The Net Effect?

A review of cetacean bycatch in pelagic trawls and other fisheries in the north-east Atlantic

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A WDCS report for Greenpeace


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Executive Summary

The incidental capture, or bycatch, of non-target species such as mammals, birds, turtles, fish and other marine species in fisheries is recognised to be a major problem in many parts of the world. It has been estimated that 23% of the global fisheries catch is thrown back into the sea dead and wasted. Globally, the toll on all cetaceans (whales, dolphins and porpoises) is estimated to exceed 300,000 animals each year and bycatch is acknowledged to be a serious threat to the conservation of cetaceans in the north-east Atlantic region. However, despite evidence of thousands of dolphins and porpoises being killed each year in a variety of fisheries in this region, some at clearly unsustainable levels, there has been remarkably little policy or practical response to the issue at either national or EU level.

The cetacean species caught in the greatest numbers in the north-east Atlantic are the common dolphin and the harbour porpoise. High levels of common dolphin bycatch have been recorded in pelagic trawl fisheries such as the UK sea bass pair trawl fishery and the Irish albacore pair trawl fishery, but the limited monitoring of pelagic fisheries to date precludes an assessment of total mortality levels. However, the number and scale of pelagic trawl fisheries operating in the Celtic Sea, Biscay and Channel area, which also include large French, Dutch and Danish fleets, coupled with the number of bycaught dolphins that strand on surrounding coasts, indicate that the total annual mortality figure is in the thousands, possibly many thousands, and is probably unsustainable.

Other species caught include Atlantic white-sided dolphins, striped dolphins, long-finned pilot whales, and bottlenose dolphins. The conservation implications for these species are difficult to assess, but they may also be a cause for major concern.

The harbour porpoise is killed in high numbers in bottom-set gillnet fisheries. Observer monitoring in some areas has recorded large and unsustainable bycatch levels: some 2,200 porpoises per year in the Celtic Sea and around 8,000 per year in the North Sea. In the Baltic Sea, where the harbour porpoise population is extremely low, and affected by both bottom-set nets and driftnets, even a very low level of bycatch is critical in conservation terms.

Given all the major areas of uncertainty, it is vital that extreme precaution is applied in assessing the significance of cetacean bycatch and, in particular, in defining conservation and management objectives. It is recommended that the intermediate precautionary objective identified by ASCOBANS (the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas), *to reduce bycatches to less than 1% of the best available population estimate,* is the absolute maximum threshold that should be applied, and that targets and timeframes to reduce bycatch to below this level, and ultimately towards zero, should be adopted.

The main options currently being pursued for mitigating bycatch involve technical measures: the dolphin exclusion device that is being developed in the UK sea bass pelagic trawl fishery; and acoustic deterrent devices (pingers), developed primarily for gillnet fisheries but now also being tried in pelagic trawls. Management options include time/area restrictions, effort reduction, alternative gear types and fishery closures. Overall reduction in fishing pressure should lead to a reduction of bycatch, but to be most effective it must be targeted at those gears or fisheries with the highest bycatch rates.

EU Member States are obliged under the Habitats Directive to monitor the incidental capture of cetaceans and to take further research or conservation measures as required to ensure that it does not have a significant negative impact on the species concerned. Parties to ASCOBANS have also

identified conservation objectives and a definition of an “unacceptable” bycatch level below which they have undertaken to reduce bycatch. However, these commitments are not being fulfilled. This fact was acknowledged by the European Commission in launching a proposal in July 2003 for a new EC Regulation to address cetacean bycatch.

The Commission’s proposal consists of three main measures:

- a limit on the length of driftnets used in the Baltic Sea to 2.5 km, followed by a total prohibition by 2007;
- compulsory use of acoustic deterrent devices (pingers) in specified gillnet fisheries associated with high levels of harbour porpoise bycatch; and
- compulsory onboard observer monitoring of cetacean bycatch in specified fisheries and areas, including fisheries required to use pingers, other bottom-set net fisheries and pelagic trawl fisheries in the Celtic Sea, Biscay, Channel area.

The proposal has generally been welcomed by conservationists. However, it has also given rise to a number of concerns about the emphasis on pingers, the adequacy of proposed observer coverage levels, the lack of management objectives, targets or a management framework for bycatch reduction and, more specifically, the absence of any measures, or even stated intent, to reduce bycatch in pelagic trawl fisheries.

In conclusion, in order to address effectively the problem of cetacean bycatch in the north-east Atlantic it is proposed that:

- Precautionary management objectives must be identified, with the ultimate aim of reducing bycatch to zero.
- A management framework for bycatch reduction must be introduced at EU level at the earliest opportunity to ensure that bycatch reduction targets are identified and met.
- The proposed EC Regulation on cetacean bycatch must be tightened up and adopted as soon as possible. In particular:
  - compulsory observer monitoring, with adequate coverage, must be introduced without delay in order to assess bycatch levels in all fisheries that pose a threat to cetaceans, and the efficacy of mitigation measures;
  - any compulsory use of pingers must be time-limited and accompanied by comprehensive observer monitoring to assess efficacy of deployment and bycatch rates, investigation of any habitat exclusion effects and research into alternative mitigation and fishing methods; and
  - the proposed length restriction and subsequent prohibition of driftnets in the Baltic Sea must be introduced, with no slippage in the proposed timing.
- The European Community must act without delay to introduce measures to reduce bycatch in those pelagic trawl fisheries where levels are problematic.
- Environmental impact assessment must be conducted for new fisheries or changes in fisheries policy in order to prevent new problems from arising.

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Introduction

1.1 Bycatch worldwide

The term bycatch refers to the unintended mortality of non-target species in fisheries. The phenomenon is common and widespread, affecting an extremely wide range of species from marine mammals, sea birds and turtles to sharks and numerous other non-target fish species. The scale of this mortality is such that bycatch may affect the structure and function of marine systems at the population, community and ecosystem levels (Crowder & Murawski 1998). Indeed, bycatch is widely recognised as one of the most serious environmental impacts of modern commercial fisheries (Alverson *et al.* 1994; Dayton *et al.* 1995).

It has been estimated that 23% of the global fisheries catch is thrown back into the sea – dead and wasted. This figure includes non-target species as well as target species that cannot be landed because they are, for instance, over quota or undersized. This figure translates to some 20 million tonnes of marine life being discarded every year (Horsten & Kirkegaard 2002).

Long-lived and slow-reproducing species such as sharks, turtles and marine mammals are likely to be most vulnerable to the depletion of populations through fisheries bycatch (Read 2000). In the case of harbour porpoises, it has been agreed internationally that an annual loss of even 1% of a population should be a cause for concern that merits investigation as a matter of priority (Bjørge & Donovan 1995). Indeed there are cases, such as that of the vaquita, a small porpoise found only in the Gulf of California, Mexico, where bycatch is driving a species to extinction (D'Agrosa *et al.* 2000).

A recent study of estimated marine mammal bycatches in fisheries in the United States in the 1990s, extrapolated to figures for fishing effort worldwide, concluded that global bycatch of cetaceans (all whales, dolphins and porpoises) is likely to exceed 300,000 animals each year (Read *et al.* 2003). In addition to the large bycatches that are known and documented in some areas, the authors note that, with mortality levels on this scale, it is likely that important conservation problems exist that have not yet been identified and that bycatch is likely to be an important factor influencing the dynamics of many marine mammal populations.

Cetaceans get caught in a very wide variety of fishing gear including active towed gears such as trawls and seines, hooks and lines, passive gillnets and driftnets and even the lines of pots and creels. The significance of these different gears for cetacean bycatch varies in different areas according to the fisheries present, the distribution of cetacean species and the vulnerability of populations. However, on a global scale, the vast majority of cetacean bycatches are thought to occur in gillnet fisheries (Read *et al.* 2003).

There is a great deal that is still unknown about cetacean bycatch in fisheries, with regard to both the scale and impact of the interactions involved, and the magnitude and composition of the fishing fleets in many parts of the world (Read *et al.* 2003). Even in fisheries where the bycatch of cetaceans has been quantified, there is still a dearth of information on the nature and causes of the interactions, such as is required in order to identify effective mitigation measures or alternative fishing methods (e.g. ICES 2002).

There is now a range of technical and management measures that have been, or are being, developed to reduce cetacean bycatch levels, some of which are being applied with some success. However, it is recognised that it is seldom possible to generalise from one bycatch problem to another, and that most interactions will require a solution that reflects the particular species and fishery involved (Read 2000). Moreover, it is widely considered that effective bycatch reduction requires the establishment of an appropriate management framework to ensure that conservation objectives are identified and that appropriate action is taken to meet these (Read 2000, CEC 2002b).

1.2 Cetacean bycatch in the north-east Atlantic

Bycatch in fisheries has been acknowledged to be a major threat to the conservation of cetaceans in the north-east Atlantic region by bodies ranging from national governments to the European Commission (e.g. DEFRA 2003; ASCOBANS 2000a; CEC 2003a). It is a problem that has been known about and documented in the region for at least 20 years (e.g. Andersen & Clausen 1983; Northridge 1984), but it is only relatively recently that governments and international bodies have started to take action to investigate the problem and initiate research into its mitigation. There are still only a few examples of measures that have been actively introduced to reduce the bycatch of cetaceans in the north-east Atlantic region.

Cetacean bycatch in the north-east Atlantic, as elsewhere, affects mainly small cetaceans – i.e. dolphins, porpoises and the smaller toothed whales. Species caught in the region are primarily the harbour porpoise, common dolphin, striped dolphin, Atlantic white-sided dolphin, white-beaked dolphin, bottlenose dolphin and long-finned pilot whale (e.g. CEC 2002a). However, other larger cetaceans, such as the minke whale, are also among the victims of fisheries bycatch in the region (e.g. ASCOBANS 2003a). Chapter 2 below examines the main species affected by bycatch in more detail.

The various species have different distributions, behaviour patterns and prey preferences, which result in different levels of interaction with the various types of fishery. In general, and as would be expected, the harbour porpoise, which tends to be distributed in the shallower waters on the continental shelf and which often feeds at or near the seabed, suffers the greatest mortality in bottom-set gillnet and tangle net fisheries. The more oceanic species such as common, striped and Atlantic white-sided dolphins are caught most frequently in pelagic (i.e. mid-water) trawls and pelagic driftnets. However, some species, including the common dolphin, are known to be bycaught in a number of different types of fishing gear, even within the same sea area, which is likely to compound the impact on the affected populations (e.g. Tregenza & Collet 1998).

Attention and concern during the 1980s and early 1990s focused mainly on the issues of dolphin bycatch in pelagic driftnets and harbour porpoise bycatch in bottom-set gillnets. A series of studies revealed bycatch levels exceeding what is considered sustainable in a number of fisheries using these gears. During and since the 1990s, however, increasing concern has arisen about the level of bycatch in the pelagic trawl fisheries that operate in the north-east Atlantic. The main fisheries implicated in cetacean bycatch are examined in Chapter 3.

Although we know which fisheries are responsible for some of the bycatch in the north-east Atlantic and have, in some cases, an indication of the scale of the problem, there remain major deficiencies in the available information. These include lack of information on: bycatch rates in many fisheries, fisheries data (including effort data, location and methods used) and cetacean populations (including abundance, distribution and population structures). As a result, it remains impossible in many cases of bycatch to ascertain properly the scale of the problem and its significance in conservation terms, or to suggest appropriate mitigation measures.

A number of international bodies have attempted to establish what level of cetacean bycatch could be considered ‘sustainable’ in conservation terms. For example, the Scientific Committee of the International

Whaling Commission (IWC) considered an annual bycatch level of 1% of estimated abundance to be a threshold for concern for harbour porpoise populations (Bjørge & Donovan 1995). This figure is based on agreement that bycatch should not exceed 50% of the maximum annual growth rate of a population, estimated at between 4% and 5% for harbour porpoises (Woodley & Read 1991, Caswell *et al.* 1998), while factoring in the considerable uncertainty inherent in estimates of both bycatch and abundance. Such limits have been calculated for very few small cetacean species (CEC 2002b). The Parties to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) have adopted 1.7% of abundance as a general definition of the threshold of "unacceptable interactions" in the context of cetacean bycatch (ASCOBANS 2000b; see 5.2.2 below).

As cetaceans are predators at the top of the marine food chain, any decline in their populations could have further knock-on impacts on the health of marine ecosystems (Jackson *et al.* 2001) which, with our current state of knowledge, are almost impossible to predict. However it is reasonable to suppose that the impact of extensive bycatch of cetaceans in the north-east Atlantic will not be confined to the population levels of the cetaceans themselves but will lead to further unanticipated, and potentially profound, changes to marine ecosystems.

It should be obvious moreover that cetacean bycatch is not only a conservation issue, but also a significant animal welfare problem. The injuries sustained by bycaught dolphins and porpoises typically include bruising, muscular tearing, broken beaks, torn and severed fins and flukes and cuts and abrasions on the skin (Kuiken *et al.* 1994). Given that thousands of cetaceans are killed in this manner each year in the north-east Atlantic region, bycatch clearly also presents an ethical issue.

1.3 Current state of play

There is an obligation on EU Member States under EU law to monitor the incidental capture and killing of all cetaceans (see 5.3.2). It is now well established that the only reliable way to gather data on cetacean bycatch is through independent onboard observer schemes (Northridge 1996). Despite this, relatively few EU fisheries have been subject to thorough or routine observer monitoring. Member States are also required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned. Again, this requirement is not being fulfilled. In addition, various goals and areas for priority action on bycatch have been agreed by the Parties to ASCOBANS (see 5.2.2). Once again, these have not been achieved (ASCOBANS 2003b).

