Bycatch and Bycatch Reduction of the Harbour Porpoise (*Phocoena phocoena*) in Danish Waters

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ABSTRACT

The harbour porpoise (*Phocoena phocoena*) is the only cetacean incidentally caught in significant numbers by the Danish fishing fleet and there is some concern that the populations in Danish waters may be in decline. The main catches are in the extensive fleet of vessels fishing dermersal gillnets. Recently, this bycatch has been quantified by a rough estimate of up to 7,000 bycaught harbour porpoises and public and political awareness of the issue is increasing. This paper reviews the Danish passive gear fishery and the level of the bycatch of harbour porpoises. Methods with potential for reducing this bycatch are briefly discussed.

KEYWORDS: NORTH ATLANTIC; BALTIC; INCIDENTAL; CAPTURE; FISHERIES; HARBOUR PORPOISE.

INTRODUCTION

The harbour porpoise (*Phocoena phocoena*) is the only cetacean that is known to be resident in Danish waters (e.g. Jensen, 1946; Clausen and Kinze, 1993). This primarily coastal species has a circumpolar distribution in the Northern Hemisphere from the Cape Verde Islands at 15°N to Thule at 78°N (Gaskin, 1984; personal observation).

Several studies have considered the status and distribution of the harbour porpoise in Danish and adjacent waters and concluded that its numbers may have declined and its distribution narrowed (e.g. Andersen, 1982; Smeenk, 1987; Clausen and Andersen, 1988). These assumptions are mostly based on information from historical catch statistics (e.g. the extensive Danish fishery up to the 2nd World War is reviewed by Kinze, In press), and scattered information from strandings and incidental sightings.

In recent years there has been increasing international interest and concern about the bycatch of small cetaceans in fishing gear (e.g. IWC, 1994a). In northern Europe, the harbour porpoise is the species most frequently caught in fishing gear and concern about the problems this may cause for the populations have been widely expressed (e.g. IWC, 1992; 1994a).

Few studies have tried to assess the magnitude of the bycatch in fishing gear, or to obtain estimates of species abundance – two factors critical to the management of the harbour porpoise. Some preliminary work has been done to attempt to find solutions to entanglements in fishing gear, but so far no commercially useful solutions have been developed.

This paper presents current information on the Danish gillnet fishery and the bycatch in fishing gear in inner Danish waters and the North Sea. The final section briefly reviews possible ways of reducing bycatches.

SUMMARY OF DANISH PASSIVE GEAR FISHERIES

This section summarises the situation of Danish fisheries in the 1990s. Information for previous years is given in Coviconsult (1988), Flintegård (1986) and Kinze (1990).

Gillnet fishery

Denmark has the largest gillnet fleet of any member state of the European Community (EC). In 1992, a total of 1,549 vessels were registered as prosecuting gillnet fisheries and 3,198 people were directly employed. The distribution of these vessels by area and as a proportion of the total number of vessels in the fleet is shown in Fig. 1. The most important species for gillnetters are (by value) cod, plaice, sole, turbot, hake, pollack and lumpsucker, with at least 30 other species of fish represented in the catches. The relative tonnage of the most important species by area is given in Table 1. The total value of the catch is at least 600 million Danish kroner (about $US100,000,000).

Gear and fishing strategies

In all gillnet fishing, the nets are constructed individually and tied together into 'strings' or 'fleets', each end of which is marked by an anchor and a buoy (IWC, 1994b). The number of nets carried by a boat and the number of nets in a string varies according to the size of the boat, the fishery, and how the net is hauled. There are approximately 50–80 nets for a vessel of 10 BRT (1 man), 100–200 nets for a vessel of 10–15 BRT (2 men) and 350–400 nets for a vessel of 20 BRT (4–5 men). The total length of the nets set by Danish gillnetters in the North Sea each day is about 5,000–10,000km. Strings vary in size depending on the fishery, but are typically 5–15 nets. In the Danish fishery, there are large numbers of both small boats operating in coastal waters that make day trips and of larger boats that work further offshore and make trips of 5 to 14 days. Operational strategies are variable depending on the particular fishery and the prevailing conditions during the day. Typically, it involves setting the net, leaving it overnight and returning the next day to haul and clean the net before resetting. This lets the net fish over two changes of tide (or two day/night changes in the Baltic where there is little tide) which is when the greatest catches occur. The exceptions to this are nets for turbot, which are left for 2–8 days before hauling, and the sole fishery, in which the soak time is often only 6 hours. Soak times are shorter during periods of high water temperature or where there are

