans).

The movement of killer whales in summer into coastal waters of Britain and Ireland coincides with seasonal concentrations of a number of the above fish species for spawning. Between June and November, Atlantic salmon enter bays and rivers on the coast of

western Ireland, northwest Scotland, eastern Scotland and northeast England (Mills 1971; Wheeler 1978). Herring concentrate to spawn in August and September off southern and northwest Ireland, the Outer Hebrides, north coast of Scotland and Grampian coast, and between September and October off the coast of northeast England (Cushing 1975; Wheeler 1978). Both cod and mackerel spawn somewhat earlier, the former between February and April (Wheeler 1978), the latter mainly between April and July (Johnson 1977; Coombs and Mitchell 1981). Spawning grounds of cod tend to be localised in a number of areas in the North Sea, around the Outer Hebrides, and the Rockall bank, often at a depth of 200 m. Mackerel spawn in shallower waters, in the Celtic Sea off southern Ireland, off northwest Ireland, and the northern North Sea west of Norway.

Killer whales have been reported associating with salmon catching activities in the Western Isles of Scotland, and with white-beaked dolphins (*Lagenorhynchus albirostris*) apparently feeding on herring shoals in the Pentland Firth off north Scotland (Evans 1980). Direct observations of feeding involve the taking of marine mammals by killer whales. The author has observed the species pursuing harbour porpoises (*Phocoena phocoena*) off Southwest Ireland, and other reports include the taking of grey seals (*Halichoerus grypus*) at the large breeding colony of North Rona (Northwest Scotland), St. Kilda (Western Isles), and along the mainland coast of North Scotland (Evans 1980). The seasonal appearance (in June-August) of killer whales close to the outer Farne Islands where large haul-outs of grey seals occur prior to breeding (Hewer 1974, p.223), may also be partly associated with opportunistic feeding on marine mammals.

BREEDING

Jonsgård and Lyshoel (1970) believed that in Norwegian waters calves are born in late autumn and winter, the two smallest calves recorded by them being taken in February, and

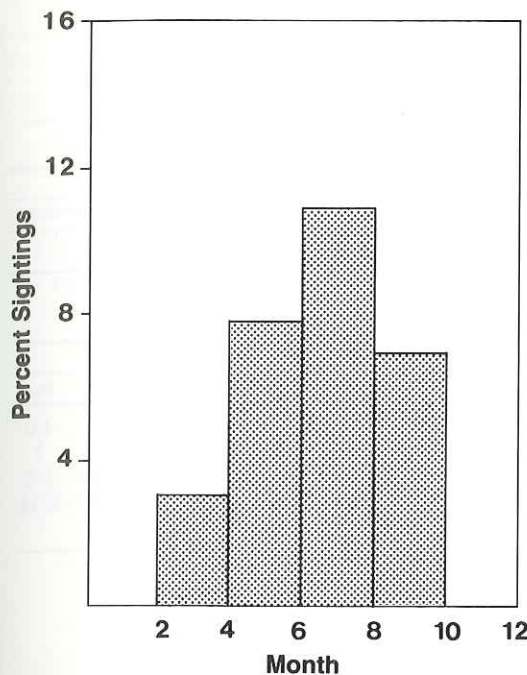


Fig. 6. Seasonal distribution of killer whale calves. Vertical axis refers to percentage of total number of sightings that include juveniles in the group; horizontal axis refers to two-monthly periods (From January/February to November/December).

the next four in size in April and May. Fraser (1974) found support for this by the stranding of a new born calf on the west coast of Scotland in February 1966. A more extensive analysis of Norwegian catches for the periods 1938–1967 and 1978–1981 by Christensen (1984) indicates that although mating occurs throughout the year, it probably occurs mainly from September to January with a peak in October to December.

The gestation period of the killer whale is still not known precisely but is thought to be 12 (possibly up to 15) months (Jonsgård and Lyshoel 1970; IWC 1982; Christensen 1984), so that births might be expected mainly between October and March. The young is born at an estimated length of around 210 cm, which is 37% of the average length of a physically mature female (Jonsgård and Lyshoel 1970; Christensen 1982, 1984). In British and Irish waters, sightings of young animals (esti-

mated one-third to one-half the length of the associated adult and hence presumed to be up to six months old) start in February and reach a peak in July (Fig. 6). This agrees with the above findings, suggesting that calves are born mainly between November and February.