Action has been taken in the case of the cetacean bycatch in EU driftnet fisheries (see section 3.4.1). This resulted in the adoption of EU regulations during the 1990s, first limiting the length of EU driftnets (except notably in the Baltic Sea) and then prohibiting their use entirely in fisheries for tuna, including albacore and bluefin, swordfish and other specified species. However, the extent of enforcement of this prohibition is a matter of serious concern, particularly in the Mediterranean Sea.

Similar action to address other known bycatch problems has been much slower in coming. The problem of harbour porpoise bycatch in bottom-set gillnets has been well studied and documented in certain, but by no means all, fisheries in the north-east Atlantic (see 2.2.2 and 3.3). It has also been the subject of considerable research efforts around the world to establish effective mitigation measures, with some notable success (see 4.2.2). However, at present the only targeted mitigation measures being taken in this region are the requirement of acoustic deterrent devices (pingers) in one small section of Danish set net fisheries in the North Sea, and similar measures being considered by other countries such as the UK and Sweden. Latest strandings figures suggest that bycatch of harbour porpoises is still a growing problem in some areas (Sabin *et al.* 2003).

The problem of cetacean bycatch in pelagic trawls in the north-east Atlantic has been known about and documented for over a decade (e.g. Kuiken *et al.* 1994; Simmonds & Hutchinson 1994). While limited observer studies have identified some of the fisheries causing this bycatch (e.g. Morizur *et al.* 1999; Northridge 2003a; see 3.2) much of the evidence of the likely scale of the problem continues to come from strandings records (Ross 2003). In 2003 the European Commission commissioned an observer study of pelagic trawl fisheries in the north-east Atlantic with a view to identifying the fisheries responsible for cetacean bycatch (CEC 2003b). Research into mitigation of this problem is still at an early stage, although work in the UK to develop an exclusion device has shown promising first results (Northridge 2003a). In the meantime, no restrictions or other management measures have been introduced to curb what is an apparently growing bycatch problem in pelagic trawl fisheries.

Various national governments in the region have produced (Denmark) or are now producing (UK and Sweden) action plans to address the problem of cetacean bycatch (e.g. Ministry of Environment and Energy 1998; DEFRA 2003). In July 2003, the European Commission published a proposal for a Council Regulation to address cetacean bycatch (CEC 2003a; see 5.4). This proposal makes provisions to limit the length of, and subsequently prohibit, driftnets in the Baltic Sea; to require the use of pingers in specified bottom-set net fisheries; and to require compulsory onboard observer schemes in specified fisheries (including many gillnet and pelagic trawl fisheries). Negotiations on this proposal and its final adoption are likely to extend well into 2004. However, even after the enactment of this regulation, there will not be any requirement, under EU fisheries law, for management measures to be taken to prevent or reduce cetacean bycatch in pelagic trawls.

2. Cetaceans under threat

2.1 Cetacean species of the north-east Atlantic

The distribution of cetaceans in the region has been reviewed in a recent publication by the Joint Nature Conservation Committee, the *Atlas of cetacean distribution in north-west European waters* (Reid *et al.* 2003).

A number of whale species either permanently inhabit or migrate through the north-east Atlantic region. The baleen whales recorded here include humpback, minke, sei, blue and fin whales. Most of these have a fairly wide range within the region. Several toothed whales are also found in this area, including orca, sperm whale and long and short-finned pilot whales, although this latter species is rarely seen as far north as northern Europe.

A large variety of dolphin species also live in or migrate through this region. The bottlenose dolphin has a very wide distribution and can potentially be sighted around many coasts of the north-east Atlantic as far north as the Faeroe Islands. The striped dolphin occurs mainly in offshore waters, extending as far north as the southern British Isles and including all of the Mediterranean. The common dolphin is also widespread in most of the north-east Atlantic, as is the harbour porpoise. Other species include Risso's white-beaked and Atlantic white-sided dolphins.

The following sections examine in more detail the species that are thought to be most affected by fisheries bycatch.

2.2 Harbour porpoise *(Phocoena phocoena)*

2.2.1 Ecology, population and distribution

The harbour porpoise is a small cetacean that generally inhabits coastal areas and is usually found in depths of under 200m (Carwardine 2000), although it has been recorded in deep water, for example between the Faeroe Islands and Iceland (Reid *et al.* 2003).

Harbour porpoises eat a wide variety of small fish species (Read 1999). In the north-east Atlantic these are mainly small gadoids such as whiting, poor cod and Norway pout, while herring, sandeels and gobies may be important at certain times or locations (Rae 1973; Santos Vázquez 1998).

The harbour porpoise is widely distributed across the north and central North Sea with important concentrations off the west coast of Scotland, in the southern Irish Sea, and off south-western Ireland (Northridge *et al.* 1995). There is also evidence of a porpoise calving ground off the islands of Sylt, Amrum and southern Rømø, off Schleswig-Holstein, Germany (Sonntag *et al.* 1999). Variations in porpoise sightings in some areas may be indicative of seasonal movements (Reid *et al.* 2003), such as those recently reported between Danish inner waters and the North Sea (Teilmann *et al.* 2003).

The harbour porpoise is the most numerous marine mammal in north-western European shelf waters (Reid *et al.* 2003). Several surveys have been conducted in different parts of the north-east Atlantic region but the most wide-ranging to date has been the SCANS (Small Cetacean Abundance in the North Sea) survey of 1994, which focused on the distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and adjacent waters (Hammond *et al.* 1995). This produced an estimated North Sea population of around 280,000 harbour porpoises, with a further 36,000 in the Skagerrak and Belt Seas and 36,000 over the Celtic shelf between Ireland and Brittany.

During the SCANS survey no harbour porpoises were seen in the English Channel or the southern tip of the North Sea, producing an abundance estimate of zero for this area (Hammond *et al.* 1995). However, an increase in strandings of porpoises along the coasts of France and Belgium was reported in the late 1990s (Jauniaux *et al.* 2002). Whereas only five porpoise carcasses were collected between 1990 and 1996, seven were collected in 1997 alone, eight in 1998, twenty-seven in 1999 and eight in 2000. The cause of this increase is uncertain, but it may have reflected a temporary increase in the porpoise population in the southern North Sea, possibly related to the abundance of prey (Jauniaux *et al.* 2002).

Other surveys have produced estimates for northern Norwegian waters and the Barents Sea of 11,000 porpoises, and for the northern North Sea and southern Norwegian waters of 82,000 (Bjørge & Øien 1995).

An aerial survey of the Baltic Sea in 1995 produced an estimated porpoise population of 599 animals in the southern and western portions (International Council for the Exploration of the Sea, subdivisions 24 and 25 excluding the Polish coastal corridor) and 817 animals for the Keil and Mecklenburg Bights in the extreme south-western Baltic (Hiby & Lovell 1996). It is widely acknowledged that this Baltic population has suffered a major decline from historic abundance levels, assumed to have been at least several thousands, and is now in serious danger (ASCOBANS 2002).

Genetic and other studies have indicated that there are several distinct populations of harbour porpoises within the region (summarised in Kaschner 2003). For instance, the harbour porpoises of the Baltic Sea are distinct from the animals in the Skagerrak and Kattegat Seas, and porpoises in the Keil-Mecklenburg Bights are distinct from those elsewhere in the Baltic and in the North Sea. While some of the results are considered controversial, the existence of such distinct populations would indicate a greater risk of local depletion (IWC 2000).

There is little information available on population abundance and distribution for harbour porpoises in the waters of south-western Europe. The harbour porpoise was not recorded at all during 14 surveys carried out over the continental shelf of Portugal between 1987 and 1994. However, there are strandings data for Portugal which show that the vast majority of harbour porpoise strandings have occurred along the northern and central zones of the country's coast (Sequeira 1996). Strandings records for Galicia, north-west Spain, show that harbour porpoises represent 7% of total cetacean strandings (López *et al.* 2002).

2.2.2 Bycatch of harbour porpoises

Harbour porpoises are highly prone to incidental capture in bottom-set gillnets, which is thought to be explained largely by their feeding behaviour on or near the seabed. High incidences of capture have been recorded in a number of fisheries throughout their range.

Concerns over harbour porpoise bycatch in the north-east Atlantic first arose in the Danish North Sea bottom-set gillnet fisheries. Various studies have been conducted since the early 1980s (e.g. Clausen & Andersen 1988; Kinze 1994), which demonstrated that large numbers of porpoises are caught mostly in large-mesh gillnets set for cod, turbot, lumpfish and plaice. Observations during the 1990s confirmed substantial catches in the Danish gillnets, with the highest total porpoise mortality occurring in the turbot fishery (which has long nets and soak-times) but the highest rate of porpoise catch was in the cod wreck nets (i.e. gillnets set over ship-wrecks or similar objects), particularly in the third quarter of the year (Vinther 1999).

A recent revision of the estimated total porpoise bycatch in Danish bottom-set nets has been produced, based on fishing effort, in terms of days at sea, in the various fisheries (Vinther & Larsen 2002). This produced an estimated mean total catch of 5,591 porpoises per year from 1987 to 2001; a peak catch of

7,366 in 1994, reducing to a low of 3,887 porpoises in 2001. The figures provided for 2000 and 2001 are assumed to be overestimates (by 570 and 405 animals respectively) as they do not take into account effects of the mandatory use of pingers in the cod wreck-net fishery that was introduced in 2000 (Vinther & Larsen 2002). The highest annual catch figure of 7,366 represents 4.3% of the porpoise population in the relevant part of the North Sea (170,000 animals) as estimated by SCANS (Hammond *et al.* 1995).

Harbour porpoises are also caught in the North Sea by UK bottom-set gillnet and tangle-net fisheries targeting cod, sole, skate and turbot. Observer studies of these fisheries have allowed bycatch levels to be assessed for the period 1995-99, with annual catches estimated to total from 818 porpoises in 1995 to 436 animals in 1999 (CEC 2002a). While porpoise bycatch rates were found to be highest in the skate fishery, the estimated total porpoise mortality was greatest in the inshore cod fishery due to the very large fishing effort (Northridge & Hammond 1999). The decrease in bycatch levels over the study period is attributed to the decline in fishing effort (measured in days at sea).

The Celtic Sea bottom-set gillnet fishery for hake presents one of the most acute bycatch problems for harbour porpoises recorded in the north-east Atlantic. The UK and Irish set-net fisheries in the Celtic Sea were investigated using onboard observers from 1992 to 1994. This study recorded a catch of 43 porpoises, all but one of them caught in hake gillnets and one caught in a tangle net. Extrapolation to the total UK and Irish fleets produced an estimated total mortality of 2,200 harbour porpoises per year, which represents 6.2% of the estimated population in the Celtic Sea (Tregenza *et al.* 1997a).

Latest strandings figures from the UK demonstrate that harbour porpoise strandings have been steadily increasing in the UK since the beginning of the 1990s, with more marked increases in 2001 and 2002 (Sabin *et al.* 2003). In particular, there has been a general increase over this period in the number of bycaught harbour porpoises that stranded annually in south-west England. There has also been an increase in the number of porpoises reported stranded around the south-west in the winter months and into early spring. Bycaught harbour porpoises that strand in the UK typically show external signs consistent with wide-meshed monofilament-type gear (gillnets), in contrast to common dolphins which tend to have injuries consistent with smaller-meshed gear such as trawl netting. However, it is notable that many of the bycaught harbour porpoises examined in the first quarter of 2002 lacked the usual monofilament-type net marks. It is suggested that these porpoises may have been caught in smaller-mesh mobile gear (trawl nets) since they often stranded in the same areas and in a similar state of decomposition to large numbers of common dolphins that were diagnosed as having died due to bycatch (Sabin *et al.* 2003).

The Baltic Sea, where the population is already severely depleted, is an area of considerable concern for the harbour porpoise. Bycatch is considered to have played an important role not only in reducing the abundance of porpoises, but also in preventing their recovery (e.g. Berggren *et al.* 2002). Bycatches of harbour porpoises are known to have occurred in many parts of the Baltic in salmon driftnets and bottom-set gillnets (for cod and other demersal species) (ASCOBANS 2002). As the density of porpoises in the Baltic is now extremely low, the animals are only rarely seen or caught, which makes assessing bycatch rates extremely difficult. However, porpoise bycatches have been reported in recent years in Swedish driftnets, various Polish gillnet fisheries and Finnish fisheries (CEC 2002a). It has been estimated that the current minimum bycatch is seven porpoises per annum (Berggren *et al.* 2002).

It has also been calculated that in order to achieve a recovery of the population (towards the interim goal of 80% of carrying capacity) then bycatch in the surveyed portion of the Baltic must be reduced to two or fewer animals per year (ASCOBANS 2002).

In the Skagerrak and Kattegat Seas harbour porpoise bycatch is reported in Swedish and Danish gillnet fisheries. Studies of Swedish set-net fisheries targeting cod and pollack were conducted between 1995 and 1997, revealing a very high bycatch rate per fishing effort and total mortalities of more than 100 animals per year (Berggren & Carlström 1999). Harbour porpoise bycatches are reported to have declined in recent years as a result of a decline in effort in all Swedish set-net fisheries (CEC 2002a). However, effort information indicates a substantial increase in effort in Swedish gillnet fisheries operating in the Baltic and current fishing effort in the Skagerrak/Kattegat area that is only slightly lower than that reported for 1996 (CEC 2002a).