Table 1

Danish gillnet fishery (incl. traps and lines) catch (tonnes) by area and species in 1992 (only those with a total catch of over 600 tonnes). Source: *Yearbook of Danish Fishery Statistics 1992.*

	North Sea	Skagerrak	Kattegat and Isefjord	Belts and Western Baltic	Sound and Eastern Baltic
Cod	9,849	3,796	573	2,500	7,628
Plaice	6,358	1,290	583	95	35
Sole	1,100	75	314	35	32
Turbot	682	60	35	159	81
Herring	181	0	69	238	1,336
Hake	1,056	371	6	0	0
Lumpfish	6	7	512	262	95
Pollack	476	453	14	3	1
Other species	1,823	604	991	879	1,406
Total	21,531	6,656	3,097	4,171	10,614

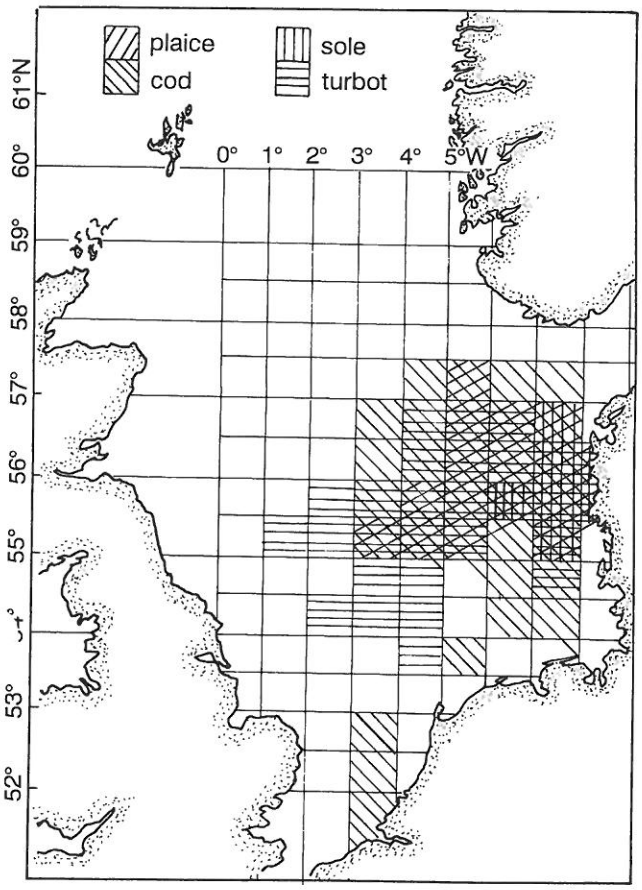

Fig. 2. Map showing areas of highest catches of cod, plaice, sole and turbot, taken by Danish gillnetters in the North Sea (based on information in Vinther, 1994). Smaller catches are taken outside these areas.

Flatfish fisheries

Turbot nets are mainly monofilament, with large mesh sizes (up to 270mm); nets are $6\frac{1}{2}$ to $10\frac{1}{2}$ meshes high. The footrope is lead cored. There is a great deal of variation in the flotation used, varying from floating polypropylene ropes to floats of the type used in the cod fishery. All Danish waters are fished, but most effort occurs in the North Sea (Fig. 2) and Western Baltic.

