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DISTRIBUTION AND ABUNDANCE OF BOTTLE-NOSED DOLPHINS *TURSIOPS TRUNCATUS* (MONTAGU) IN THE SHANNON ESTUARY

Simon D. Berrow, Brian Holmes and Oliver R. Kiely

ABSTRACT

The feasibility of developing commercial whale-watching in the Shannon Estuary was investigated by determining the distribution and abundance of bottle-nosed dolphins in the estuary. A variety of field techniques were employed, including photo-identification, fixed boat transects, scan sampling, minimum number estimates and the collection of incidental sightings over an eighteen-month period. Land-based observations showed that the presence of dolphins was influenced by the state of the tide, with a peak in sightings recorded three hours after high water. Dolphins were observed on 25 (61%) of 41 boat transects surveyed, of which sixteen turned into encounters, with dolphins sometimes present for many hours. A minimum number estimate conducted on 16 October 1994 showed that at least 56–68 animals were present, and photo-identification has recognised 25 animals individually. Dolphins were often recorded in discrete areas, especially off Kilcredaun Head, Beal Bar and off Leck Point. Sighting records from the Tarbert to Killimer ferry showed that dolphins were regularly seen especially in the spring and summer (May to August), being recorded on up to 88% of days in the month. Photo-identification showed that the same dolphins were present in the estuary throughout the study period, suggesting that they were resident. This is the first known resident population of bottle-nosed dolphins in Ireland. The implications of this work for the development of commercial dolphin-watching in the estuary are discussed.

INTRODUCTION

The bottle-nosed dolphin *Tursiops truncatus* (Montagu) occurs throughout the world's temperate and tropical waters. In the north-east Atlantic they are locally common, with small populations in scattered localities, especially bays and estuaries, but the most important concentrations in Europe appear to be off the west coast of Ireland (Evans 1980). In Ireland bottle-nosed dolphins have been reported from all coasts, and although they are thought to be the second most abundant cetacean in Irish waters (Evans 1980; Fairley 1981) very little is known about their ecology. They have been seen in most months and are most frequently reported in Irish waters during July to September, though an offshore movement may occur in the winter (Evans 1991).

Whale-watching, defined by the International Whaling Commission as any commercial enterprise which provides opportunities for the public to see cetaceans in their natural habitat, was estimated worldwide in 1992 to be worth around £184.7 million (\$317.9 million) annually and, with a growth rate of 5% per annum predicted for the

current decade, it is one of the fastest-growing industries (Hoyt 1992). Traditionally commercial whale-watching has focused on the large baleen whales, which undertake predictable annual migrations, often close inshore, but in recent years whale-watching has been developed with dolphins as the target species. Whale-watching in Ireland was estimated to be worth around IR£1.25 million per annum in 1993 (Berrow 1994). The objectives of the present study were to gain information on the distribution and abundance of bottle-nosed dolphins in the Shannon Estuary and to provide advice for the development of commercial whale/dolphin-watching.

STUDY AREA

The River Shannon is Ireland's largest waterway, and its estuary divides the western seaboard at approximately 52° 30'. The main study area was in the outer estuary in the vicinity of Kilcredaun Head, Co. Clare (Fig. 1), while boat transects were carried out between Kilbaha, Co. Clare, and Foynes, Co. Kerry. Casual sighting records were

