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Common Dolphin, *Delphinus delphis* L., Bycatch in Bottom Set Gillnets in the Celtic Sea

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ABSTRACT

A programme to assess the marine mammal bycatch of the Irish and UK bottom set gillnet fisheries in the Celtic Sea was conducted from August 1992 to March 1994 using unpaid observers. 2,871km of net set resulted in the capture of four common dolphins and 43 harbour porpoises. The bycatch rate for common dolphins was 1.4 per 1,000km of net set. The total common dolphin bycatch of the fishery is estimated at 230 (95% CI 80-700). Bycatches appear to occur during the shooting and hauling of nets. Common dolphins were seen more often in winter and were particularly attracted to the boats during the shooting of the nets. Possibilities may exist for reducing this bycatch.

KEYWORDS: COMMON DOLPHIN; INCIDENTAL CAPTURE; FISHERIES; NORTH ATLANTIC

INTRODUCTION

In the winter of 1991-1992, 110 common dolphins, *Delphinus delphis*, stranded off southwest England, mainly along the south coast of Cornwall (Kuiken *et al.*, 1994). A peak in common dolphin strandings was also recorded along the south coast of Ireland during 1991-1992 when 23 strandings were recorded during the period January to March (Berrow and Rogan, 1997). To help investigate this the local hake gillnet fleet agreed to take observers. An observer programme using unpaid volunteer observers was funded by the European Commission and included the study of the Irish Celtic Sea hake fishery. The primary objective was to assess the rates of incidental capture of cetaceans in these fisheries and to estimate total annual bycatch. The study period was between August 1992 and March 1994. The porpoise bycatch has already been reported by Tregenza *et al.* (In press).

METHOD

The fishery

The boats studied work from Newlyn in the southwest of England and from ports between Dingle and Dunmore East in the southwest of Ireland (Fig. 1). These boats are around 20m in length and all used bottom set gillnets during the periods around neap tides in the Celtic Sea, the area of shelf waters to the southwest of the British Isles bordered by Ireland, Wales, England and France.

The target species were hake, *Merluccius merluccius*, and other whitefish such as pollack, *Pollachius virens*, and ling, *Molva molva*. Incidental capture of pelagic fish species is exceptional.

Net types

The gillnets used in this fishery are made of blue or colourless monofilament 0.75mm diameter nylon and are anchored to the sea bed. Two types are used: hake nets; and tangle nets.

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Hake nets

These have air filled plastic floats on the headline and an internally leaded footrope weighing 15 or 23kg per 220m. The stretched mesh diagonal used ranged from 100-150mm with 96% of net being 120mm mesh and 30 meshes deep (giving a maximum standing height of about 5m). A few nets were 45 or 60 meshes deep. Panels are 90m long when rigged and are made up into nets about 1,600m long. Irish boats usually set nets at dawn and started hauling in the early evening. UK boats used nets with a double footrope to create a gap of about 0.5m above the sea bed, and usually set their nets in the evening or directly after hauling. 90% of net hauling on UK boats was done between 0600hrs and 2100hrs.

Tangle nets (also called turbot or ray nets)

These were also carried by some of the boats and made up 0.7% of km of net use observed. They have very small or no headline floats and a large mesh (180-400mm). The footrope weighs 5.2 or 7.2kg per 220m. These nets lie close to the bottom and are set for two to four days to entangle benthic species such as angler fish, *Lophius piscatorius*, rays, *Raja* spp. and crawfish, *Palinurus elephas*.

Data collection

Observers recorded the location, length, type of net and the time of shooting and hauling of each net, and attempted to watch all net hauling and shooting. UK observers, with assistance from crews, also kept a continuous record, from departure to return, of changes in: sea state (corresponding to the Beaufort scale); boat activity (in transit, patrolling nets, shooting nets or hauling nets); and boat speed. They also recorded the time of dawn or dusk judged against the apparent feasibility of making sightings of distant small cetaceans, and the periods when they were making dedicated searches of the sea surface for cetaceans. UK observers kept detailed records of all cetacean sightings including a diagram of arrival, departure and movements, noting whether they were first seen by the observer or the crew. Boats generally took no special action in relation to dolphins.