This may be associated with an apparent offshore movement just prior to this time (Fig. 5).

GROUP SIZE, GROUP COMPOSITION AND BEHAVIOUR

Although the mean group size of killer whales in British and Irish waters is 4.6 individuals, most sightings are of single animals and 89% of all records involve group sizes of less than eight (Table 2a). The largest group was of 80–100 individuals in the northern North Sea in August 1979. However, this probably represents a temporary aggregation of a number of pods.

Group sizes show little sign of a seasonal variation, median values being between two and four animals throughout the year, although the most common group size in the months July–December never exceeds two animals in a group compared with 2–5 animals for the first six months of the year (see Table 2b). The same applies to group sizes at various water depths (see Table 2c) and distances from land (see Table 2d) although in the latter case, all groups exceeding 20 animals were at least twenty kilometres from land. Hammond and Lockyer (1988 – this volume) obtained a significant seasonal difference in mean group size of killer whales in British waters north of 55°N, with larger groups between May–October than in November–February. The mean group size was also significantly larger in British waters north of 55°N, than south of this latitude. Re-analysis of our data set divided both seasonally and latitudinally revealed no such differences. Indeed, there were a number of sightings of herds of 15–20 individuals south of 55°N, off the west coast of Ireland. On the other hand, sightings in the Irish Sea and the Channel were mainly of single animals and involved no groups larger

TABLE 2
Group sizes of killer whales.

a) Frequency of different group sizes.

| | Group size (No. of animals) | | | | | | | | | | | | | | | | | | |
|-------|-----------------------------|----|----|----|----|----|----|---|---|----|----|----|----|----|----|-------|-------|-------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16-20 | 21-30 | 31-50 | 51-100 |
| Freq. | 78 | 47 | 46 | 33 | 20 | 21 | 12 | 3 | 2 | 2 | 1 | 4 | 1 | 1 | 5 | 7 | 3 | 2 | 1 |

b) Group sizes in each month of the year.

| | Month | | | | | | | | | | | |
|--------|----------------|-----|-----|------|------|------|------|------|------|------|-----|------|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Mean | 8.4 | 3.3 | 2.0 | 4.2 | 7.0 | 5.3 | 3.2 | 5.2 | 3.8 | 4.7 | 2.7 | 4.0 |
| Median | 10 | 3 | 2 | 2 | 3 | 4 | 4 | 3 | 3 | 3 | 2 | 2 |
| Mode | — ¹ | 4 | 2 | 2 | 2-3 | 2-3 | 2 | 1 | 1 | 1 | 1-2 | 1-2 |
| Range | 1-20 | 1-6 | 2 | 1-15 | 1-36 | 1-33 | 1-12 | 1-90 | 1-20 | 1-15 | 1-6 | 1-11 |
| n | 4 | 6 | 1 | 18 | 22 | 46 | 46 | 68 | 41 | 14 | 7 | 7 |

c) Group sizes at various water depths.

| | Water depth (metres) | | | | | | |
|--------|----------------------|-------|-------|-------|--------|---------|------|
| | 1-10 | 11-20 | 21-30 | 31-50 | 51-100 | 101-300 | 301+ |
| Mean | 4.0 | 3.3 | 4.3 | 3.2 | 4.3 | 8.2 | 7.6 |
| Median | 3 | 3 | 3 | 3 | 2 | 3 | 3 |
| Mode | 2-3 | 2 | 1 | 1 | 1 | 2 | 3 |
| Range | 1-20 | 1-7 | 1-17 | 1-12 | 1-25 | 1-90 | 1-24 |
| n | 31 | 15 | 54 | 49 | 22 | 26 | 26 |

d) Group sizes at various distances from land.