The harbour porpoise is also frequently caught in gillnets off the northern Portuguese coast, resulting in a significant number of strandings (Sequeira 1996). Systematic monitoring of marine mammal strandings between January 2000 and October 2002 recorded a total of 77 cetaceans, of which 19% were harbour porpoises. Up to 53% of harbour porpoise strandings are thought to have been the result of bycatch in beach purse seine nets, with further mortalities occurring in inshore gillnet fisheries (Ferreira *et al.* 2003). Beach purse seines are used mainly for sardines and are usually set from a small boat some distance offshore and then operated from the shore (Sequeira 1996).

In Spain, the scale of small cetacean bycatch in fisheries based in Galicia (the main fishing region in Spain has been examined from observer trips on fishing vessels, an interview survey with fishermen and a carcass recovery scheme (López *et al.* 2003). Although two harbour porpoises were handed in out of a total of 17 bycaught cetaceans recovered, no gillnetters agreed to carry observers on board their vessels. In addition, it was noted that Galician fishermen do not routinely distinguish between common dolphins and harbour porpoises, making it difficult to assess their respective catches from interview data.

Other gillnet fisheries exist in the region that have not yet been subject to observer monitoring. For instance, there is no programme established to monitor cetacean bycatch in Norwegian fisheries. However, it has been noted that harbour porpoises are caught in coastal gillnet fisheries and that this bycatch may be substantial (CEC 2002a). Therefore the figures presented represent only a minimum estimate of porpoise bycatch in the region.

2.3 Common dolphin *(Delphinus delphis)*

2.3.1 Ecology, population and distribution

The short-beaked common dolphin is the most numerous offshore cetacean species in the temperate north-east Atlantic (Reid *et al.* 2003). They are gregarious animals, frequently found in groups of dozens or even hundreds. They also frequently breach and often bow-ride.

Two population estimates have been made of separate but overlapping areas to the south-west of Britain, both looking at summer populations. The MICA survey was conducted in 1993 to assess the impact of cetacean bycatch in the French albacore tuna driftnet fishery and estimated the abundance of common dolphins in the tuna fishery area to be 62,000 (Goujon *et al.* 1993). The SCANS survey in 1994 included the Celtic Shelf and produced an estimate for this area of 75,500 common dolphins (Hammond *et al.* 1995). The two survey areas overlap along the shelf edge and Goujon (1996) suggested a total population of around 120,000 common dolphins in the two areas combined.

Off the western coasts of Britain and Ireland the species is found in continental shelf waters, such as the Celtic Sea and the western approaches to the English Channel, and off southern and western Ireland (Reid *et al.* 2003). It is frequently seen in the Sea of the Hebrides in the summer months and has been observed occasionally in the North Sea. The usual northern limit of this species' range appears to be around 60ºN.

Seasonal movements onto the continental shelf of the British Isles are reported to occur between July and October, whilst in the Bay of Biscay the species occurs throughout the year but with numbers lowest between March and May (Evans 1998). In the seas around Spain and Portugal, common dolphins occur closer to the coast than elsewhere in the region on account of the continental shelf sloping steeply near the coasts of the Iberian Peninsula (Forcada *et al.* 1990).

The diet of common dolphins comprises a wide range of small fish and squid, and the most common prey species in the north-east Atlantic appear to be pelagic schooling fish (Reid *et al.* 2003). Mackerel, sprat, pilchard, anchovy, horse mackerel (also known as 'scad'), hake, blue whiting and squid are all known to be exploited. The distribution of common dolphins is largely controlled by the distribution of their major prey species, resulting in seasonal movements following those of species such as mackerel and blue whiting (Evans 1980; Collet 1981).

2.3.2 Bycatch of common dolphins

Common dolphins are frequently recorded as the victims of fisheries bycatch in the north-east Atlantic region, both in strandings records and from observations of fisheries. They have been shown to be caught in a number of fisheries in the region, although pelagic trawls appear to present the greatest current threat to this species (see 3.2).

During the 1990s, substantial common dolphin bycatches were recorded in several studies of the albacore tuna driftnet fishery, which has now been terminated (see 3.4.1). A study was conducted in 1992 and 1993 of the French fleet, which operated in north-east Atlantic waters within and beyond the Bay of Biscay using driftnets nominally 5 km long (Goujon *et al.* 1993). This produced an estimated bycatch level by the whole French fleet of 1,700 dolphins in each of the years studied. Approximately 400 of these were common dolphins, but the majority were striped dolphins.

The UK in 1995 placed observers on its much smaller albacore driftnet fishery, operating at that time with 2.5 km long nets, producing an estimated total bycatch for the UK fleet of 165 dolphins, of which 61 were common dolphins and 104 striped dolphins (SMRU 1995). Although the total UK dolphin catch was smaller than that recorded in the French study, the rate of dolphin bycatch per 100 tuna caught was found to be almost three times greater than the French rate. This difference may be at least partially explained by the more northerly distribution of UK fishing effort (SMRU 1995).

In 1996 the Irish driftnet fishery for albacore was observed and a mean catch rate of two cetaceans per haul was recorded (Harwood *et al.* 1999). With just seven boats operating in the fishery during that year, the estimated total cetacean bycatch was 535 animals, including 134 striped dolphins and 345 common dolphins. However, in 1998 the Irish fleet had increased to 18 boats and the extrapolated annual bycatch for the whole fleet was 964 striped dolphins, 2,522 common dolphins and smaller numbers of less frequently caught species (Harwood *et al.* 1999).

The first notable peak in common dolphin strandings in the UK was recorded in 1992 when 118 dolphin carcasses came ashore in Cornwall and Devon in the first three months (Kuiken *et al.* 1994). Nearly half of the animals were positively identified as common dolphins and post-mortem examinations revealed that most of them had died as a result of incidental capture in fisheries. The injuries visible on the animals, reported as being characteristic of capture in a small-meshed net, and the fish present in the dolphins' stomachs led to the conclusion that they had died in trawl or purse seine nets used to catch mackerel or pilchard.

Recent strandings records in the UK have shown a consistent spatial and seasonal pattern for common dolphins (Sabin *et al.* 2003). In 2002, 119 common dolphins stranded, the vast majority in south-west England, and 65% of the animals examined were diagnosed as bycaught. In 2003, a total of 116 dead cetaceans (58% of them confirmed as common dolphins) were recorded stranded in the south-west of England (Cornwall, Devon and Dorset) in January alone, increasing to 131 animals by the end of March (NHM 2003). Overall strandings figures for the period from 1990 to 2002 show that over 95% of the stranded bycaught common dolphins found were in the south-west, and the majority stranded in the first three months of the year. Most of these bycaught animals are recorded as having injuries consistent with entanglement in small-meshed mobile gear (trawl netting) (Sabin *et al.* 2003).

Even more pronounced winter peaks of dolphin strandings have been recorded in France in many recent years (Tregenza & Collet 1998). At the end of February 1989 more than 600 dead dolphins stranded in just two days on the coasts of the Landes and Vendée, some freshly dead while others had been decomposing for many weeks. In 1997 a prolonged westerly storm brought 629 dead cetaceans (mostly common dolphins) ashore on the southern Breton and Biscay coasts over a three-week period in February and March. Of the animals examined, 74% showed obvious signs of incidental capture in fisheries. In 2002, more than 300 cetaceans stranded along the Atlantic coast of France, south of Brittany, in a period of 10 days (from about 20th to 30th January). By far the dominant species was the common dolphin with a few striped dolphins and very few harbour porpoises. The majority of these animals showed clear marks of bycatch (broken beaks, missing fins or flukes, body cut open, etc) (V. Ridoux, Centre de Recherche sur les Mammiféres Marins, pers.comm.).

Taking the common dolphin strandings figures for the winter period of 2002 in south-west England and in France, and making the conservative assumption that the stranded animals represent only 10% of the total mortality that occurs in fisheries, provides a very rough estimate of the likely total mortality in that year of around 4,000 dolphins (Ross 2003). This level would represent a mortality rate of somewhere between 3% and 5% of the estimated common dolphin population in the Celtic Sea/Biscay area.

During 1993-1995 observer studies were conducted in pelagic trawl fisheries operating seasonally in the area from the Bay of Biscay north to south-west Ireland and in the western approaches to the English Channel. Dolphin catches were recorded in four of the 11 fisheries studied: the Dutch horse mackerel fishery, the French hake fishery, the French albacore tuna fishery and the French sea bass fishery, although it is emphasised that zero observed bycatch in the remaining fisheries does not imply there is no bycatch in them (Morizur *et al.* 1999). The species caught were common dolphin, Atlantic white-sided dolphin and a probable bottlenose dolphin. This study made no attempt to extrapolate from the observations to a total cetacean bycatch. However, the report notes that the size of the European fleet and the amount of fishing effort mean that the total number of animals caught may be significant. It also observes that the bycatch estimate must be treated as a minimum because some fishing fleets such as the Irish west coast mackerel fishery refused to take observers on board. Also, in fisheries such as the UK mackerel and pilchard fisheries that use fish pumps to transfer the catch from the net to the boat, cetaceans would be too large to be pumped aboard and they would be flushed from the net before it was hauled and thus may go unobserved.

A Dutch observer study of the cetacean bycatch in the pelagic trawl fishery for mackerel and horse mackerel was conducted in 1992-1994 (see also 2.5.2 below). Incidental catches of cetaceans were found to be largely restricted to late winter/early spring in the area along the continental slope south-west of Ireland, with a peak in late February/early March (Couperus 1997a). The main species caught in this fishery was the Atlantic white-sided dolphin (83%) but other species caught included long-finned pilot whale, common dolphin, bottlenose dolphin and white-beaked dolphin. In 1994, a total catch of 172 dolphins was recorded by twelve Dutch and two English vessels in this fishery, but the limited data available prevented the researchers from estimating the overall extent of the bycatch problem.

This Dutch study also included observations of Dutch pelagic trawling operations in the western and northern North Sea (primarily targeting herring) and in the Channel south of Cornwall (targeting horse mackerel) (Couperus 1997a). In these areas smaller, but still significant bycatches of cetaceans were recorded, including five common dolphins, three white-beaked dolphins, five long-finned pilot whales and twenty-two unidentified dolphins (assumed to be common or white-beaked dolphins).

Further evidence of common dolphin bycatch in pelagic trawls is provided by the Irish study of the trial-use of pelagic pair trawls in the albacore tuna fishery which occurs in the summer months (BIM 2000). In 1999 observers monitored a total of 313 hauls over 160 days and recorded 145 cetaceans caught by just four pairs of trawlers. These included 127 common dolphins, the rest consisting of striped dolphins, pilot whales and Atlantic white-sided dolphins. A catch of 30 dolphins was recorded in a single haul.

In 2001 observers placed on UK pair trawlers engaged in the winter sea bass fishery in ICES area VII (mainly in the Channel) recorded a catch of 53 common dolphins in 12 tows (out of a total of 116 hauls monitored). A further eight common dolphins were taken in two tows of the 66 observed in 2002 (CEC 2002b). Monitoring was also undertaken in the UK mackerel, pilchard, blue whiting and anchovy fisheries in this area but no cetacean mortalities were recorded.

Common dolphins are also caught in bottom-set gillnets. In the study of the UK and Irish gillnet fishery for hake in the Celtic Sea (see 2.2.2 above), in addition to the bycatch of harbour porpoises, four common dolphins were recorded. This produced an estimated annual catch in this fishery of 200 common dolphins (Tregenza & Collet 1998). The dolphins were observed to arrive at the fishing boats significantly more frequently during the setting of the nets, leading to the suggestion that they may be attracted to the 'float clatter' of the gillnets as they are set (Tregenza *et al.* 1997b).

A study of cetacean bycatches in Spain, based on observer trips on fishing boats and interviews with fishermen in Galicia and Asturias, found that around 80% of bycatches are probably dolphins, consisting mainly of common dolphins and less commonly bottlenose dolphins (Aguilar 1997). Offshore trawling was identified as a major contributor to common dolphin bycatch mortality and pair trawls were considered the main cause. According to fishermen interviewed in this study, during nocturnal fishing it was rare not to catch dolphins, usually up to 10 animals but sometimes 30 or more. During 1996 and 1997 observers were present on four trips using pair trawls at night and in all cases common dolphins were caught, totalling eight individuals (Aguilar 1997).

A subsequent study of Galician fisheries in 1998-2000 used observers, carcass recovery and interviews with fishermen, and recorded six common dolphins among the 17 bycaught animals that were retrieved by skippers of fishing boats (López *et al.* 2003). Although the observers on board 67 fishing trips observed no cetacean bycatches, data collected from interviews with fishermen allowed total annual catches to be estimated. Highest bycatch rates were found to occur in offshore gillnets (estimated to total around 1,500 animals per year) and trawling in Grand Sole, off south-west Ireland (about 350 animals per year). Most of these bycatches are assumed to be common dolphins. A further 200 dolphins per annum were estimated to be bycaught in inshore gillnet fisheries and these are assumed again to be mostly common dolphins, with in addition long-finned pilot whales, bottlenose dolphins and harbour porpoises (López *et al.* 2003). The interview data collected in this study also produced references to cetaceans being used for human consumption (69 out of 500 interviewees) and use of cetaceans for bait, animal food and as a source of fat was also mentioned (López *et al.* 2003).

Records of common dolphin strandings in Portugal between 1975 and 1998 have been analysed, revealing that up to 44% of the animals may have died as a result of fisheries interactions. Gillnet fisheries were responsible for 67% of these mortalities, while beach seine nets and trawling operations killed 11% and 9% respectively (Silva & Sequeira 2003).