Fishing effort was recorded as:

(1) kilometres of net set and kilometre.hours of net immersion; and

(2) days at sea and number of trips made with an observer - days at sea were available for the whole fleet and were used for estimation of the total bycatch.

RESULTS

Observed fishing effort

Between August 1992 and March 1994, 42 trips by UK boats and 40 trips by Irish boats were observed, amounting to 328 days at sea during which 2,871km of gillnet were hauled, 58% by UK boats and 42% by Irish boats. Total effort was 55,828km.h. 0.7% of the total length of net set was tangle net.

The seasonal distribution of observed net use was 24% in March-May, 28% in June-August, 27% in September-November and 21% in December-February. Fishing effort observed (Fig. 1) was widely distributed across the Celtic Sea with a small amount in the adjacent western English Channel and Irish Sea areas.

Soak time averaged 20 hours for all hake nets. While actually working the fishing grounds, a boat spends about two hours shooting nets and about nine hours hauling nets per day. The rest is spent travelling between or patrolling the nets.

Cetacean bycatch

In total, four common dolphins were recorded entangled. These bycatches occurred in winter between 20 October 1993 and 20 January 1994 and consisted of two at 50°56′N, 08°58′W and one each at 50°56′N, 08°35′W and 49°8′N, 06°54′W (Fig. 1). Three were caught by Irish boats, two being close together in one net, and one was alive and fell out of the net when lifted out of the water. One was caught by a UK boat.

The bycatch rate was 1.4 per 1,000km of net set or 1.2 per 100 days at sea, with a coefficient of variation of 61% (Table 1). To derive the CVs in Table 1 we have treated kilometres of net as independent sampling units, although they cannot be identified as such at sea. The two dolphins found within a few metres of each other have been ascribed to the same kilometre.

Common dolphin captures showed a possible bias towards greater sea depths (Fig. 2).