| | Distance from land (km) | | | | | | | |
|--------|-------------------------|-------|-------|-------|-------|--------|---------|------|
| | 1-10 | 11-20 | 21-30 | 31-40 | 41-50 | 51-100 | 101-200 | 201+ |
| Mean | 3.8 | 5.4 | 10.6 | 1.0 | 7.5 | 6.7 | 1.8 | 8.3 |
| Median | 3 | 3 | 5 | 1 | 7.5 | 2 | 2 | 5 |
| Mode | 1 | 1 | — | 1 | — | 2-3 | 1 | 2 |
| Range | 1-20 | 1-25 | 2-33 | 1 | 2-13 | 1-90 | 1-2 | 1-24 |
| n | 150 | 9 | 5 | 1 | 4 | 24 | 5 | 21 |

¹ A dash denotes that there was no specific group size more common than another within that category.

than five individuals. Since these latter areas account for all the sightings reported by Hammond and Lockyer (1988 this – volume), this may be the reason for the apparent discrepancy.

Adult male killer whales can usually be readily distinguished by their very tall upright dorsal fin. Adult females have a small, more recurved dorsal fin, and are generally of small

size. Subadult males cannot be reliably distinguished from female subadults, and there is a danger that subadult males may be confused with adult females except when the latter closely accompany their calf. Table 3 only presents the results for those groups whose composition could be determined with confidence. Inevitably, this could introduce a bias, since an adult female is best identified when it is ac-

TABLE 3
Composition of killer whale groups.

| | | Age/Sex | | | | | Age/Sex | | |
|-----------------|--|------------|----------------------------|---------------|--------------------|--|------------|----------------------------|---------------|
| | | Adult male | Adult female/ Subadults | Juvenile/Calf | | | Adult male | Adult female/ Subadults | Juvenile/Calf |
| a) Lone | | 17 | 12 | 0 | Group size 4 | | 1 | 3 | |
| b) Group size 2 | | 2 | | | — — | | 1 | 3 | |
| — — | | 2 | | | — — | | 3 | | |
| — — | | 1 | 1 | | — — | | 1 | 2 | 1 |
| — — | | 1 | 1 | | — — | | 1 | 2 | 1 |
| — — | | | 2 | | — — | | 1 | 2 | 1 |
| — — | | | 1 | | — — | | | 3 | 1 |
| — — | | | 1 | | — — | | | 4 | |
| — — | | | 2 | | — — | | | 4 | |
| — — | | | 2 | | — — | | | 4 | |
| c) Group size 3 | | 2 | 1 | | e) Group size 5 | | 2 | 3 | |
| — — | | 1 | 2 | | — — | | 1 | 4 | |
| — — | | 1 | 2 | | — — | | 1 | 4 | |
| — — | | 1 | 2 | | — — | | 1 | 4 | |
| — — | | 1 | 2 | | — — | | | 4 | 1 |
| — — | | 1 | 2 | | — — | | | 4 | 1 |
| — — | | 1 | 2 | | — — | | | 4 | |
| — — | | 1 | 2 | | — — | | | 5 | |
| — — | | 1 | 2 | | f) Group size 6 | | 1 | 5 | |
| — — | | 1 | 2 | | — — | | 1 | 5 | |
| — — | | 1 | 2 | | — — | | 1 | 5 | |
| — — | | 1 | 2 | | — — | | 1 | 5 | |
| — — | | 1 | 2 | | — — | | 1 | 3 | 2 |
| — — | | 1 | 1 | 1 | g) Group size 7 | | 3 | 4 | |
| — — | | 1 | 1 | 1 | — — | | 2 | 5 | |
| — — | | | 3 | | — — | | 1 | 6 | |
| — — | | | 3 | | — — | | 1 | 6 | |
| — — | | | | 3 | — — | | 1 | 6 | |
| d) Group size 4 | | 2 | 2 | | — — | | 1 | 5 | 1 |
| — — | | 2 | 2 | | h) Group size 8-10 | | 4 | 6 | |
| — — | | 1 | 3 | | — — | | 3 | 5 | |
| — — | | 1 | 3 | | — — | | 1 | 8 | |
| — — | | 1 | 3 | | — — | | 1 | 8 | 1 |
| — — | | 1 | 3 | | i) Group size 11+ | | 1 | 11 | |
| — — | | 1 | 3 | | — — | | 2 | 7 | 3 |
| — — | | 1 | 3 | | — — | | | 16 | 4 |

companied by a calf. Most sightings of single individuals were of adult males, the remainder usually thought to be subadult males by the relatively upright dorsal fin. Groups of three individuals usually comprised a single adult male and two others thought to be adult females, whilst groups of four and above were more likely to include one or more subadults

or calves. Few mixed groups contained more than one adult male. Overall sex ratios suggested a preponderance of males amongst lone individuals and of females in larger groups (identified by their close association with a calf). These results support evidence from elsewhere, that killer whales may have a matriarchal social system with males being

polygynous, attending a harem of females, or living alone, or as separate bachelor herds (Bigg 1982; Matkin and Leatherwood 1986).