2.4 Striped dolphin *(Stenella coeruleoalba)*

2.4.1 Ecology, population and distribution

In some parts of the world, striped dolphins occur in groups of hundreds or even thousands of individuals. In continental European waters, group sizes of 6-60 are most common, whereas in British and Irish waters sightings are generally of groups of less than 10 individuals and often in mixed schools with common dolphins (Reid *et al.* 2003). Groups of striped dolphins can show segregation by age, and there is also evidence of segregation of the sexes outwith the breeding season.

The striped dolphin is a largely oceanic species, tending to occur well beyond the continental shelf in depths of 1000 m or more, although it has been recorded in waters of 60 m depth or less (Forcada *et al.* 1990). In the north-east Atlantic, the species mainly occurs offshore west of the Iberian Peninsula and France, and in the Bay of Biscay (Forcada *et al.* 1990). The striped dolphin occurs rarely in UK waters, but can be seen in the south-west Channel approaches and off southern Ireland. Occasional sightings and strandings come from as far north as Shetland, and even the Faeroe Islands, Iceland and Norway (Reid *et al.* 2003). The species was noted for the first time in Norwegian waters in the period from 1986 to 1999. The appearance of striped dolphins in these waters has been attributed to an increase in sea temperature (Isaksen & Syvertsen 2002) and it has been suggested that this species may occur in this area throughout the year in small numbers, but is more likely to strand or die between January and March, the coldest time of the year (see also Bloch *et al.* 1996).

The only population estimate for striped dolphins in the north-east Atlantic is derived from the MICA survey (see also 2.3.1 above). This produced an estimated abundance of about 74,000 animals for an area extending south-west of Ireland to France and north-west Spain (excluding the Bay of Biscay) and westwards to 20º W (Goujon *et al.* 1993).

Striped dolphins in the north-east Atlantic feed on a variety of small pelagic and benthic fish, including sprat, blue whiting, silvery pout, hake, horse mackerel, bogue, anchovy and gobies. Squid and crustaceans are also frequently taken (e.g. Desportes 1985; Santos Vázquez 1998). Surveys in the western Mediterranean indicate the striped dolphins may feed along the shelf edge at night and move offshore during the day (Gannier & David 1997).

2.4.2 Bycatch of striped dolphins

Striped dolphins do not appear to be attracted to vessels to the same extent as common dolphins (Reid *et al.* 2003). However, there is evidence of their entanglement in a number of fishing operations.

In the 1990s several studies were made of bycatch in the driftnet fishery for albacore tuna in the north-east Atlantic which occurs in the summer months (see also 2.3.2 above). Substantial catches of striped dolphins were recorded in the French driftnet fleet in 1992 and 1993. This fleet operated in north-east Atlantic waters within and beyond the Bay of Biscay using driftnets nominally 5 km long, producing an estimated bycatch by the whole fleet of almost 1200 striped dolphins a year (of a total of 1,700 cetaceans taken) (Goujon *et al.* 1993). This bycatch rate was deemed to be unsustainable (Woodley 1993; CEC 1993). Use of a demographic model for striped dolphins indicated that the population can only sustain incidental mortalities of up to about 1% per year (Woodley 1993). This compares with estimated mortality rates of 1.62% and 1.56% of the population for the years 1992 and 1993 respectively in the French driftnet fishery alone (Goujon *et al.* 1993)

Observation of the UK's much smaller albacore driftnet fishery (using 2.5 km long nets) in 1995 resulted in an estimate of total bycatch for the UK fleet of 165 dolphins, of which 104 were striped dolphins and the rest common dolphins (SMRU 1995). Subsequent results from observations of the Irish albacore driftnet fishery demonstrated an even higher cetacean bycatch rate, and produced an estimated total bycatch of 535 cetaceans (including 134 striped dolphins) in the fishery in 1996 (Harwood *et al.* 1999). The extrapolated bycatch figure for 1998, when the number of vessels in the Irish fishery had increased, was 3,754 (including 964 striped dolphins). Largely as a result of the cetacean bycatch, the decision was made in 1998 to prohibit of the use of driftnets in the albacore and similar fisheries, a prohibition which came into force in January 2002 (see also 3.4.1).

Bycatch of striped dolphins has also been recorded in the Irish pelagic pair trawl fishery for albacore tuna, which ironically was introduced to replace the prohibited driftnet fishery (see also 2.3.2 above). This fishery also occurs in the summer months. A study of the trial fishery in 1999 monitored a total of 313 hauls over 160 days by four pairs of trawlers and recorded a bycatch of 145 cetaceans, eight of which were striped dolphins (the majority being common dolphins) (BIM 2000).

2.5 Atlantic white-sided dolphin *(Lagenorhynchus acutus)*

2.5.1 Ecology, population and distribution

Atlantic white-sided dolphins are very gregarious animals and frequently mix with other cetacean species, particularly white-beaked dolphins, and sometimes bottlenose and common dolphins and larger whale species. The species sometimes gathers in very large groups of up to 1,000 individuals, within which smaller subgroups of some 2-15 animals can often be distinguished (Reid *et al.* 2003).

Distribution of the Atlantic white-sided dolphin is limited to the temperate and sub-Arctic seas of the north Atlantic. In the north-east Atlantic it occurs from Iceland, southern Svalbard and the Barents Sea, south to the Bay of Biscay and occasionally to Portugal, the western Mediterranean and the Azores. The species is rare in the Irish Sea, the Channel, the southern and German bights of the North Sea and the Kattegat, Skaggerak and Belt Seas, although groups have been recorded in these waters. There is only one record from the Baltic Sea (Reid *et al.* 2003).

The preferred habitat of white-sided dolphins is cool waters (7-12°C), particularly seaward or along the edges of continental shelves, and they may also be numerous in much deeper oceanic waters (Leopold & Couperus 1995). Large numbers of the species have been reported in the Celtic Sea and off south-west Ireland.

Population estimates for the white-sided dolphin in this region are difficult to obtain, largely because of confusion with the white-beaked dolphin during sightings surveys (Hammond *et al.* 1995). However, an estimate of 21,000 animals has been made for the Faeroese-Shetland channel in 1998 (Macleod 2001).

Little is known of the seasonal movements of this species (Reid *et al.* 2003). They are found in deep waters around the north of Scotland throughout the year and are thought to enter the North Sea mainly in summer. The dolphins appear to move into the waters south-west of Ireland to feed on the mackerel that migrate southwards to spawn there in February and March (Couperus 1997a). Indeed it is speculated that the animals observed south-west of Ireland at this time must come from deeper, westward offshore Atlantic waters as white-sided dolphins are not caught by the trawlers that exploit the mackerel further north earlier in the year.

The diet of white-sided dolphins includes a wide variety of fish including blue whiting, whiting, cod, hake, herring, silvery pout, lantern fishes, pearlsides, mackerel, horse mackerel, salmonids and squid (Reid *et al.* 2003).

2.5.2 Bycatch of Atlantic white-sided dolphins

Catches of Atlantic white-sided dolphins have been recorded in a number of fisheries in the north-east Atlantic. These include the Irish driftnet fishery and the Irish pelagic pair trawl fishery for albacore tuna (CEC 2002a; BIM 2000; see 2.3.2 and 2.4.2). In both these cases, white-sided dolphins constitute a very small proportion of the total cetacean catch (1 animal out of 253 cetaceans observed caught in the driftnet fishery; and 2 out of 145 cetaceans observed caught in the pelagic pair trawls).

However, a large bycatch of this species has been reported in the Dutch pelagic trawl fishery for mackerel and horse mackerel that occurs south-west of Ireland (Couperus 1997a) (see also 2.3.2). A study of bycatch was conducted in 1992-1994, with observers placed on board five Dutch freezer trawlers (covering about 5% of the annual effort in the fishery) and subsequent voluntary reporting of bycatch by skippers. Although the mackerel fishery follows the movements of mackerel southwards broadly from northern North Sea/Norwegian waters to the south-west of Ireland during the winter season, the vast majority of cetacean catches (89%) occurred along the continental shelf south-west of Ireland. The main species caught in this fishing area was the Atlantic white-sided dolphin (83%) but other species caught included long-finned pilot whale, common dolphin, bottlenose dolphin and white-beaked dolphin. Cetacean bycatches were largely restricted to late winter/early spring, with a peak in late February/early March (Couperus 1997a). The bycatch rate was also found to vary considerably from year to year. In 1994, a much higher bycatch level was recorded than in 1993, with a total catch of 172 dolphins reported by twelve Dutch and two English vessels in this fishery. However, the limited data available prevented the researchers from estimating the overall extent of the bycatch problem.

Studies of the stomach contents of dolphins bycaught in this fishery showed that nearly all the white-sided dolphins had been feeding very recently on mackerel (Couperus 1997a). However, none of the white-sided dolphins were found to contain any remains of horse mackerel, although some of the common and bottlenose dolphins did. Older remains indicated that the white-sided dolphins had previously been feeding on other species, mainly silvery pout, lanternfishes and pearlsides, which suggests that the animals had been feeding in deeper waters before they started to prey on mackerel in the vicinity of the trawlers (Couperus 1997a).

2.6 Bottlenose dolphin *(Tursiops truncatus)*

2.6.1 Ecology, population and distribution

The bottlenose dolphin is a social animal, commonly found in groups of 2-25 and occasionally low hundreds of animals. These dolphins often display breaching, somersaults and tail slapping and frequently bow-ride vessels. They are commonly observed with pilot whales in offshore habitats and also associate with white-beaked, Atlantic white-sided, common and Risso’s dolphins and occasionally larger whales.

The bottlenose dolphin has a worldwide distribution in tropical and temperate seas, occurring in all oceans and in habitats ranging from shallow estuaries and bays to the continental shelf edge and beyond into deep oceanic waters (Reid *et al.* 2003). In coastal waters, the species often favours river estuaries, headlands and sandbanks, where there is uneven bottom relief and/or strong tidal currents (e.g. Lewis & Evans 1993).

In the eastern north Atlantic the species has been recorded as far north as northern Norway and Iceland (Wells & Scott 1999). Bottlenose dolphins are locally common in the inshore waters of Spain, Portugal, north-west France, western Ireland, the Irish Sea (particularly Cardigan Bay), and north-east Scotland (particularly the Moray Firth). Smaller numbers occur in the Channel, particularly the western portion. The species also occurs around the Faeroe Islands (Reid *et al.* 2003).

Overall population estimates do not exist for the bottlenose dolphin in the north-east Atlantic. The resident population in the Moray Firth, Scotland, has been estimated to be around 130 individuals (Wilson *et al.* 1997), although it has been calculated that this may be declining by more than 5% per year (Sanders-Reed *et al.* 1999). The population in Cardigan Bay, Wales, has been variously estimated at between 130 and 350 individuals (Lewis 1992; Arnold *et al.* 1997). An estimated 115 dolphins inhabit the Shannon Estuary, Ireland (Ingram *et al.* 1999). A photo-identification project in the Channel has catalogued 85 individuals from UK and north-western French waters (Liret *et al.* 1998).

The largest numbers have been seen off western Ireland and in the vicinity of the shelf break south-west of Ireland, towards the French coast (Reid *et al.* 2003). However, the species also occurs further offshore in deep waters of the North Atlantic.

In the English Channel, groups around the French coast appear to be very stable, whereas those along the southern English coast are wider-ranging and may make seasonal movements, moving eastwards from Cornwall towards Sussex during the spring and summer (Evans 1992; Williams *et al.* 1996). Seasonal distribution of bottlenose dolphins in this area has been linked to the distribution of both fish and chlorophyll (Sykes *et al.* 2003).

Bottlenose dolphins are also common along coastlines further south. For example, the Sado estuary area of Portugal has a year-round population (Sequeira & Texeira 1990). Further offshore, bottlenose dolphins have often been sighted near deep underwater canyons, which are nutrient-rich and are reported to be particularly important feeding grounds (Sequeira & Texeira 1990).

Bottlenose dolphins take a wide variety of benthic and pelagic fish species as well as cephalopods and shellfish (Reid *et al.* 2003). Records from European animals include haddock, cod, hake, saithe, eels, blue whiting, mullet, silvery pout, sea bass, salmon, trout, sprat and sandeels among its many dietary preferences. These feeding habits are adaptable and the dolphins may feed alone or cooperatively in groups, herding fish and trapping them against the water surface, shoreline or tidal interface.

2.6.2 Bycatch of bottlenose dolphins

Bottlenose dolphin bycatches have been recorded, albeit at low levels, in a number of the fisheries already described.

For instance, bottlenose dolphins were caught in the Dutch pelagic trawl fishery for mackerel and horse mackerel south-west of Ireland, constituting 1.5% of the recorded cetacean catch incidents (the majority being Atlantic white-sided dolphins) (Couperus 1997a; see 2.5.2). Bottlenose dolphins were also included in the list of cetacean species caught in the French driftnet fishery for albacore tuna, the majority being striped and common dolphins (Goujon *et al.* 1993; see 2.3.2). In addition, a large dolphin, thought to be a bottlenose dolphin, was reported as bycaught in the study of the French pelagic pair trawl fishery for tuna in 1994 (Morizur *et al.* 1999; see 2.3.2).

The carcass recovery scheme operated in Galicia, Spain in 1998 and 1999 resulted in the retrieval of two bottlenose dolphins out of seventeen bycaught cetaceans that were handed in (López *et al.* 2003). Data from interviews with the fishermen suggested an estimated bycatch by the Galician fleet of 65 bottlenose dolphins (out of a total of 2,000 cetaceans). The majority of bottlenose dolphin catches were reported in gillnet fisheries in inshore (24 animals) and offshore (20 animals) waters off Galicia, with fewer animals (12) reported caught in the trawl fisheries operated in Grand Sole, off southern Ireland.