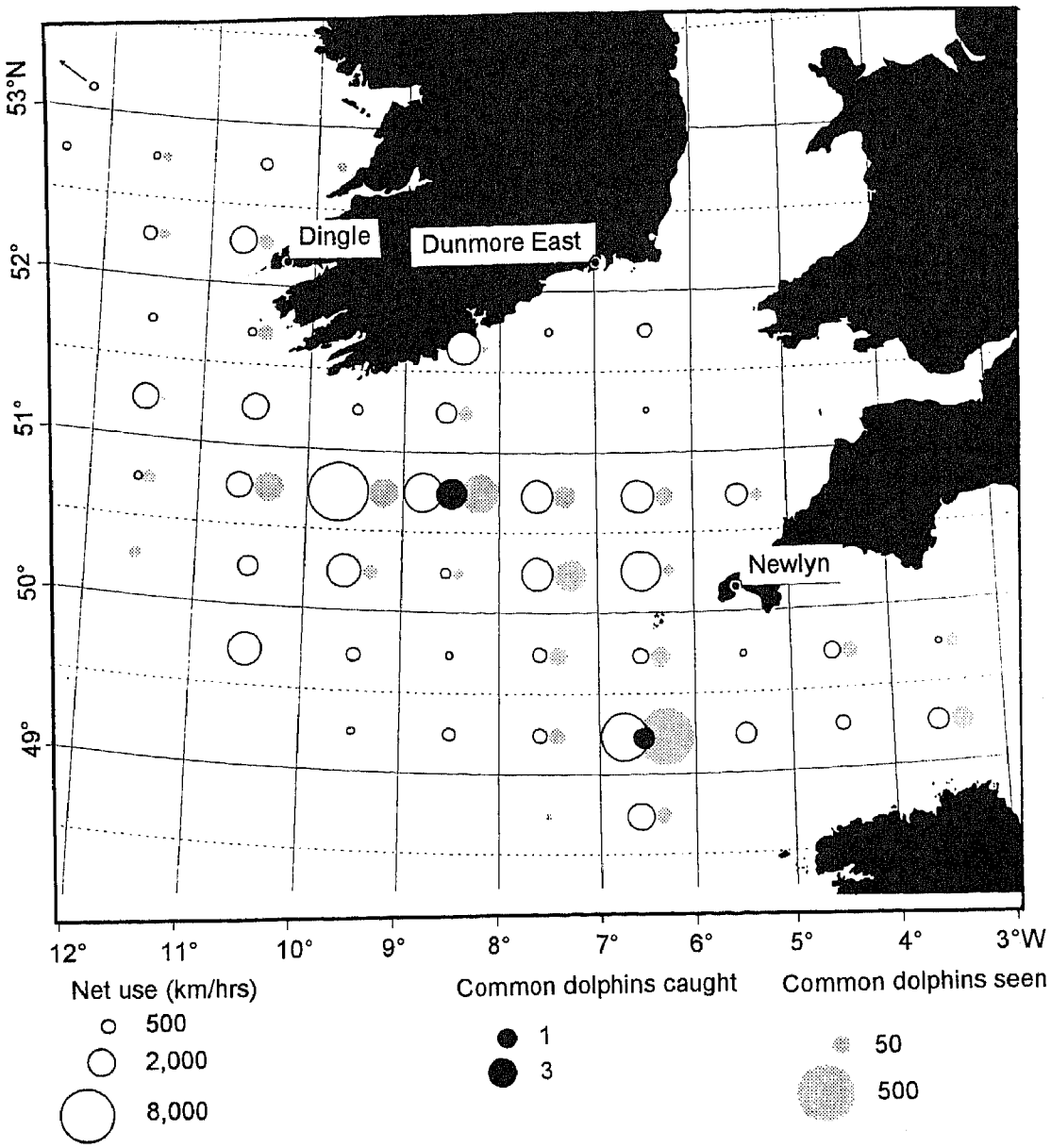

Fig. 1. Observed fishing effort and common dolphin bycatch by UK and Irish boats 1992-1994.

Table 1

Common dolphin bycatch rates in the Celtic Sea hake gillnet fishery 1992-94.

Unit of effort	Bycatch rate	CV
1,000km net set	1.39	61%
10,000km.hrs	0.72	61%
100 days at sea	1.22	61%
Trip-UK	0.024	100%
Trip-Irish	0.075	74%

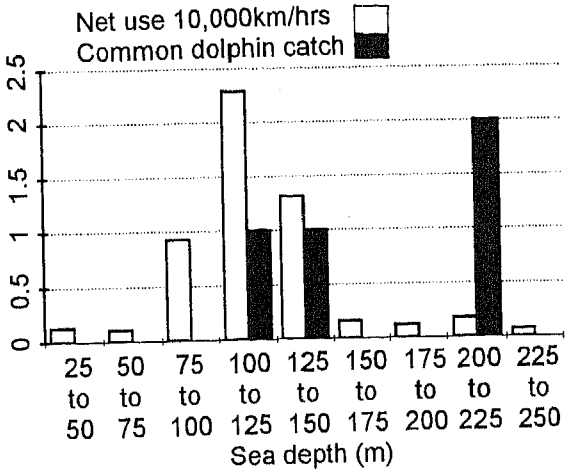

Fig. 2. Sea depths of hake nets set and common dolphins caught in the Celtic Sea 1992-94.

Cetacean prevalence in the area of the fishery

One hundred and twenty three groups of common dolphins with a mean group size of 9.4 (SE 1.1) were recorded from UK boats and 85% of these groups were first seen within 50m of the boat. Some 87% of groups approached the boat with half of these engaged in bowriding at some point. The 13% not attracted to the boat were recorded mainly when the boat was moving slowly.

Cetaceans were often seen first by the fishermen, but detection rates were 18% higher ($p<0.01$) when the observer was making a dedicated sea watch, mainly through detection of groups of dolphins that stayed only for short periods. The group sighting rate during twilight and night fell by 73% and these sightings have been excluded from further analysis. The geographical distribution of UK and Irish sightings of common dolphins is shown in Fig. 1.

Common dolphin sightings were much more frequent from September to March with a peak in November and December (Table 2, $p<0.001$ for c^2 test). This seasonal pattern was evident even though sea states were lower in summer. In summer, dolphin groups stayed around the boats for shorter periods. Mean stay in minutes and 95% confidence limits for each quarter (in parentheses) were: December-February 19 (9-29); March-May 18 (9-27); June-August 4 (1-7); September-November 32 (17-47).

Table 2

Common dolphin groups by month seen from UK hake boats in the Celtic Sea 1992-94.