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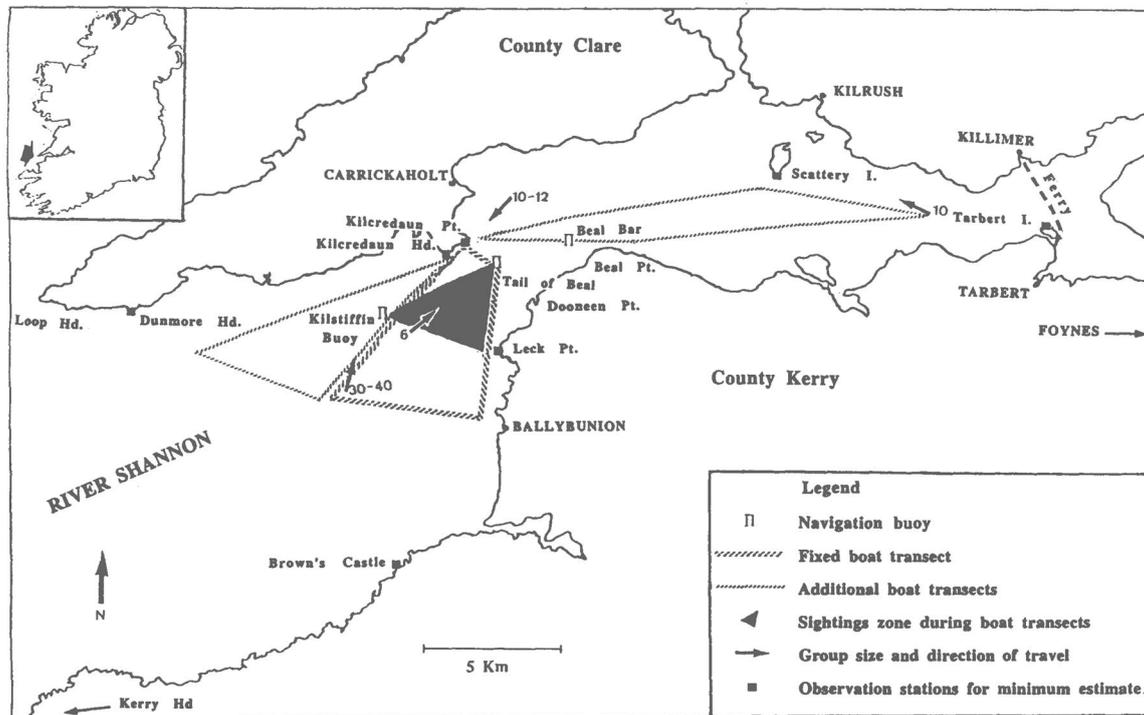


Fig. 1—Map of the study area, showing boat transects, dolphin encounter zone and observation stations used for the minimum estimate. Numbers and arrows indicate the estimated group size and direction of travel as recorded at 14.30h, 16 October 1993. (Map based on the Ordnance Survey by permission of the government.)

obtained from all parts of the river west to Loop Head, Co. Clare, and Kerry Head, Co. Kerry.

The estuary between Kilcredaun Head and Dooneen Point (Fig. 1) is only 2km wide and strong tidal currents are set up, with tidal flows rising to four knots during spring tides. The hydrography of the area is further affected by a complex bathymetry of shoals and ridges, such as Ballybunion Bank, Kilstiffin Bank and the Beal Spit. These cause localised rips and turbulent overfalls on both flood and ebb tides, particularly under Kilcredaun Head and off the Tail of Beal. This latter area is of particular interest since the sea bed drops almost vertically from 2m to 28m and is a favoured site for local anglers.

METHODS

The present study was carried out between May 1993 and November 1994. During this period a number of field techniques were employed to provide a range of data with which to address the aims of the study. Intensive land-based surveys and boat transects were complemented by more extensive methods such as opportunistic aerial coverage and casual sightings.

LAND-BASED OBSERVATIONS

Land-based observations of the estuary from Kilcredaun Head, Co. Clare, were carried out

between 5 July 1993 and 6 June 1994. To assess the influence of tidal conditions, observation samples were conducted over 24 days from 5 July to 7 August 1993 during each hour of the tidal cycle between high and low water, while samples in October (16–18) 1993, January (1), February (27–28), March (1), April (15, 30), May (2) and June (6) 1994 were carried out at a variety of times and tidal states. To sample the estuary, scans were taken every 30 minutes using a Kowa TSN-2 telescope with a $\times 20$ eyepiece. Each scan lasted approximately ten minutes. During each scan, the number and approximate sizes of any dolphins observed were recorded and assigned to an approximate location using fixed landmarks such as headlands and navigation buoys. Group size and behaviour were recorded, as well as the presence of calves.