Cetacean bycatch has been documented in the pole and line tuna fishery in the Azores that targets five tuna species, primarily bigeye and skipjack but also albacore, yellowfin and bluefin (Silva *et al.* 2002). From 1998 to 2000, 49 dolphins were recorded hooked in 44 fishing events (out of 6,554 events observed). Common dolphins were involved in 36 of these incidents, striped dolphins in eight and bottlenose in one. For the tuna fishery as a whole it was estimated that 38 dolphins of all species were caught in 1998, 55 in 1999, and 16 in 2000. Although all the animals caught were released alive (by cutting the fishing line), it was impossible to know if they survived the event or if injuries caused their deaths after release.

2.7 Long-finned pilot whale *(Globicephala melas)*

2.7.1 Ecology, population and distribution

The long-finned pilot whale is one of the largest dolphins (despite its name) and can be difficult to distinguish from the short-finned pilot whale. However, as the latter is generally a tropical and warm-temperate species, the pilot whales seen in more northerly north-east Atlantic waters are more likely to be the long-finned species (Reid *et al.* 2003).

Pilot whales usually occur in large pods, with a mean pod size of about 20 animals recorded in surveys in the north-east Atlantic. Large aggregations of up to 1,000 animals have been observed offshore west of the British Isles during April (Evans 1992), which coincides with the start of the peak mating season (Desportes *et al.* 1993).

Long-finned pilot whales occur in temperate and sub-Arctic regions, mainly in deep-water habitat. Surveys in the northern and north-eastern North Atlantic in 1987 and 1989 indicate that their core range is deep water south-west of the Faeroes and south and west of Iceland. The species also occurs in the Bay of Biscay south to the Iberian Peninsula (Reid *et al.* 2003). Long-finned pilot whales are recorded in high numbers to the north of Scotland and south-east of the Faeroes as well as along the continental shelf edge from southern Ireland south to the Bay of Biscay, with most records from waters deeper than 200 m.

Although little seasonality has been observed in their distribution, a peak of long-finned pilot whale sightings has been reported in the south-west English Channel and North Sea between November and January, when pods were frequently seen near vessels fishing for mackerel (Evans 1980). The species' distribution has also been linked to its preferred prey of squid. Other species recorded in its diet include mid-water shoaling fish species such as blue whiting and greater argentine, and crustaceans (Reid *et al.* 2003).

2.7.2 Bycatch of long-finned pilot whales

The incidental capture of long-finned pilot whales has been recorded in a number of the fisheries already described.

Records from the Dutch pelagic trawl fishery for mackerel and horse mackerel during 1989-94 include the capture of nineteen long-finned pilot whales off south-west Ireland and a further five in other areas (North Sea and Channel). Bycatches of long-finned pilot whales constituted 12% of all the recorded bycatch events in these fisheries, the majority involving white-sided dolphins (Couperus 1997a; see also 2.5.2).

The study of the Irish pair trawl fishery for albacore tuna in 1999 recorded 8 pilot whales caught (out of 145 cetaceans, mainly common dolphins) during 313 hauls (BIM 2000; see also 2.3.2).

Two bycaught long-finned pilot whales were handed in during the Spanish carcass recovery scheme operated in 1998-99, out of 17 retrieved animals (López *et al.* 2003). Based on interview data from fishermen, about 100 long-finned pilot whales were estimated to be caught per year in Galician fisheries, some 80% of these in gillnets. A few were also reported as being bycaught in Spanish trawl fisheries operating in Grand Sole off south-west Ireland (see 2.3.2).

3. Fisheries associated with Bycatch

3.1 Overview

The use of almost any kind of fishing gear can be associated with bycatch (Alverson *et al.* 1994) and this generality is equally true for cetacean bycatch, which has been recorded in a surprising diversity of fishing operations. While many fisheries in the north-east Atlantic region have yet to be subjected to observer monitoring, bycatch of cetaceans has been identified or is suspected in fisheries that can be broadly characterised as: towed gears, including pelagic (mid-water) trawls and to a lesser extent purse-seines and demersal (bottom) trawls; and passive gears, primarily bottom-set gillnets but also driftnets and tangle nets. Entanglement of cetaceans has also been recorded in trap fisheries such as herring weirs, and in the lines of pots and creels. Cetaceans are even known to be caught in some hook and line fisheries. Lost or discarded fishing gear (ghost netting) is also assumed to be responsible for cetacean deaths.

Fisheries known or suspected to be associated with cetacean bycatch are very diverse and as many vessels in the north-east Atlantic region use mixed gear types and can target a range of fish species, it can be problematic to assess the scale and cause of bycatch problems.

Although all EU Member States are obliged under the Habitats Directive to establish a system to monitor the incidental capture and killing of cetaceans (see 5.3.2) this requirement has not been widely fulfilled. It is generally accepted that the only reliable method to estimate cetacean bycatch rates involves the use of independent observations of fishing activity (Northridge 1996). However, there are acknowledged difficulties with observer schemes. For instance, certain fisheries are more difficult to observe than others, and small boats may not have sufficient space to carry an observer. Nevertheless, there are ways to get round these difficulties, such as observation from a nearby platform or patrol vessel, or by sampling only the larger vessels in the fleet where they fish in the same manner and area as the smaller ones (CEC 2002a). It is also important to note that observer schemes can only ever provide a minimum estimate of bycatch, as even the most vigilant observer will miss some bycatches, bycaught animals can fall out of the net while it is being hauled in, and hauling of nets frequently occurs at night.

Observational bycatch data are only useful for estimating total bycatch levels where there is an adequate measure of the activity levels of the total fleet, using comparable data (CEC 2002a). For instance, if bycatch rates are recorded as bycatches per length of net per hour of fishing time, extrapolation to the whole fleet requires full data on length of nets used and duration of sets (soak-time).

For many fisheries there is insufficient collection of data on fishing effort and gear used to be able either to devise appropriate observation schemes or to extrapolate the data collected to obtain a total figure. In some cases, total bycatch estimates have had to be derived using the weight of landed catch as an index of fishing effort. While catch landings are very widely recorded, they provide a poor measure of fishing effort, because underreporting can occur and also because fish catches per unit of fishing effort vary, especially with the size of the target fish stock (CEC 2002a). Equally, days at sea is a standard measure of fishing activity, but can represent a very different amount of fishing activity for vessels of different sizes or using different sized nets.

It is clearly critical that, where bycatch monitoring occurs, fleet effort records be made available for the estimation of total bycatch. This is frequently not the case. For instance, in EU fisheries, logbook data, which typically record measures of fishing effort as well as catches, are maintained solely for enforcement purposes and are often not made available for assessment of fisheries (CEC 2002a).

In addition, in most European waters, logbook recording requirements only apply to boats over 10 m, and at present data collection requirements do not include those for assessing environmental impacts.

Based on experience from existing and previous observer monitoring schemes, advisers to the European Commission have recommended that an initial sampling level of 5-10% of the total, annual fleet effort is necessary in most fisheries to determine the approximate level of bycatch (CEC 2002b). Higher levels than this are recommended in areas where there are known problems of cetacean bycatch. In particular, observer coverage in the pelagic trawl fisheries in the Biscay, Celtic Sea and Channel area is recommended to be “as high as feasible” during December to March when mass strandings of bycaught dolphins occur (CEC 2002b). Clearly, the more observation is conducted, the more precise the estimate of total bycatch will be (as long as there are adequate data on the fishing effort).

Where observation schemes are not in place, records of stranded animals, where they have been subject to post-mortem examination, can be used to identify the existence of a bycatch problem in an area. However, strandings data cannot provide any more than an absolute minimum level of bycatch, as the rate at which bycaught and discarded animals are washed ashore is highly variable and unpredictable (CEC 2002a).

Details of injuries of stranded bycaught animals can, though, provide an indication of the type of fishery responsible, for instance whether large-mesh monofilament net or small-mesh trawl-type netting was involved (Sabin *et al.* 2003). In addition, analyses of stomach contents of bycaught animals may show which fish the cetaceans were feeding on when or immediately before they were caught, which may again give an indication of the fishery responsible (e.g. Kuiken *et al.* 1994). Details of carcasses that are retrieved by onboard observers, such as body temperature, can also provide useful information as to how and when the animals were killed (e.g. Morizur *et al.* 1999).

The following section describes in some detail the main pelagic trawl fisheries, and outlines other key fishing types, where data are available, that are known or suspected to be associated with cetacean bycatch in the north-east Atlantic.

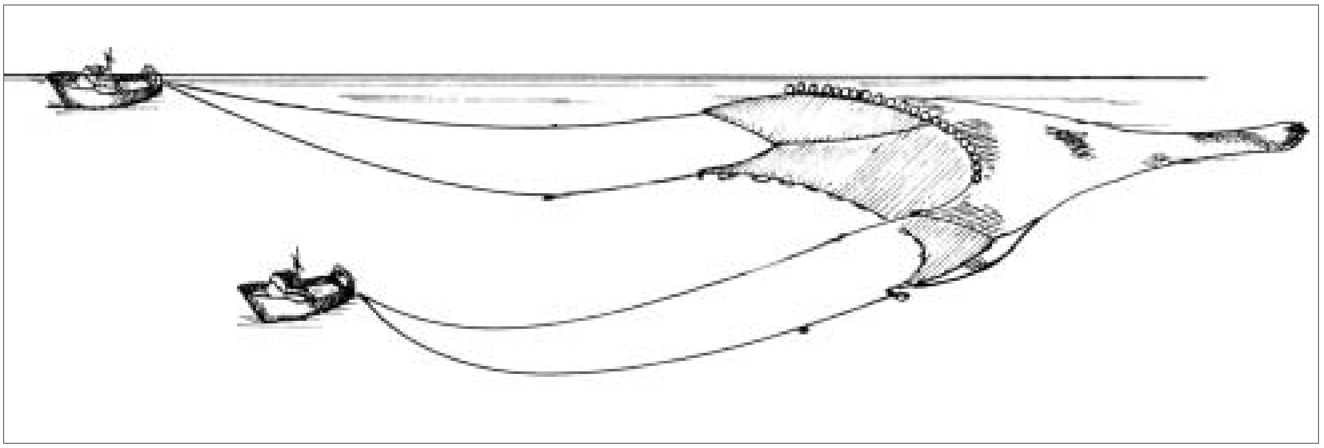
Much of the information presented is the result of extremely limited observer programmes. Until comprehensive observer data is available and analysed, the true extent of the cetacean bycatch problem will not be apparent. However, from the limited data available in the following sections, there is clear cause for concern.

3.2 Pelagic trawls

Pelagic or mid-water trawling involves the towing of a trawl net, which is essentially a bag net with a very wide mouth that gradually tapers to a narrow tube known as the extension piece, leading in turn to the closed end of the net, the cod-end, where the fish are collected. Pelagic trawl nets typically have large floats on the head line at the mouth of the net to keep the mouth open, and weights on the footrope at the sides, or wingends, of the net opening. The net consists of very large mesh size at the mouth, gradually decreasing along the net to a small mesh at the cod-end, depending on the size of fish being targeted. A pelagic trawl net can be towed either by a single boat (single trawl) or by a pair of boats (pair trawl), with the configuration of the gear varying between these two fishing methods, as well as between different fleets.

Mid-water trawls are considered to have a much greater potential to capture cetaceans

Figure 1. Schematic representation of a pair trawl operation.



from Northridge 2003a.

Table 1. Pelagic trawl fisheries known or suspected to catch cetaceans in the north-east Atlantic

Gear type	Nation	Season	Location	Target species	Bycatch species	Known or Suspected	Monitored /estimated
Pelagic trawling	Denmark,Sweden, Norway, UK, Germany	June-September	Kattegat, Skaggerak, North Sea	Herring	Long-finned pilot whale, other small cetaceans	Known Suspected	Opportunistic record.
Pelagic trawling	Denmark, UK, Sweden, Norway	October-December	Kattegat, Skaggerak, North Sea	Mackerel	Small cetaceans	Suspected	
Pelagic trawling	UK, France, Netherlands, Denmark, Ireland	October-December January-March	West of Ireland, Celtic Sea, Channel	Blue Whiting, Mackerel Horse mackerel	Common dolphin, Atlantic white-sided dolphin	Known from some métiers, but not recorded in all studies.	Morizur etal.1996.
Pelagic pair trawling	France	Non-seasonal	Bay of Biscay	Hake	Common dolphin	Known	Morizur et al.1996.
Pelagic pair trawling	France, UK, Ireland	Summer	Bay of Biscay Celtic Sea	Albacore tuna	Common, striped, Atlantic white-sided and white-beaked dolphins, long-finned pilot whale	Known	Morizur et al. 1996. BIM 2000
Pelagic pair trawling	France, UK	December-May	Western Channel	Sea bass	Common dolphin	Known	Morizur et al. 1996. Northridge 2003a
Pelagic pair trawling	France	November-March	Biscay	Sea bass	Common dolphin	Known	Morizur et al. 1996.
Pelagic pair trawling	France	January-March June-November	Biscay	Anchovy, Pilchard, Horse mackerel	Small cetaceans	Suspected	
High aperture demersal pair trawling	Spain	Non-seasonal	Biscay	Hake, Horse mackerel	Small cetaceans	Known	CEC 2002a

Adapted from CEC 2002b.

than demersal trawls (Read 1996). This is partly because the nets can be towed at much faster speeds as they are not in contact with the sea bed, and also because the target species of such fisheries are often important prey animals for the cetaceans.