In the sole fishery, monofilament gillnets with mesh sizes of around 100mm are usually used. Nets are 1000 meshes long and $9\frac{1}{2}$ to $16\frac{1}{2}$ meshes high. Hanging ratios are around 30%. The footrope is lead cored and the headrope is usually polypropylene, which is sufficiently buoyant that little or no other flotation is needed. The main fishing area is off the North Sea coast of Jutland (Fig. 2). The fishery has low quotas and only takes place in the spring and early summer. About half of the fishery uses trammel nets. These nets use monofilament or multimono inner meshes of 120mm with outer meshes of 600mm and the nets are $1\frac{1}{2}$-2 outer meshes deep. Hanging ratios are about 40% of the inner net and higher for the outer. Headlines with $20gm^{-1}$ braided in floats are used.

Trammel nets account for about 90% of the plaice fishery. The nets used are similar to those used in the sole fishery, except for a slightly larger inner mesh size, about 150–170mm. The plaice fishery occurs mainly in the North Sea (Fig. 2), Skagerrak and Kattegat. The fishery is year round but location moves with migration of plaice; the peak occurs during the northward migration from April to October.

Other species

The lumpsucker fishery uses similar nets to the turbot fishery, mainly in the Kattegat, the Belts and the Sound. The fish are caught mainly for the lump caviar industry, so the fishery only occurs during spring.

The gear used in the hake fishery is similar to that used in the cod fishery, although the nets have a smaller mesh size and greater height. The fishing area is mainly off the coast of Northern Jutland during the summer.

Driftnet fishery

There are few Danish driftnet fisheries. The major fishery is the fishery for salmon in the Baltic Sea. Kinze (1990) summarised the available information. In the late 1980s, 50–70 driftnetters operated using net panels mounted to a headrope equipped with floaters. The nets are made of polyester multifilament (terylene) which (twine diameter, 0.5mm) nets of 300–350 meshes long and 40–50 meshes deep (mesh size 160mm) with no footrope or an unweighted footrope are used. Usually, some 30 nets are set in a straight line at sunset and hauled just before sunrise (maximum soak time 15 hours). A maximum of 600 nets per vessel per operation is allowed. In 1992, driftnets accounted for about half of the total Danish salmon catch (308 tonnes out of 656 tonnes), worth over 15m Danish kroner (about $US2,500,000). Herring driftnets (small mesh, 45mm) are used only in the Sound, by small vessels.

Pound nets

Pound nets used to be commonly used in Danish waters but numbers have decreased recently (Kinze, 1990). Land fixed pound nets are used in the autumn for eels. This provides the most important part of the poundnetters' income. In spring, the nets are set further offshore for herring and mackerel.

LEVELS OF BYCATCH

Gillnet fisheries

The bycatch of porpoises in the Danish fisheries has, until recently, been poorly documented, although concern was expressed as early as 1983 about the status of the stocks of harbour porpoise in the North Sea and Baltic, due to the apparently large bycatch in the Danish gillnet fisheries

bycatches is to be determined, improving our knowledge of stock structure in these waters should be accorded high priority.

Population size

Until recently, little was known about the numbers of harbour porpoises in these waters. The first quantitative work was carried out in Danish and German waters by Heide-Jorgensen *et al.* (1992; 1993). However, in July 1994, a major multi-national survey of the Baltic and North Sea area was undertaken (Anon., 1994). Although analyses of the results are not yet complete, this survey should provide a useful base for attempting to evaluate the effect of bycatches on harbour porpoise stocks.

Implications for the fishing industry

The cost to gillnet fishermen in terms of damage to gear and loss of catch caused by entanglement of marine mammals can be high; annual losses of $2,000,000 were estimated for Newfoundland, but this included damage by seals and large whales (Lien *et al.*, 1988). The losses experienced by Danish fishermen cannot be quantified from the available data but in general they do not consider the losses to be significant. The main impact on the Danish fishing industry is probably in the form of the negative publicity which is associated with the bycatch of marine mammals. Public pressure has had a major impact on fisheries around the world in terms of changed fishing practices (e.g. the tuna fishery in the eastern tropical Pacific – see IWC, 1992), closed seasons (e.g. New Zealand – Dawson, 1991a) and even complete bans (e.g. driftnetting in many areas including the North Pacific – see Nagao, 1994). All these measures may, of course lead to losses of income to the fishing industry and in some cases lead to fishermen losing their livelihood. However, it should be noted that changes in fishing gear and practices may have unforeseen ecological consequences that should be monitored, such as reducing the average length of the target fish species caught or increasing bycatches of non-marine mammal species (e.g. Joseph, 1994).