There are many ways of defining a group or pod of cetaceans and cetacean behaviour. Long-term studies of bottle-nosed dolphins have shown that groups are highly dynamic and there can be a large interchange of individuals between groups (Scott *et al.* 1990). Definitions of a group range from, for example, 'any group of dolphins observed in apparent association, moving in the same direction and often, but not always, engaged in the same activity' (Shane 1990) to 'any aggregation of one or more dolphins' (Hansen 1990). In the present study, the definition of a group of dolphins follows Shane's (1990) definition, i.e. one or more dolphins in apparent association. The term 'group'

is not meant to imply any long-term or exclusive association. Behaviour can be defined in many different ways, and a behavioural ethogram should be compiled for each study area or population. This was not considered necessary in the present study and thus only general activities were recorded. Group behaviours were described under three categories.

- (a) Travelling: swimming steadily in one direction with regular surfacing intervals.
- (b) Foraging: individuals moving in a variety of directions relative to one another; repeated dives and surface rushes.
- (c) Others: bow-riding, tail-slapping, jumping, physical contact with other individuals, and 'playing' with objects.

BOAT TRANSECTS

In order to determine the probability of witnessing dolphin activity from a vessel in the Shannon Estuary, fixed boat transects were surveyed. Surveys were carried out from a 5.4m Avon Searider RIB with a 70hp Johnson outboard engine. Transects were executed between navigation buoys to enable a fixed course to be surveyed regularly and at a speed of approximately fifteen knots. Whenever possible a team of three surveyed from the boat, with each person assigned a sector. Port quarter surveyed from 225° to 325°, starboard quarter surveyed from 45° to 135°, and forward quarter surveyed from 325° to 45° while steering the boat.

Transects were conducted in May (2–3), June (8–10), July (10–12), August (two trips, 7–14), October (16–18) 1993 and January (29), April (30), May (1–2), June (5–6) and September (18) 1994 at various times of the day and tidal cycle. Transects were not broken if dolphins were observed, and only after the transects had been completed would the vessel attempt to approach dolphins for detailed observation and photography. The transects surveyed depended on prevailing weather conditions. During calm conditions (sea-state < 3) the route was approximately fifteen nautical miles long and took about an hour to complete. In poor weather (sea-state > 3) the transects were six nautical miles long and took around 45 minutes. Extended transects to other areas of interest in the study area (additional boat transects, Fig. 1) were occasionally surveyed.

Time, weather, sea-state and direction of travel were recorded every fifteen minutes on standardised log sheets. When dolphins were observed, the number, relative size, behaviour and duration of contact were recorded. The potential for whale-watching is greater if dolphins are near the boat for extended periods (encounter) rather than only briefly sighted (sighting). In order to

quantify this, a sighting was defined as contact of less than one minute—usually 1–5 surfacings—and an encounter as contact greater than five minutes. Once the type of contact had been defined the transect was continued.

MINIMUM NUMBER ESTIMATE

In order to get an estimate of the number of dolphins in the estuary minimum surveys were carried out. This technique was developed in the Moray Firth, Scotland (Hammond and Thompson 1991), and provides an estimation of the minimum number of dolphins in an area at any one time. An initial survey was hampered by poor visibility because of fog, but a successful survey was conducted on 16 October. Two observers were stationed at seven locations around the estuary between Brown's Castle and Tarbert, Co. Kerry, and Dunmore Head and Scatterry Island, Co. Clare (Fig. 1). Observers at Brown's Castle and Dunmore Head were equipped with ×20 telescopes, while observers at all other locations used 10 × 50 binoculars. At least one experienced observer, who was familiar with and could identify bottle-nosed dolphins, was located at each station.

Co-ordinated counts were carried out every hour from 11.30h to 16.30h. Counts were carried out during a flood tide, with low tide occurring at 12.30h. Observers marked on maps the location, number and direction of travel of all bottle-nosed dolphins observed. Whenever possible, the relative sizes of the animals in each group were recorded.