Pelagic trawls in the north-east Atlantic are used in fisheries targeting a wide range of pelagic and shoaling fish species, including albacore tuna, hake, herring, mackerel, horse mackerel (scad), blue whiting, sea bass, pilchard (sardine) and anchovy. The main nations operating pelagic trawl fisheries in the region are France, Ireland, the Netherlands, the UK, Denmark and Spain. Norway and Germany also have pelagic trawl fisheries, the latter targeting mainly herring in the North Sea (CEC 2002b). Monitoring for cetacean bycatch has been conducted in only a few of the fisheries operating in the region, and most of this has involved a sample size too small to be able to deduce total bycatch levels. However, the data that are available at least allow some of the fisheries responsible for bycatch to be identified, and others to be suspected by analogy.

Table 1 summarises some of the data available on pelagic trawl fisheries and their known or suspected cetacean bycatch in the north-east Atlantic region.

3.2.1 French pelagic trawl fisheries

Data on French fleets for 1992 show that up to 268 vessels were active in pelagic trawl fisheries (Biseau *et al.* 1996; see Appendix 2). Data provided for the study of bycatch in 1994-95 (Morizur *et al.* 1999) give the breakdown of effort (by number of vessels in 1992) between the various fisheries, their estimated landings (for 1994), area fished and seasonality as shown in Table 2.

Table 2. Details of French pelagic trawl fisheries sampled during the 1994-95 study

Fishery	hake	tuna	sea bass	horse mackerel	anchovy	black bream	pilchard
No. of vessels	120	50	70	130	130	15	90
Est. landings (tonnes)	3,310	1,907	217	3,235	14,500	691	3,700
Area fished (ICES div.)	VIIIa-b	VIIIa-d	VIIe, VIIIb	VIIIa	VIIIa-b	VIIe	VIIIa
Fishing season	All year	Aug-Dec	Jan-March	Jan-Aug	June-March	Apr-Jun Oct-Dec	April-Oct

Adapted from Morizur et al. 1999.

The same vessels participate in a number of fisheries, therefore the total fleet is not the sum of the number of vessels listed. Also, different fish species may be targeted during the same fishing trip, therefore for calculation of effort each individual tow has to be allocated to a specific fishery according to the catch composition (Morizur *et al.* 1999). Most pelagic trawling effort takes place in the Bay of Biscay and some of the boats enter the western Channel for the winter sea bass season (CEC 2002a).

The French fleet first introduced pelagic pair trawling into the albacore tuna fishery in 1987 (CEC 1993), although the techniques employed were very similar to those already in use by French fishermen for other species (BIM 2000).

Characteristics of the nets used in the French pelagic trawl fisheries studied during 1994 and 1995 were recorded by Morizur *et al.* (1999). While there is variation in most parameters between the fisheries, the width of the headline at the mouth of the net ranges from 100 m to 200 m, the vertical opening of the net ranges from 20 m to 60 m, the depth of the tow ranges from 10 m to 80m, and the speed of the tow is between 3 and 4.5 knots. The fisheries for sea bass, horse mackerel and anchovy were reported to consist mainly of pair trawlers, although the characteristics given for these fisheries do not show markedly larger nets or faster towing speeds than those of the other, presumably single-trawl fisheries.

Data from 2000 indicate that the French pelagic trawl fleet (mainly pair trawlers) comprises 70 full-time pelagic pair boats and 140 mixed (demersal/pelagic) vessels (CEC 2002b). There are three large industrial boats (78-88m long) that fished mainly in ICES area VII (the Channel, Celtic Sea and west of Ireland) for pilchard, mackerel, horse mackerel and herring, the latter being sold in the Netherlands (Anon. 2003). However, most of the French pelagic fleet fall in the range of 16-24m. The full-time pelagic pair trawlers fished for anchovy in ICES area VIII (Biscay and west of Biscay), other seasonal fisheries including sea bass and albacore in areas VII and VIII, and pilchard, horse mackerel and hake in area VIII. The remaining part-time pelagic fleet fished mainly on small pelagic species in area VIII (Anon. 2003). In the albacore trawl fishery 65 boats were linked to 149 months of fishing effort. In other pelagic trawl fisheries the effort amounted to 1,480 fishing months among 200 boats (CEC 2002b). Direct employment (crew) in the French pelagic fleet in 2000 was around 480 full-time and 658 part-time men and total annual landings for 1999-2000 were between 58,000 and 80,000 tons (Anon. 2003).

Observation of French pelagic trawlers, conducted during 1994-95, recorded cetacean bycatch in three of the fisheries, targeting hake, tuna and sea bass (Morizur *et al.* 1999). A total of nine cetaceans were recorded as bycaught, comprising common dolphins and one probable bottlenose dolphin (see 2.3.2). However, generally low proportions of these fisheries were observed.

In the hake fishery, seven trips were observed, totalling 52 sampled tows over 314 hours (representing 0.3% of annual effort). Four common dolphins were caught, which equates to 0.077 catches per tow (or 0.012 catches per hour of towing) (Morizur *et al.* 1999). The dolphins were caught in two tows, the first at a depth of 100 m with a trawl aperture height of 50m and the second at a depth of 60m with an aperture height of 30 m. In both, the footrope of the trawl was located just above the seabed. All the bycatches occurred over 64 km from the shore and the seven sampled vessels always worked in pairs (Pouvreau & Morizur 1996).

In the summer albacore tuna fishery, four trips were observed, totalling 43 sampled tows and 265 hours of towing (representing 1.6% of annual effort). Three common dolphins and one probable bottlenose dolphin were caught, which equates to 0.06 catches per tow (or 0.015 catches per hour of towing) (Morizur *et al.* 1999). The catches occurred at the end of September, in the extreme south of the Bay of Biscay. All the dolphins were caught at night, when the pair trawl was being towed near the surface, with a trawl aperture height of 38 m (Pouvreau & Morizur 1996).

In the sea bass fishery only two trips were observed, with a total of 10 sampled tows and 73 hours of towing (representing 1.6% of annual effort). One common dolphin was bycaught which equates to 0.1 catches per tow (or 0.014 catches per hour of towing) (Morizur *et al.* 1999). Like the other French trawlers examined, the boats were using pair trawls (Pouvreau & Morizur 1996).

Although no cetacean bycatches were recorded in the horse mackerel, anchovy, black bream and pilchard fisheries, the level of sampling in these was very low (between less than 0.1% and 0.4% of annual effort). It was noted that zero recorded bycatch does not imply there is no bycatch in the fishery (Morizur *et al.* 1999).

3.2.2 Dutch pelagic trawl fisheries

Between 1989 and 1994 the size of the Dutch pelagic trawl fleet in the north-east Atlantic varied from 11 to 13 freezer trawlers, although an additional nine vessels were operating for the same Dutch company under foreign flags (three German, three British and three French) (Couperus 1996). The smallest of these trawlers was 70 m long. The four largest trawlers were 115-120 m, with a 3,000-5,000 tonne storage capacity and engines of 8,000 to

10,000 horsepower. Vessels tend to stay at sea until their freezer stores are full, which can take three to five weeks for the larger vessels. Total annual catch in the early 1990s was about 300,000 tonnes.

The Dutch pelagic freezer fleet increased to 18 vessels by 2000, dropping to 16 vessels in 2001 (Anon. 2003). However, landings in 2001 were recorded as 420,000 tonnes, a 12% increase on the previous year. The total number of crew members in this fleet was 573 in 2001 (Anon. 2003).

The pelagic trawls are very large with a vertical opening of between 30 m and 60 m and the horizontal spread of the wings ranging from 80 m to 120 m. The mesh size at the front of the net is up to 30 m, diminishing to 4 cm at the cod-end. The trawl is generally towed just a few metres above the seabed, at varying depths depending on the target species, and the duration of each tow may vary from five minutes to more than ten hours, depending on signals received from sensors in the cod-end. During the early 1990s about half the Dutch fleet used fish pumps to empty the cod-end (Couperus 1996).

The target species of the freezer trawlers during this period were, in order of importance, horse mackerel, herring, mackerel, blue whiting and greater argentine. The most important fishing areas were on the continental slope west of the British Isles, in the Channel, along the British east coast and in the northern North Sea. The fleet's annual fishing pattern is described by Couperus (1996). Generally, at the start of the year part of the fleet fishes south-west of Ireland and in the northern Bay of Biscay for horse mackerel, and other vessels fish north of Scotland and Shetland for mackerel. As winter progresses, the mackerel fleet follows the mackerel southwards along the continental shelf edge, meeting the horse mackerel fleet south-west of Ireland towards the end of February. In March the whole fleet fishes along the shelf edge south-west of Ireland, mainly targeting horse mackerel but also catching mackerel. By the end of March and into April some trawlers fish for blue whiting on the Porcupine Bank and west of Scotland. By May and June some of the fleet is still fishing for horse mackerel south-west of Ireland, some target greater argentine and herring along with blue whiting west of Scotland, and an increasing proportion moves into the central and northern North Sea to catch herring. Over the summer, most trawlers target herring in the North Sea, along the shelf edge north of Shetland and north and west of Scotland. By September most of the fleet moves to the western approaches of the English Channel and south-west of Ireland to fish for horse mackerel and herring. In October the fishery for wintering mackerel north-west of Shetland starts but the horse mackerel fishery in the western Channel and northern Biscay is still important. By the end of November, the fishery for spawning herring starts in the Channel (Couperus 1996).

An independent observer programme covering about 5% of annual effort in the Dutch pelagic trawl fisheries was conducted between 1992 and 1994 (Couperus 1997a). In parallel with this scheme, a self-reporting scheme was set up to cover the same fishery for the last two years of the study. With the addition of data collected from 1989 to 1991, bycatch records are available for a six-year period, constituting 71 bycatch incidents involving in total 312 dolphins. Of these bycatches, 89% occurred south-west of Ireland, and these account for all the reported bycatches in the period February-April. At this time of year both mackerel and horse mackerel are found in this area. The vast majority of bycatches were Atlantic white-sided dolphins (78% of all identified animals and 83% of animals caught south-west of Ireland; see also 2.5.2). Other species caught were long-finned pilot whale (12%), common dolphin (7%), bottlenose dolphin

(1.5%) and white-beaked dolphin (1.5%) (Couperus 1997a).

Further monitoring of the Dutch mackerel and horse mackerel fishery in the Celtic Sea and south-west of Ireland was conducted in January to March of 1994 and 1995. This sampled 119 tows over 841 hours of towing, representing 3% of annual effort (Morizur *et al.* 1999). The observers recorded catches of nine dolphins, consisting of five Atlantic white-sided and four common dolphins. This represents a bycatch rate of 0.076 animals per tow, or 0.01 animals per hour of towing. The animals were all caught at or near the continental shelf edge and the bycatches occurred either at night or in the early morning even though more hauling operations were actually conducted during daylight (Couperus 1996).

The body temperature of the bycaught animals was measured and ranged from 26.6ºC to 38ºC, and exceeded 34ºC for seven of the individuals, which is close to that for a living animal (37ºC). This finding, along with the state of rigor mortis, was taken to indicate that the animals had only recently died and had been captured during or close to hauling, perhaps being trapped by net closure during the haul-back process. It was also noted that when a vessel turns sharply during a tow, the fishing line is hauled in until the trawl doors break the surface and the net itself is closed just under the water surface (known as 'turning on the doors'). After turning, the line is paid out again, the whole process lasting for 10-20 minutes in water depths of 200 m. This procedure was also considered likely to increase dolphin bycatches compared to a haul maintained in the same direction (Couperus 1996).

In five out of the six bycatch incidents the bulk of the fish catch was mackerel (Couperus 1996). Analysis of bycaught dolphins' stomach contents has shown that white-sided dolphins were feeding heavily on mackerel shortly before capture, but not on horse-mackerel, even when the latter was present in the catches (Morizur *et al.* 1999). Trawling depth for mackerel in this fishery was reported to be between 100 m and 400 m and the duration of hauls in which dolphins were caught ranged from 4.5 hours to over 12 hours (Couperus 1996).

Bycatch monitoring continued in the Dutch fishery in 1995-96, when 84 hauls were sampled over 45 days at sea, and eight cetaceans were recorded as bycaught. During the course of the study, an additional 37 animals were recorded as bycaught in skippers' reports. However, there were insufficient data to estimate annual bycatch rates (Couperus 1997b).

No further bycatch monitoring has been conducted in the Dutch pelagic trawl fisheries. However, Dutch fishing intensity south-west of Ireland is assumed to have reduced as part of the fleet has moved to Moroccan and Mauritanian waters. The African fishing grounds are of growing importance and accounted for more than 35% of the total earnings of the fleet in 2001 (Anon. 2003). Dolphin bycatch is also reported to be high in the Mauritanian fishery (CEC 2002b).

3.2.3 UK pelagic trawl fisheries

The UK pelagic trawl fleet targets a range of fisheries including mackerel, herring, sprat, pilchard, blue whiting, anchovy and sea bass, and operates in waters all around the British Isles including the northern waters of ICES area II and south into the Bay of Biscay. The number of vessels in the UK's pelagic fleet was 67 in 1995, decreasing to 47 in 2001. However, the installed engine power of the fleet increased by 30%, from 82,900 hp to 108,150 hp, over that period (Anon 2003). The total landings of the UK pelagic fleet were 324,000 tonnes in 2001. Mackerel is the most important species, accounting for around 50% of landings, followed by herring, at around 35%. The other species each make up 5% or less of the total landings (Anon 2003).