Month	Daylight hours at sea	Mean groups/10hrs
January	179	0.9
February	319	0.3
March	422	0.4
April	181	0
May	77	0.1
June	258	0
July	340	0
August	309	0.2
September	280	0.3
October	208	0.6
November	194	1.1
December	9	1.1

Significantly, during the shooting of nets, dolphin groups arrived more frequently than during other activities ($p<0.05$) (Table 3).

No correlation between boat activities and the direction of approach or behaviour of dolphins was found except for instances, during hauling, of dolphins seen swimming at high speeds very close to the rising net. Sightings per mile fell progressively with increasing boat speed throughout the speed range.

Mechanism of bycatch

Three pieces of circumstantial evidence suggest that common dolphins become entangled while the net is being shot or hauled, rather than while it is set on the bottom.

(1) One of the four common dolphins was alive when the net was hauled, indicating capture during or just before hauling. This contrasts with none alive out of 46 common and striped dolphins in a recent study of tuna driftnets (Sea Mammal Research Unit, 1995), and one alive of 43 porpoises in this study (Tregenza *et al.*, In press).

(2) In two of the three bycatch events common dolphins had been seen around the boat either during or within 15 minutes of the shooting of the net in which a bycatch occurred. In addition a boat without an observer reported catching three dolphins in a net around which dolphins had played during shooting.

(3) The observed attraction of common dolphins to boats and to playing around nets makes it possible that bycatches can occur with disproportionate frequency during the relatively short period of shooting. This contrasts with harbour porpoises which showed no detectable attraction to boats.

Table 3

Common dolphin groups seen arriving during main boat activities in daylight from hake gill netters in the Celtic Sea 1992-94.

Boat activity	Typical speed range n.miles/hr	Hours observed	Dolphin groups arriving *n*	Dolphin groups arriving/10hr	*p* of *n* or greater (Poisson)
Hauling net	0-2	866	29	0.33	0.62
Patrolling	2-4	892	27	0.30	0.80
Shooting net	4-8	177	13	0.73	0.011
In transit	8-10	780	26	0.33	0.62

[1] Over 90% of time for each activity was within the speed range shown.

This may make kilometres set a more relevant measure of effort than soak time for dolphin bycatch by bottom set nets because it better reflects the time taken in shooting and hauling.

No partly eaten fish or other evidence of cetaceans feeding from the nets was seen. No stomach content analysis was undertaken. The stranded common dolphins, which had been the reason for this study, were found by Kuiken *et al.* (1994) to have pelagic species, mackerel, *Scomber scombrus*, and pilchard, *Sardina pilchardus*, in their stomachs, but may not have been representative of animals encountered in a different context.

Estimated total annual common dolphin bycatch in the Celtic Sea

UK fleet

Official statistics of days at sea by vessels in three length classes for UK registered boats using gillnets in the Celtic Sea in 1993 and 1994 were provided by the Fisheries Research Division of the Ministry of Agriculture, Fisheries and Food.

A total of 5,523 days at sea in 1993/94 for vessels > 14.9m and > 19.9m were distributed between the size classes in proportions similar to the boats observed so the data for these length classes have been pooled. Observed UK boats set an average of 7.1km of nets per day at sea, giving an estimated annual common dolphin bycatch of 54 for vessels > 14.9m (95% CI: 18-162). The confidence interval was calculated assuming that the estimate is log-normally distributed and is approximate. Seasonal stratification of UK fishing effort gives a 6% lower estimate, but with a wider confidence interval.

Vessels < 15m in length and those declaring their main gear to be tangle net are excluded from this figure. These smaller vessels work nearer to the coast and more often set tangle net. Both factors will affect their bycatch rate to an unknown extent.

Irish fleet

The Irish Department of the Marine records total set gillnet effort off the south coast of Ireland by Irish registered vessels from Dunmore East, County Wexford to Dingle and County Kerry during 1993 as 4,277 trips by vessels of over 30GRT. A small proportion were boats under 15m.

In this study, Irish boats set an average of 30km of net per trip. Using the observed bycatch rate of 1.4 per 1,000km set gives a total common dolphin bycatch for this fleet during 1993 of 180 (95% CI: 60-540). The data required for seasonal stratification were not available for Irish fishing effort.