INCIDENTAL SIGHTING RECORDS

To complement and extend the dedicated fieldwork, a standardised recording form was designed and distributed to organisations and individuals throughout the Shannon Estuary for the collection of casual or incidental sighting records. An incidental sighting record is a sighting of a dolphin or group of dolphins made while the observer is carrying out other activities. An incidental sighting may be made from land, from the air, or while at sea.

Most sighting records were received from the Shannon Ferry operating between Killimer, Co. Clare, and Tarbert, Co. Kerry. Although the ferry operates up to fifteen daily sailings during the summer (1 April–30 September), with reduced sailings in the winter the vigilance of the ferry operators will be strongly influenced by many factors, including weather conditions, number of passengers and interest in the study. The sightings have thus been treated as incidental sightings. The operators also recorded days when no dolphins were seen despite their vigilance. Sightings were corrected for tidal state by expressing times as hours ± low water.

PHOTO-IDENTIFICATION

The opportunity to study many aspects of animal behaviour depends on the ability to identify individual animals. Once individual dolphins can be recognised, it is possible to determine the activity patterns of individual and specific groups of dolphins, to identify breeding and dominant animals, and to determine their home range or territory and favoured areas. Photo-identification is widely used in studies of cetaceans (Wursig and Jefferson 1990). The technique relies on the presence on the body of the animal of nicks, notches, scars or scratches which are specific to that animal and are consistent in time. By photographing a dolphin, usually around the dorsal fin, and examining the prints for these notches and marks, individual animals can be recognised and monitored.

Photo-identification of dolphins in the estuary was attempted between boat transects (see section on boat transects for dates). Photographs were taken from the survey vessel using a Canon EOS RT autofocus camera and 70–300mm lens. Film type and speed varied with weather conditions and availability. A platform constructed on the A-frame to the stern of the survey vessel greatly aided photography, providing the photographer with a 3m vantage point from which to obtain photographs. From this platform dolphins could be observed before they broke the surface of the water, which helped to predict where they would surface and thus aided photography. Dolphins readily approached the survey vessel, often swimming in the bow wave, thereby facilitating photography of the dorsal fin. Only those dolphins recognisable from photographs were recorded, as visual identification in the field is difficult and can often miss subtle markings, leading to misidentification of the individual. Each animal identified was assigned a number and catalogued, with notes made on its location and associated group composition.

RESULTS

LAND-BASED OBSERVATIONS

During the study, 312 scan samples were taken from Kilcredaun Head between 5 July and 7 August 1993 ($2 \times 12 \times 6.5 = 156$ hours) and 112 samples between 1 January and 23 June 1994 ($112/2 = 56$ hours), making a total of 212 hours of observation. No dolphins were seen from Kilcredaun Head during 1994 but they were observed in 45% of all scan samples during the July–August 1993 period.

During the July to August period, dolphins were recorded in 58% of samples made at high water and in 33% of samples made at low water. On an ebb tide the proportion of dolphin sightings