Cooperative food herding has been reported for a number of odontocetes, including the killer whale (Connor and Norris 1982; Würsig 1983; Evans 1987). An interesting and detailed observation off the coast of North Scotland has been provided by P. Taylor of a herd comprising an adult male, two females (possibly subadult males) and an immature animal. His description (see Evans 1980) was as follows: "...the herd followed close to the cliffs occasionally making high-pitched squeaks, and then suddenly united and dashed for a seal that was making for the rocks. On capture, the male took it in its jaws and carried it out to deeper waters where the others appeared to queue up and play with the seal before dividing it up." Taylor further reports that the adult male kept to one side, whilst members of the herd fed upon the seal.

STOCK IDENTITY

Killer whales in different parts of the world show variation in the size, shape and position of lateral markings (Evans *et al.* 1982). These probably reflect restricted gene flow between different populations, and with this in mind, it was thought useful to review variations in markings for killer whales sighted in British and Irish waters. Comparisons can then be made with individuals from populations elsewhere in the Northeast Atlantic as well as off the coasts of eastern North America and West Greenland.

An examination of photographs of both sightings and strandings indicates that killer whales in British and Irish waters have a rather indistinct simple dorsal saddle, a single black subocular notch lying immediately posterior of a very small but distinct white patch on the lips, a conspicuous long oval white postocular patch which in some cases shows a ragged anterior margin, no shoulder notch, and a simple rounded white flank field with no serrated margin (nomenclature follows Evans *et al.* 1982). There are too few records of ven-

tral markings to determine variation in ventral, genital and fluke fields. Indeed, the above results should be considered as very preliminary. They are based on photographs of only eight separate individuals, not all of which could be used for every feature described here. Variation occurred in the shape of the postocular patch, and although usually showing an uninterrupted margin, close-ups of two stranded animals on the southeast Irish coast showed a ragged anterior edge.

Until more photographs have been obtained from the region and compared with others elsewhere in the North Atlantic, it is not possible to draw conclusions as to a possible population differentiation.

DISCUSSION AND CONCLUSIONS

Killer whales are widely distributed in British and Irish waters, although apparently in smaller numbers than further north off western Norway, the Norwegian Sea and around Iceland (Jonsgård and Lyshoel 1970; Christensen 1982; Sigurjónsson 1984, Sigurjónsson in press). They occur primarily along the Atlantic seaboard and in the northern North Sea, and are virtually absent from the southern North Sea and eastern Channel. Coastal waters are occupied primarily between April and October, and this may be followed by a movement offshore associated with mating and/or birth between November and February.

In 1978 the Norwegian government permitted catches of killer whales for three years outside the regular whaling season, in response to suggestions that populations in those waters were increasing and were imposing a pressure on the Atlanto-Scandian stock of herring (Christensen 1984). Similar reasons have been put forward regarding killer whales in Icelandic waters (Sigurjónsson 1984), although no organised fishery has been conducted in that area by Icelanders — only live-capture takes. Bearing in mind the apparent wide ranging movements of the species in British waters, it is thought unlikely that it forms distinct populations in the region. In

particular, it is probable that killer whales from the northern North Sea, off western Norway, may visit British waters.

There is little evidence that killer whales are increasing in British and Irish waters, and there is indeed some evidence that they may have decreased in number since 1980. There is a need for a more extensive monitoring of sightings where sightings effort can be quantified, and examination of variation in morphological (and preferably genotypic) characteristics that might reflect population differentiation. Until this information has been gathered, it is difficult to say much about the present status of the species in the region or the effects of hunting in neighbouring areas.

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