These different approaches to extrapolation for the two fleets have been used to allow one figure for bycatch rate (dolphins per km set) to be applied to the different measures of fleet effort recorded in the UK and Ireland.

The UK and Irish figures can be combined as an estimate of 234 (95% CI: 78-702) common dolphins caught in the Celtic Sea in 1993.

DISCUSSION

Impact

Two recent surveys, overlapping along the shelf edge, have given population estimates for common dolphins. The SCANS survey of the Celtic Sea (Hammond *et al.*, 1995) in July 1994 estimated 75,500 (CV 0.67). Goujon *et al.* (1993) surveyed an area centred south and west of the Celtic Sea extending to 20°W and 43°N and estimated the population of that area as 73,800 (95% CI 36,000–151,000). The area of overlap appears to be the highest density area in both studies.

The common dolphin bycatch in the Celtic Sea gillnet fishery for hake is clearly less than 1% of the population. However northeastern Atlantic common dolphins may also suffer incidental mortality in the following fisheries.

(1) Pelagic trawl fisheries (Waring *et al.*, 1990) which are widespread along the west coast of Europe where many fish species are targeted and large strandings of common dolphins have been reported in winter by Collet and Mison (1995) and attributed to this cause by Kuiken *et al.* (1994).
(2) Fourteen UK freezer netters of 35m average overall length are believed to use 100 to 300km of tangle nets, mainly northwest of 51°N 12°W. No observation has been made for either these large vessels or for netters under 15m.
(3) French set gillnet fisheries which include about 160 boats from north Brittany using tangle or trammel nets as far north as 49°50′ and 270 using hake nets in inshore waters (Morizur *et al.*, 1992).
(4) Portuguese and Spanish gillnet fisheries. 4,100 gillnet licences exist south of 42°N (R.P. Silva, pers. comm.) in Portugal.
(5) The Biscay tuna driftnet fishery. Annual kills of around 410 by French netters were reported in 1991 and 1992 by Goujon *et al.* (1993) and kills of 60 by UK netters in 1995 (Sea Mammal Research Unit, 1995). Pelagic trawling for tuna is known also to catch dolphins in summer (Morizur *et al.*, 1996).

Strandings

The observer programme was a response to a mass mortality of common dolphins. These data support the view that the cause of these strandings was not the hake fishery.

The winter peak in common dolphin sightings reported here and the evidence from Kuiken *et al.* (1994) suggests an explanation for the highly irregular peaks of winter strandings of common dolphins in southwest England. These may arise only in years when the winter eastward movement of common dolphins on to the Celtic Shelf extends far enough to bring large numbers into the area of the pelagic trawl fisheries for mackerel, bass, pilchard and scad south of Devon and Cornwall (Morizur *et al.*, 1996). Further interannual variation may then arise from the prevalence of the winds that bring any discarded animals ashore.

Mitigation

Fishermen remarked that 'dolphins appear just when you don't want them to' - after the shooting of the nets has started. This process cannot be paused to wait for them to go away as the boat is liable to drift and wrap the net around the propeller. A possible explanation for dolphin attraction during shooting is the loud rhythmical tonal clatter of the headline floats striking the steel hoop which is used to spread the net at the stern of the boat. This possibility was indirectly supported on two occasions when deliberate hammering on the boat's hull appeared quickly to attract distant common dolphins, even at 800m range.

If further study confirmed that 'float clatter' is a significant factor in attracting dolphins to boats during net shooting, it could be reduced by installing a 'skirt' in front of the net hoop. The floats would strike this at a lower angle of incidence and slither over it, making less noise and suffering

less impact damage. Another approach would be to make repellent sounds, if such could be found, from the boat when the presence of dolphins was identified from detection of their sonar clicks during shooting.

Tangle net without headline floats would be less liable to attract dolphins but sinks very slowly when set. For these nets the risk to pelagic dolphins travelling at the surface might be reduced by using a slightly heavier footrope to speed sinking.

It appears that the particular attraction of dolphins during shooting of nets may be doubling their exposure to entanglement at the most dangerous time. Attraction may be a factor in common dolphin bycatches in many different fisheries and amenable to reduction in practical ways.

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