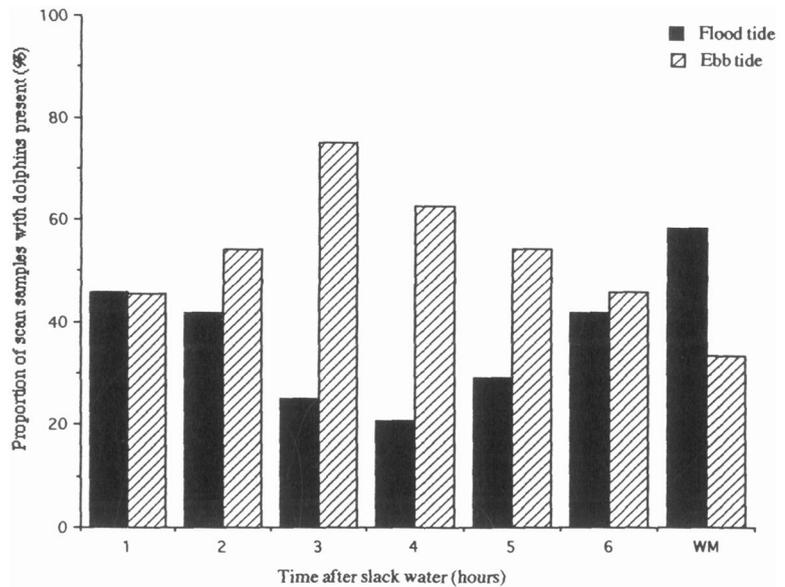


Fig. 2—Proportion of scan samples in which dolphins were observed, July–August 1993 ($n = 312$).

increased to a maximum three hours after high water, when dolphins were recorded in 75% of samples (Fig. 2). On a flood tide most sightings were recorded at high water and a minimum (21%) recorded four hours after low water. Dolphins were mainly observed off Kilcredaun Head, but also at Beal Bar and off Leck Point.

Sightings of a single group of dolphins were recorded in 71% of sighting samples, two groups in 23%, three groups in 4% and four groups in 2% of sighting samples. Although most groups consisted of 4–10 individuals, numbers ranged from one to 27 (Fig. 3). In 59% of sighting samples a group of six or more dolphins contained at least one calf, and the maximum number of calves observed was five in a group of 25 dolphins. Approximately 40 dolphins were seen from Kilcredaun Head on 24 July in different groups around the estuary.

Dolphins were observed travelling in 59% of sighting samples. Foraging behaviour was observed in 36% of sighting samples and other behaviour in 5% of sighting samples. Travelling was mainly recorded around slack water, while the frequency of foraging behaviour rose to a maximum (76%) 2–3 hours after high water and three hours (78%) after low water. Other behaviour was mainly recorded in the two hours before low water. On one occasion a dolphin was seen 'playing' with a strand of kelp *Laminaria* sp. in its mouth, and on two separate occasions individual dolphins were observed tossing fish into the air four or five times.

BOAT TRANSECTS

Forty-one transects were made during the survey period, 27 during 1993 and fourteen during

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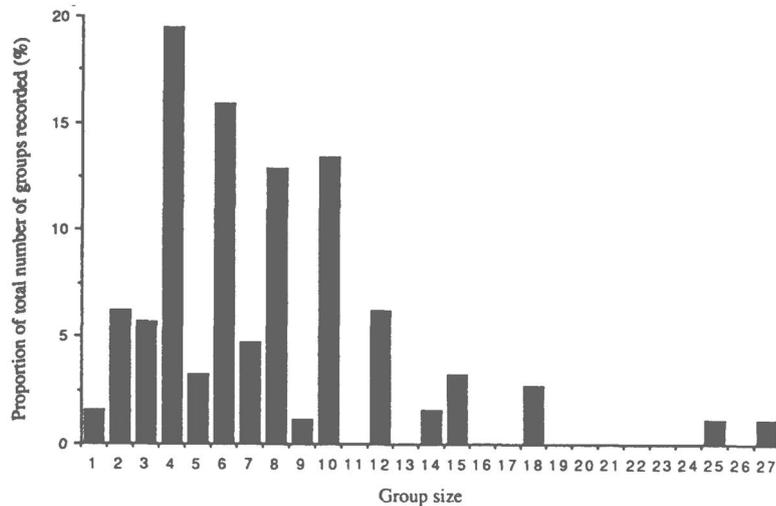


Fig. 3—Frequency distribution of group sizes observed from Kilcredaun Head, July–August 1993.

1994. Bottle-nosed dolphins were sighted on 61% of all transects. Sixteen of these 25 sightings developed into encounters, with dolphins sometimes present for many hours. Dolphin sightings during boat transects occurred anywhere in a

triangle bordered by the Tail of Beal Buoy, Kilstiffin Buoy and Leck Point (Fig. 1). Encounters took place in more restricted areas, being either at the Tail of Beal or off Leck Point. The proportion of dolphin sightings and encounters varied with the state of the tide (Table 1). The highest proportion of sightings that developed into encounters occurred at high water and the lowest on flood tide.