The increasing public awareness of the bycatch of harbour porpoises in gillnets in Denmark is likely to result in more pressure being put upon the fishermen to reduce this bycatch, and may result in legislation closing areas to fishing or in regulation of gear types. Current US legislation in the western North Atlantic states that the deaths of harbour porpoises must be significantly reduced towards zero in the near future (Read, 1994). One beneficial effect of this is that it has resulted in co-operation between fishermen and scientists to attempt to achieve this (Fullilove, 1994). It is important that the fishing industry, biologists and gear technologists work together to find solutions to bycatch problems which will minimise the difficulties to the industry, without losing the practical benefits of gillnets as a gear type (IWC, 1994a).

POSSIBILITIES FOR BYCATCH REDUCTION

A major difficulty in attempting to reduce cetacean bycatches is our lack of knowledge of why cetaceans become entangled (IWC, 1994a). In simple terms, it is not known if porpoises get entangled in the gear because they do not know it is there (detection) or if they do know it is there but do not perceive it as a threat (classification). Much of the early work on modifying gear relied on the trial-and-error approach, rather than an understanding of the physiology of the animals and the entanglement process.

Acoustic devices

A considerable body of work now exists that shows that cetaceans are at least theoretically able to detect gillnets acoustically (e.g. Au and Jones, 1991; Dawson, 1991b; Au, 1994; Goodson *et al.*, 1994a). At present there are two schools of thought concerning the utility of using acoustic devices (either 'passive' or 'active') to reduce cetacean bycatches (IWC, 1994a). Some authors (e.g. Dawson, 1991b; 1994) believe that this approach is unlikely to succeed, whilst others (e.g. Goodson *et al.*, 1994a; b; Hatakeyama *et al.*, 1994) believe that the approach has considerable potential. It is not appropriate to enter into this debate here but merely to note that there is some evidence from field trials that is encouraging for both acoustic enhancement of nets (Goodson *et al.*, 1994b) and the use of a commercially available buzzer (Lien *et al.*, 1994a). As yet, however, there remain problems of sample size in determining their effectiveness and in the practical deployment of modified gear in an actual fishery.

Other alterations to fishing gear

Net height

Vinther's (1994) data from the North Sea suggested that the catch rate per hour may be correlated with the net height (and hence area of mesh), but no such correlation was observed in the Gulf of Maine (Frady *et al.*, 1994). As yet the evidence is equivocal and from the fishermen's perspective, any change in the net height will only be acceptable if it is not associated with a significant reduction in the catch of the target species.

An approach which may have some potential to reduce bycatches in flatfish fisheries is to reduce the effective fishing height of the net by reducing the amount of flotation. It is known that the effective height of the net during fishing is less than the rigged height and varies due to tidal flow (Stewart, 1988). Fishermen do not consider that it is important to have great flotation on nets for flatfish (many sole nets have almost no flotation) and it is thought that these nets are effective when almost flat on the bottom due to the habits of the target species. However, it is likely that this approach would reduce catches of groundfish species.

Mesh size

All mesh sizes pose some risk to porpoises, but there is no clear evidence that different mesh sizes result in different bycatch rates (e.g. Frady *et al.*, 1994). Any change in mesh sizes will of course affect the size of fish caught and perhaps the species composition of the catch; this will probably be unacceptable to fishermen.

Hanging ratio

The hanging ratio for most demersal gillnets used in the North Sea, Baltic and in the Western Atlantic, is approximately 30–50%. The hanging ratio has an effect on whether fish are gilled or tangled in the net (more are gilled, fewer tangled with tighter hanging ratios). This is especially the case for the flatfish fisheries that use very slack nets and catch many fish by entanglement. This may be relevant to porpoises, with more tightly stretched meshes causing the porpoises to 'bounce off' the netting without getting entangled (Dawson, in Frady *et al.*, 1994). However, increasing the hanging ratio would be likely to cause a decrease in target species catch rates.

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