In 1993-94 observer studies were made of the UK's pilchard and mackerel fisheries which operate in the western English Channel from October to December and November to March respectively, some using single and some pair trawls (Lewis *et al.* 1996). No cetacean bycatch was observed in either of these fisheries but it was noted that the use of fish pumps to empty the catch from the net would have compromised the ability of the observer to record marine mammal catches (Morizur *et al.* 1999). Cetaceans would be too large to pass through the pump and, in the case of the UK fisheries, the final emptying of the cod-end occurred outboard and thus any bycaught animals may have gone unobserved, particularly during the night.

Since 2000, the UK has conducted further observer monitoring to estimate the level of bycatch in UK pelagic fisheries. Initially, observers were placed on board 13 UK vessels for a total of 190 days at sea, coving 206 trawling operations around the UK. The fisheries covered include herring, mackerel, sprat, pilchard, blue whiting, anchovy and sea bass. The only fishery in which cetacean bycatch has been observed to date is the sea bass fishery (DEFRA 2003b).

The UK sea bass trawl fishery consists mainly of Scottish vessels of 30-40m in length, with up to four pairs operating in the years since 2000. The trawl nets are of a French design and are towed near the surface with a wing spread of about 140 m and a length of about 280 m, including a long 40 m tunnel to the cod end. The average duration of the observed tows was 7.4 hours (Northridge 2003a). Fishing effort in the UK sea bass pair trawl fishery (in terms of hauls per year) showed a marked increase from 1996 and then a further substantial rise since 1999 (Northridge 2003a).

In 2001, the sea bass fishery, operating mainly in the western English Channel, was observed over 71 days at sea, covering 116 hauls. A total of 53 common dolphins were observed caught in 12 of these hauls. The fishery occurs between November and April although most fishing activity occurs in late February and March when the sea bass have moved offshore to spawn in the mid-Channel region. Indeed all but one of the bycaught dolphins were observed during March (Northridge 2003a). Further monitoring during 2002 recorded eight common dolphins caught during observation of 66 hauls. By the end of the 2002-03 season over 310 tows had been observed in the sea bass fishery during 193 days at sea, and 91 cetacean catches (all common dolphins) were recorded (Northridge 2003a).

Over the course of this observer monitoring, work has also been conducted to investigate potential bycatch mitigation measures, including acoustic deterrent devices (pingers), which have not been successful (see 4.2.3) and an exclusion device (selection grid), which appears to be showing more promise (see 4.2.1).

3.2.4 Irish pelagic trawl fisheries

Data from 1992 indicate that pelagic fisheries accounted for 83% of the total fish landed into Irish ports (Berrow *et al.* 1996). Three species - herring, horse mackerel and mackerel - accounted for 97% of these landings.

In the early 1990s the Celtic Sea herring fishery was perhaps the most important single fishery within the Irish fishing industry (Berrow *et al.* 1996). In 1994-95 Ireland had a fleet of 49 pelagic vessels active in the herring fishery, operating in pairs, and with annual landings estimated to be 20,000 tonnes (Morizur *et al.* 1999). These vessels are mainly 21-25 m in length and use relatively small trawl nets with a headline width of 20-30 m and a vertical opening of 15-20 m (Berrow *et al.* 1996). This fishery operates from October to February, with a peak in effort recorded in January during the 1994-95 season.

Observers were placed in the Celtic Sea herring fishery between October 1994 and January 1995, and monitored 78 tows during 85 days at sea, mostly close inshore to the south and south-east of Ireland (Berrow *et al.* 1996). The only reported marine mammal bycatch was that of four grey seals, caught individually which were found to have been feeding on herring at the time of capture. No cetaceans were caught, although it was also noted that no live cetaceans were observed from the vessels during this study.

Ireland's fleet of pelagic pair trawlers that target horse mackerel and mackerel consisted of 23 vessels in 2001 and this number has been constant since 1995 (Anon 2003). However, the total installed engine capacity of the fleet increased over this period by 13%, from 48,700 hp to 55,000 hp. These vessels are listed as being over 24 m and employ a total crew of 300. Landings of horse mackerel in 2001 were recorded as 63,000 tonnes (just over a third of that recorded for 1995). Landings of mackerel were 70,000 tonnes in 2001 and have fluctuated less over the previous 6 years. These fisheries are both widespread, with catches of both species occurring in the northern North Sea and northwards, west of the Faeroes and Scotland, and in ICES areas VII and VIII (Anon. 2003).

The researchers who studied bycatch in the Irish pelagic trawls during 1994-95 initially approached the representative organisation of the mackerel fishery but this fleet was not prepared to cooperate with the study and so no observers could be placed (Berrow *et al.* 1996). However, the report of this study concludes that the mackerel/horse mackerel fishery, as one of the largest in Ireland and having the largest vessels, should be studied to quantify incidental capture. It also notes anecdotal reports of up to 50 dolphins taken in a single tow by Irish pelagic trawlers (Berrow *et al.* 1996).

In 1998 Ireland initiated an experimental pelagic pair trawl fishery for albacore tuna in response to the EU's decision to ban the use of driftnets to catch tuna and similar species (see 3.4.1). This is a summer fishery and the main areas targeted are from the Bay of Biscay north-westwards, broadly following the continental shelf edge to the waters south-west and west of Ireland. In 1999, there were 16 vessels participating in the trials, ranging from 21 m to 33 m (BIM 2000). Although the number of vessels dropped in the intervening years, there were 16 Irish vessels pelagic pair trawling for albacore in 2002. These had a total engine power of 12,000 hp and a crew of 100. Albacore landings by the pelagic trawl fleet rose from 65 tonnes in 1998 to 1,200 tonnes in 2002 (Anon. 2003).

The experimental fishery was studied during 1998 and 1999 to evaluate the efficacy of this (and other) fishing methods for catching albacore. The trials used a variety of net constructions based on French and Irish trawl designs, differing mainly in construction material and the fact that the French boats tow only one warp per vessel, whereas the Irish boats tow two, from the top and bottom of the bridles at the side of the net (BIM 2000). During 1998, the trial fishery was predominantly south-west of Ireland and also in the northern Bay of Biscay, fishing from August to mid-October. In total, 105 hauls by four pairs were monitored and 35 cetaceans were caught, including 23 dolphins caught in a single haul. During 1999, four pairs were again monitored, from August to late September, concentrating on waters west and south-west of Ireland and further south to the southern Bay of Biscay. A total of 313 hauls were monitored, recording a catch of 145 cetaceans (127 common dolphins, 8 striped dolphins, 8 long-finned pilot whales and 2 Atlantic white-sided dolphins). Ninetyeight of these (68%) were taken in just 10 hauls and one haul accounted for 30 animals (BIM 2000). The tows were generally made at night and lasted from four to six hours.

The researchers analysed the cetacean bycatch dataset by correlating it with a range of factors in the fishery such as geographic position, water depth, time of haul, towing speed and albacore catch. The strongest correlation was found to be with the depth of water during the tow, with cetacean bycatch only recorded once when the depth of water exceeded 500 m (BIM 2000).

Research into the use of acoustic deterrent devices to prevent bycatch in the Irish albacore pair trawl fishery has been conducted in 2002 and 2003 (see 4.2.3).

3.2.5 Danish pelagic trawl fisheries

Denmark has a fleet of pelagic trawlers that targets horse mackerel, mackerel and blue whiting, mostly in ICES areas VII and VIII, with the major fishing grounds located in the western Channel and the Western Approaches. The fleet consisted of 21 vessels in 2001, having declined from 35 vessels in 1998-99 (Anon 2003). Direct employment in this fleet for 2001 is given as 119 crew, and annual landings as 23,000 tonnes (down from 64,000 tonnes in 1997). Denmark also has pelagic trawlers that fish in the Kattegat and Skaggerak Seas targeting mackerel and herring.

Danish pelagic fisheries do not appear to have been monitored for cetacean bycatch, although given the size and distribution of the fishing effort it would be reasonable to assume a significant level of bycatch by analogy with other fleets targeting the same fisheries. Occasional catches of long-finned pilot whales have been recorded in the herring fishery in the Skagerrak Sea and bycatch of other species is also suspected (CEC 2002b).

3.2.6 Spanish trawl fisheries

Spanish fleets are prohibited from using pelagic trawls by national legislation. However, a new Spanish gear was introduced in the early 1990s which is in effect a demersal trawl with a very high vertical opening (VHVO or Naberan trawl: CEC 2002b). The gear is used by pair trawlers and in 1992 there were 22 Spanish Basque boats using it to target hake in the Bay of Biscay. In 2000, there were 27 pairs working with these nets, operating in ICES areas VIIIa and VIIIb (inner Bay of Biscay), while 37 pairs were fishing in area VIIIc (southern Biscay) and 18 pairs in area IXa (eastern Portuguese waters) (CEC 2002b). Although the fishing type is difficult to determine, data from 1998 also list 243 Spanish boats using “trawls” in waters offshore of Galicia and 250 boats using “trawls” in inshore Galician waters (CEC 2002b). Around 150 Galician vessels, mainly trawlers and long-liners, are reported to fish at Grand Sole, off south-west Ireland (López *et al.* 2003), presumably targeting mainly hake, blue whiting and horse mackerel.

An observer programme covering VHVO trawls has been conducted by the Institute of Fisheries Research of the Basque Country since 1996. During the period 1996-2000, 661 hauls were observed over 266 fishing days and a total of 24 dolphins were caught in ICES areas VIIIa, b and d (Bay of Biscay) (CEC 2002b). Further observation programmes have been undertaken by the Spanish Institute of Oceanography. In the 1997 survey, covering ICES areas VIIIc and IXa, 439 bottom trawl hauls and 45 bottom pair trawl hauls were observed and one bycatch incident was recorded, involving three animals in area IXa (eastern Portuguese waters). In 1999-2000, 1,759 bottom trawl hauls and 67 pair trawl hauls were monitored and one common dolphin was taken in ICES area VII (CEC 2002b).

These apparently low bycatch rates should be considered in the context of the extremely high level of fishing effort in the Spanish fleet. For instance, the total number of fishing trips by the (full-time) Galician fleet is estimated to be around 1.1 million per year (López *et al.* 2003). These findings also appear to be at odds with other recent surveys. For instance, a survey of cetacean bycatch in Galician fisheries conducted in 1998-1999 recorded no bycatch during 67 observed fishing trips (López *et al.* 2003). However, data from interviews with fishermen produced an estimated annual cetacean bycatch of 415 cetaceans per year in Galician offshore trawl fisheries and a further 332 in the trawl fishery on Grand Sole. The interviews also yielded numerous references to cetaceans being used for human consumption (69 out of 500 interviewees) and use of cetaceans for bait, animal food and as a source of fat was also mentioned (López *et al.* 2003). An earlier Spanish study, also using observers and interviews with fishermen, identified offshore pair trawling as the major cause of common dolphin mortality (Aguilar 1997). In this study, fishermen reported that during night-time fishing it was rare not to catch dolphins, usually between one and ten and sometimes thirty or more. During 1996 and 1997, observers were present on four trips using pair trawls at night and in all cases common dolphins were caught, totalling eight individuals (Aguilar 1997).

3.3 Bottom-set gillnets

Gillnetting is a simple, passive form of fishing that involves the setting of sheets of netting suspended vertically in the water by way of a floatline at the top and a leadline at the bottom. Fish are caught by swimming into the net and becoming wedged within a mesh opening, or literally ‘gilled’ by the mesh catching behind the gill covers. Bottom-set gillnets are used to catch a wide variety of demersal species including cod, turbot, hake, saithe and dogfish. There are several variations on this theme. Tangle nets have little or no flotation so that they are extremely slack, and are used to catch species such as flatfish and crustaceans, which are entangled rather than gilled. Trammel nets consist of three parallel sheets of netting, the middle sheet of which has a smaller mesh and is hung loosely, so that fish swim through the outer sheet and are caught in a pocket of the small mesh netting. All these nets are usually anchored so that they are located on or near the seabed. Driftnets are gillnets that are left to drift at or near the sea surface, sometimes attached to the boat at one end (driftnets are addressed in 3.4 below).

Although gillnets have a long history, their use has increased massively since the introduction in the 1950s of nylon yarns and particularly monofilament netting, which increased their efficiency (Northridge *et al.* 1991). The FAO and other organisations actively promoted the use of gillnets in coastal areas because of their low cost, ease of use and productivity, and they have became the most common type of fishing gear in coastal waters worldwide (Crespo & Hall 2001). Gillnets are regarded by fisheries managers as attractive because they can be very size-selective for the target fish. However, they can be very unselective at a species level, both for non-target fish and for other groups such as marine mammals, birds and turtles. The durability of nylon gillnets also means that when they are lost at sea (which frequently happens) they may continue to trap fish (ghost fishing) for an indeterminable period, posing an additional bycatch threat.

The harbour porpoise, in particular, has been found to be acutely prone to incidental capture in bottom-set gillnets in the north-east Atlantic and many other regions throughout its range (see also 2.2.2).

3.3.1 Danish bottom-set gillnets

Denmark has a large bottom-set gillnetting fleet, operating largely in the North Sea and also in the Kattegat and Skaggerak Seas and into the Baltic Sea. The main fisheries targeted in the North Sea are for cod, caught in bottom-set nets and wreck nets (where gillnets are set over wrecks and rough ground), hake, turbot, plaice and sole.