MINIMUM NUMBER ESTIMATE

During the minimum number estimate survey the cloud cover was less than 1:8 and sea-state ranged from 0 to 1 depending on the station. These prevailing weather conditions were favourable for the survey, with visibility across the estuary greater than 15km.

The number of dolphins recorded at each station is shown in Table 2. Bottle-nosed dolphins were recorded from four stations during the present survey. No dolphins were seen from Brown's Castle, Tarbert or Dunmore Head, although two minke whales *Balaenoptera acutorostrata* (Lacépède) were observed from Dunmore Head. Numbers varied throughout the survey period, reaching a maximum of between 56 and 68 animals at 14.30h

Table 1—Proportion of dolphin sightings and encounters during boat transects conducted in the Shannon Estuary.

State of tide	Number of transects	Number of sightings (%)	Number of encounters (%)	Number of transects with no dolphins observed
H.W. ± 1.5h	7	2(29)	4(57)	1
Ebb ± 1.5h	12	5(42)	6(50)	1
L.W. ± 1.5h	10	0	4(40)	6
Flood ± 1.5h	6	3(50)	2(33)	1

Table 2—Minimum counts of bottle-nosed dolphins in the Shannon Estuary at each observation station during minimum number estimate. (Numbers in brackets refer to animals counted by other observers and are not included in totals.)

Station	Time					
	11.30	12.30	13.30	14.30	15.30	16.30
Dunmore Head	0	0	0	0	0	0
Kilcredaun Head	30–40	30–40	(36–46)	36–46	9–13	0
Kilcredaun Point	0	6	6–8	10–12	0	0
Scattery Island	5	4	6	10	4	4
Tarbert	0	0	0	0	0	0
Leck Point	0	(30–40)	38–48	(30–40)	0	0
Brown's Castle	0	0	0	0	0	0
Total	35–45	40–50	50–52	56–68	13–17	4

(L.W. + 2 hours). The location of each group and their direction of travel at 14.30h is shown in Fig. 1. Owing to the large distance of most groups of dolphins from the observers, it was not possible to determine the relative sizes of the animals in these groups. However, at least three calves were recorded, two in a group of ten to twelve individuals visible from Kilcredaun Point and one in a group of ten individuals near Scatterry Island.

INCIDENTAL SIGHTING RECORDS

A total of 158 sighting records were received during the study period with most records (90%) received from the Shannon Ferry. From 1 June to 23 August 1993, dolphins were seen from the ferries on 53 out of 84 days (63%). Dolphins were seen regularly during June (64% of days) and July (81%), but sightings were less frequent during August (39%). Between 11 March and 30 November 1994, dolphins were observed on 88 days (33%). Sightings were scarce in March (15% of days) and April (13%), reaching a peak in May (74%) and June (63%), and decreasing through the summer (July 39%, August 32%) to a minimum in the autumn (September 10%, October 35%, November 10%). When each sighting is corrected for tidal state, most sightings were made on an ebbing tide, peaking around mid-water (Fig. 4). Most sightings were of one to six individuals, but up to twelve were seen at any one time, including a minimum of three calves.

PHOTO-IDENTIFICATION

To date, 25 dolphins have been positively identified from photographs taken during boat transects over the study period (Table 3). Some were identified from nicks in their dorsal fin and others from markings and scratches. Some other individuals do not have any distinctive markings suitable for photo-identification and are therefore unrecognisable. The proportion of recognisable dolphins in the population is not known, and those identified so far are treated as a minimum number.

Of the 25 individually recognisable dolphins, one (CN1) was recognised on seven of the eleven trips, three (CN8, CN12 and CN24) were recognised on six trips, and one (CN13) was recognised on only one trip (Table 3). It should be remembered that this does not mean that those dolphins not recognised were not present, but rather that they could not be recognised from photographs.

At least five calves were born during the survey period. Newly born calves are easily recognisable from conspicuous neonatal folds (white vertical lines) along the length of their body, small size and pale colouration. Calves tend to associate

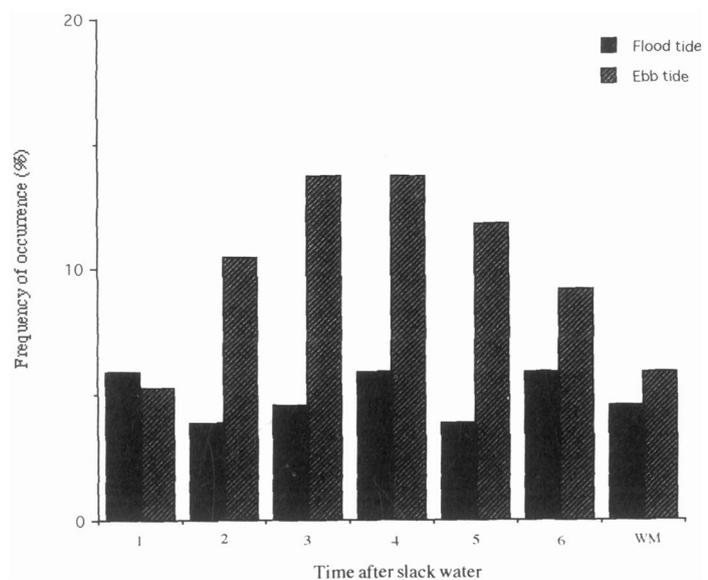


Fig. 4—Proportion of dolphin sightings made from the Shannon Ferry with respect to tide ($n = 151$).

very closely with their mothers during the first few months of life, so if an individual dolphin is observed with a newly born calf, then it can be assumed that the calf was born since the previous trip. Single calves were present during trips 3 and 10, and three were present during trip 5, suggesting that dolphins were born during June/July and September/October 1993 and June 1994.

DISCUSSION

This study was conducted to assess the distribution and abundance of dolphins in the Shannon Estuary with a view to examining the feasibility of developing commercial whale-watching in the estuary. A variety of field techniques were employed: each method of data collection has its own advantages and limitations but, providing these limitations are realised, each can contribute to a study of this kind.

Observations from land do not—or only minimally—disturb the dolphins' behaviour, unlike studies carried out from boats, which may strongly influence behaviour. Although visibility may be limited, a large area of the estuary can be surveyed from a suitable vantage point or points with the aid of a telescope. Boat-based transects and observations have a restricted horizon but have the advantage of bringing the researchers into close proximity to dolphins. This enables more detailed observation of the animals' behaviour and provides opportunities for photography. The disadvantage of incidental sighting records is that there is no indication of the degree of effort put into making the sighting, and results may reflect the distribution

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and abundance of effort rather than of animals. If sighting records are obtained throughout the study area the results can give a good qualitative indication of the distribution and abundance of dolphins in the estuary.

Bottle-nosed dolphins are one of the most suitable species for photo-identification, although the success of this technique depends on environmental factors and the opportunity to approach dolphins. Individual dolphins and groups will react differently to boats, and markings have varied longevity. Although notches and nicks are the preferred markings, a study of marks on the wild, sociable dolphin in Dingle, Co. Kerry, has shown that scratches on the dorsal fin may last for at least two years (Holmes and Berrow, unpublished), so these markings have also been used in the present study.

DISTRIBUTION

Bottle-nosed dolphins in the Shannon Estuary were readily seen from land and boats. Although

they were observed in many locations around the estuary, dolphins were more frequently recorded in discrete areas, especially off Kilcredaun Point, Beal Bar and Leck Point, and between Tarbert and Killimer.

The occurrence of bottle-nosed dolphins in an area varied throughout the day and appeared to be strongly influenced by the tidal state. At two monitored sites (Kilcredaun Head and Killimer-Tarbert) dolphins were most frequently recorded during mid-ebb tide, when the tidal current was at its strongest. Both of these areas are characterised by narrow restrictions in the estuary where any tidal influence will be enhanced. Foraging was the most frequently reported behaviour during this period, suggesting that bottle-nosed dolphins in the Shannon Estuary feed in locations with strong tidal races during periods when the tidal flow is at its strongest. Similar behaviour has been recorded for bottle-nosed dolphins from a variety of other locations (Acevedo 1991; Ballance 1992). Outside this period, dolphins were more likely to indulge in other activities, including associating with boats.

Table 3—The presence of individually recognisable bottle-nosed dolphins identified during boat transects in the Shannon Estuary.

Catalogue number	Sample trip number (see text for dates)											Individuals with calves
	1	2	3	4	5	6	7	8	9	10	11	
CN1	*	*	*	*	*					*	*	
CN2	*	*		*	*							*
CN3	*									*	*	
CN4	*	*	*		*				*	*	*	
CN5		*	*	*						*		
CN6		*	*	*	*					*		With calf (TS)
CN7		*	*	*	*					*		
CN8		*	*	*	*				*	*	*	
CN9		*	*				*			*		
CN10			*							*	*	
CN11			*	*			*	*	*	*	*	With calf (T5)
CN12		*	*	*	*					*	*	With calf (T5)
CN13				*					*			
CN14			*	*								
CN15				*						*		With calf (T10)
CN16				*	*					*		
CN17		*	*									
CN18		*		*	*					*	*	
CN19			*		*		*				*	With calf (T3)
CN20			*								*	
CN21				*			*				*	
CN22				*	*							
CN23		*	*							*		
CN24		*		*	*					*	*	
CN25			*		*					*		

ABUNDANCE

Dolphins were most frequently reported in the Shannon Estuary from May to October, although fieldwork was restricted during the winter. Weather conditions during the winter will adversely affect the observation of dolphins, but these effects are likely to be less pronounced in an estuary than in the open sea. Incidental sightings between Killimer and Tarbert increased from May to July, suggesting that dolphins were using this area more frequently during the summer. This may be associated with seasonal migration upriver of salmon *Salmo salar*, a known prey species (pers. obs.). The variation in group size reported in the estuary, often in the same day, suggests that these groups are highly fluid, typical of bottle-nosed dolphins (Scott *et al.* 1990).

The number of individually recognisable dolphins varied between visits. Residency in an area by dolphins can be defined in many different ways. Degrees of residence may be described as the number of times an animal was sighted in an area, the time between the first and last sighting, and the last re-sighting of an individual animal (Ballance 1990). From this study, it is considered that dolphins are resident in the estuary, as the same individuals recorded in May 1993 were also present in June 1994, with some individuals recorded in over half the visits during this period. This is the first published record of a resident group of bottle-nosed dolphins identified in Ireland, and the presence of young calves suggests that the Shannon Estuary is also a calving area.

DEVELOPMENT OF COMMERCIAL DOLPHIN-WATCHING

The Shannon Estuary appears to be one of the best locations to see dolphins in Ireland. The occurrence of a resident population facilitates long-term planning for tourism and investment, but also increases the potential for disturbance of the dolphins. The results from this study could help in the development and management of the industry. Whale-watching in the Shannon Estuary could be land-based, which minimises disturbance and is especially useful for people with limited mobility, or could be organised around boat-based whale-watching trips. A land-based facility at Kilcredaun Point could provide the interpretative and educational resources essential for the proper sustainable development of whale-watching. Bottle-nosed dolphins were regularly sighted from May to October, which supports the operation of boat-based whale-watching in the estuary during this period.

Development of whale-watching must consider the conservation implications. The bottle-nosed dolphin is entitled to full protection under

the Wildlife Act (1976), and Ireland is also signatory to a number of relevant international conventions. Whale-watching vessels in other countries have elicited a consistent negative reaction from dolphins (e.g. Evans *et al.* 1992), and voluntary codes of conduct have been produced.

Whale-watching is a potentially viable industry in the Shannon Estuary, especially if it is marketed in conjunction with other areas of wildlife and cultural interest.

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