Several programmes of bycatch monitoring have been conducted in the Danish set-net fisheries, and have indicated high and unsustainable levels of harbour porpoise bycatch (outlined in 2.2.2). Total porpoise bycatch by the Danish fleet is estimated to have peaked at 7,366 animals in 1994 (Vinther & Larsen 2002). The greatest porpoise mortality occurs in the turbot fishery, which uses long nets with large mesh sizes (mainly 270 mm) and a very long soak-time. However, the highest rate of porpoise bycatch per km of net per hour occurs in the wreck-net fishery for cod, particularly in the third quarter of the year (Vinther 1999).

As a result of these findings, the Danish Government introduced in 2000 a requirement for the use of pingers in the North Sea cod wreck-net fishery in the third quarter of the year. This measure is reported to have completely eliminated observed bycatch in the wreck-net fishery during this quarter (Larsen *et al.* 2002a; see also 4.2.2). Danish trials of high-density gillnets have also been conducted and have shown that they reduce porpoise bycatch, but also reduce catches of cod (Larsen *et al.* 2002b; see also 4.2.4 below).

Since its peak in 1994, bycatch of harbour porpoises in Danish set nets has declined steadily, largely as a result of reduced fishing effort due to poor fish stocks (Vinther & Larsen 2002). However, total annual catches are still substantial, estimated at 3,482 porpoises in 2001 (CEC 2002b), and no mitigation measures have yet been introduced in most Danish bottom-set gillnet fisheries.

3.3.2 UK bottom-set gillnets

The UK also has substantial gillnet fisheries operating in all waters around the British Isles, many of which land mixed species, making categorisation difficult (CEC 2002a). Most gillnetting effort in the central and southern North Sea up to 2000 targeted cod (in both bottom-set and wreck nets), followed by sole, although effort in almost all the North Sea fisheries has decreased substantially since the mid- to late 1990s. In Atlantic and Channel waters a wide variety of species is targeted. The greatest gillnetting effort occurs in the coastal waters of the eastern Channel (ICES area VIId), targeting cod, flatfish, cuttlefish and other species, and there is significant fishing effort in the Celtic Sea, targeting hake, monkfish (Angler fish) and crustaceans (CEC 2002a). There is also an offshore set-net fishery operated by large freezer-netters which typically operate along the continental shelf edge and on offshore banks. Gillnetting (set and driftnet) effort in many areas, for example the North Sea, has decreased, but there were notable increases in effort recorded in the few years up to 2000 in the waters well offshore west of Scotland (ICES area VIb), the Irish Sea (VIIa), and in the Celtic Sea (VIIg) (CEC 2002a).

Many UK gillnet fisheries have been monitored for cetacean bycatch since the early 1990s, and predictably the main species recorded is the harbour porpoise (see 2.2.2).

In 1992-94 the Celtic Sea hake gillnet fishery from the UK and Ireland was investigated, revealing an estimated annual catch of 740 porpoises by the UK fleet and an additional 1,500 by the Irish fleet, giving a total of 2,240 animals (Tregenza *et al.* 1997a). Bycatches of common dolphins were also recorded in this fishery, with an estimated annual catch of 200 animals (Tregenza & Collet 1998). Fishing effort has declined in the hake fishery as a result of fish stock recovery measures. However, there have also been shifts in effort between fisheries, and bycatch in Celtic Sea set-net fisheries is still considered to be at unacceptable levels.

Cetacean bycatch in UK gillnet and tangle net fisheries was observed in the North Sea and off the west coast of Scotland between 1995 and 1997. In the North Sea, porpoise catches in the cod, sole, skate and turbot fisheries were estimated to total between 600 and 800 animals per year (Northridge & Hammond 1999). West of Scotland, fisheries for dogfish, crayfish and skate were estimated to catch between 150 and 200 porpoises per year (Northridge & Hammond 1999). These figures are estimated to have fallen by 1999, to around 450 animals in the North Sea and 22 west of Scotland, as a result of fishing effort reductions and the collapse of the Scottish crayfish fishery (CEC 2002a).

Since these studies, there has been significant research effort in the UK into pingers as a potential mitigation measure, particularly in the Celtic Sea hake set-net fishery (see 4.2.2). Despite several years of field trials and a finding of 92% reduction in bycatch levels in pingered nets (SMRU 2001), no mitigation measures have yet been introduced in the UK. However, the UK Government launched a consultation paper in March 2003 detailing proposals for a bycatch response strategy that would include compulsory use of pingers in specified bottom-set gillnet and wreck-net fisheries (DEFRA 2003). These proposals are still under consideration.

3.3.3 French, Spanish and Portuguese bottom-set gillnets

In 1994, there were around 800 French boats fishing with bottom-set gillnets (Pouvreau & Morizur 1995). In the Bay of Biscay the main target is sole, but hake, monkfish, turbot, whiting and rays are also taken. In the western Channel (ICES area VIIe), sole, monkfish, turbot, rays, spider crabs, pollack and hake are targeted, and in the eastern Channel set nets are used for cod. There is little reported bycatch in these French fisheries, but interviews with fishermen indicate that some porpoise bycatch occurs in the middle of the western Channel (CEC 2002a). Bycatch of porpoises is suspected by analogy in French hake and monkfish fisheries in the Celtic Sea and on the continental shelf edge, and also of a range of cetaceans in the sole, hake and monkfish fisheries in Biscay.

Spain has a very large fleet of set-netters. In 1998, there were over 1,000 small Galician boats fishing in inshore waters and 535 netting offshore (ICES areas VIIIc and IXa). In 2000, 43 boats were recorded fishing in areas VIIIa and b (inner Bay of Biscay) targeting demersal species (CEC 2002a). No catches of cetaceans were observed in Spanish gillnets during two monitoring programmes conducted in 1994 and between 1996-2000. However, a recent study of Galician fisheries, involving interviews, carcass retrieval and observation, estimates that the annual cetacean bycatch is 190 animals in the inshore gillnet fleet and 955 in the offshore fleet (López *et al.* 2003).

Portugal also has a large gillnetting fleet, mainly of small boats fishing in inshore waters, with over 4,800 netters registered in 1991 (Sequeira & Ferreira 1994). Although there is little reliable information on cetacean bycatches in Portuguese fisheries, considerable numbers of cetaceans are reported to be killed incidentally each year, with highest levels in the gillnet fishery. Common dolphins are thought to be the most affected, particularly in the central zone, but harbour porpoises are particularly vulnerable in the northern region. Bycatches of striped and bottlenose dolphins are also reported (Sequeira & Ferreira 1994). A recent analysis of common dolphin strandings data in Portugal suggests that gillnets were responsible for 67% of the bycaught animals recorded (Silva & Sequeira 2003). Beach seine nets were the next most prevalent cause, responsible for 11% of the bycatches.

3.3.4 Baltic Sea bottom-set gillnets

Bottom-set gillnets are used by fleets from all Baltic States, targeting species such as cod, turbot, sole, salmon and sea trout. There is little information available on fishing effort in the Baltic. However, Sweden, for example, has a very large set gillnet fishery for cod and herring, in which effort increased from 173,400 km net.days to 203,000 km net.days (17%) between 1997 and 2000 (CEC 2002a). An assessment of bycatch, based on reports from fishermen, produced an estimated minimum catch of five harbour porpoises per year in Swedish salmon driftnets and cod gillnets in the early 1990s (Berggren 1994).

There is also a substantial Polish bottom-set gillnet fishery, targeting cod, herring and other species. In addition, there is a small semi-driftnet fishery for sea trout and salmon. Although there is no independent observer programme in Poland, analysis of bycatches voluntarily reported by fishermen since 1990 shows that the majority of animals (25 harbour porpoises and one striped dolphin) were caught in bottom-set gillnets (Kuklik & Skóra 2003). The small semi-driftnet fishery for salmonids accounted for more than 40% of all reported porpoise bycatches, most of these occurring in the small area of Puck Bay. A further two bycaught porpoises were reported in 2002, one in a Polish coastal salmon set net and the other in a trawl net (ASCOBANS 2003a). Porpoise bycatches have also been reported in German bottom-set gillnets in the Baltic (CEC2002b).

In light of the critically depleted state of the harbour porpoise in the Baltic Sea and continued losses through fisheries bycatch (see 2.2), a Recovery Plan for Baltic Harbour Porpoises (Jastarnia Plan) has been agreed (ASCOBANS 2002; see also 5.2.2). Amongst other measures, this plan recommends that action should be taken to reduce the fishing effort of driftnet and bottom-set gillnet fisheries in the Baltic and to shift fishing effort towards alternative, less harmful gear.

3.4 Driftnets

Driftnets are usually deployed at or near the sea surface and are used in a wide range of fisheries. The more traditional driftnets, typically using cotton net, are short, small-meshed and used by small boats operating inshore to target species such as herring, sprat and mackerel. However, as with other gillnets, the emergence of synthetic nylon netting enabled larger-scale driftnet fisheries to develop for larger and offshore species such as tuna, squid and swordfish. Driftnets are also widely used to catch salmon.

3.4.1 Driftnets in the North-east Atlantic and Mediterranean Sea

Small inshore driftnet fisheries exist in the UK, for herring in the Irish Sea, south-west England and the Thames estuary, for sea bass in the Channel and Irish Sea, and for salmon off north-east England (CEC 2002b). Harbour porpoise bycatch is known or suspected in most of these fisheries but not quantified. Norway had, until 1998, a salmon driftnet fishery, in which the rate of harbour porpoise bycatch was among the highest recorded cetacean bycatches in a net fishery. This fishery was subsequently closed mainly for reasons of salmon conservation (CEC 2002a). Ireland still has a salmon driftnet fishery that occurs west of Ireland and in the Celtic Sea, in which cetacean bycatch of a number of species is known to occur (CEC 2002b).

The driftnet fishery for albacore tuna in the north-east Atlantic developed in the late 1980s. France introduced the use of driftnets in this fishery in 1986, followed by Ireland in 1990 and the UK in 1991 (CEC 1993). Initially these driftnets were not restricted in length, although the French driftnetters had a voluntary maximum limit of 9.25 km (BIM 1994). Considerable concern had already arisen by this time about the damage being caused to both target fisheries and non-target marine species as a result of the indiscriminate and wasteful nature of large-scale pelagic driftnets in other ocean areas. This led to the United Nations agreement of a worldwide moratorium on the use of such nets as from the end of 1992. Similar concerns resulted in the adoption by the EU of Council Regulation 345/92 which prohibits the use of driftnets longer than 2.5 km in the waters of the Member States, with the exception of the Baltic Sea, and, outside those waters, to all Community fishing vessels. However, a derogation was granted under this regulation, which allowed vessels that had operated in the albacore fishery for the previous two years to continue to use nets of up to 5 km.

This derogation only applied to French vessels and was for one year, only to be extended *"in the light of scientific evidence showing the absence of any ecological risk linked thereto"*. As a result, French scientists conducted an observer programme in 1992 and 1993 to assess the ecological risk associated with the French use of 5 km nets. This study produced an estimated bycatch in the French tuna fishery of 1,700 cetaceans per year, including 1,200 striped dolphins and 400 common dolphins (Goujon *et al.* 1993). This level represents around 1.6% and 0.6% of the estimated populations of striped and common dolphins respectively in the tuna fishery area. Considering also the Irish and UK components of the tuna driftnet fishery, the total mortality was assumed to be 30% higher (CEC 1993). The European Commission's Scientific and Technical Committee for Fisheries recommended that bycatch should be kept below half the maximum rate of increase of the population (assumed to be 4%) i.e. below 2% of the population. They concluded that for striped dolphins the estimated mortality was above this level (CEC 1993). The French derogation was not extended.

Subsequent observer monitoring of the smaller UK tuna driftnet fishery in 1995 produced an estimated catch of 165 dolphins in that season, comprising 61 common dolphins and 104 striped (SMRU 1995). This rate of dolphin bycatch was almost three times greater than the French rate per 100 tuna caught. In 1996 the Irish driftnet fleet was observed, recording a mean catch rate of 2 cetaceans per haul (Harwood *et al.* 1999), considerably above the French or the UK rate. Using this bycatch rate, the total bycatch by the Irish fleet in 1998 (18 vessels) was estimated to be 964 striped dolphins and 2,522 common dolphins (Harwood *et al.* 1999).

In 1998 EU Fisheries Ministers agreed to a ban on driftnet fishing for tuna, swordfish and similar listed species in the waters of Member States, with the exception of the Baltic Sea, and, outside those waters, to all Community fishing vessels (Council Regulation (EC) No. 1239/98). This ban came into force in January 2002.

Although the phasing out of driftnets seems to have been adhered to in the north-east Atlantic albacore fishery, this has not been the case in the Mediterranean. The French fleet has continued to operate driftnets, known as 'thonaille', to catch bluefin tuna. This fishery is known to catch striped dolphins (CEC 2002b). There is also increasing evidence of a resurgence of illegal driftnet use by Italian vessels to catch tuna and swordfish. In addition, non-EU Mediterranean countries such as Morocco and Turkey, which are not bound by the EU driftnet ban, continue to use these nets, despite the UN moratorium on large-scale pelagic driftnets. These fisheries catch a large number of cetaceans, mostly striped dolphins but also including pilot whales, common dolphins and sperm whales (CEC 2002b).

3.4.2 Driftnets in the Baltic Sea

The restrictions on EU driftnets introduced in 1992, restricting driftnet length to 2.5 km, and in 2002, prohibiting the use of driftnets of any length in fisheries for tuna, swordfish and similar species (see 3.4.1), do not apply to the Baltic Sea, which was specifically exempted during the negotiations. A substantial driftnet fishery for salmon occurs in the Baltic, operated by a number of Baltic states, in which nets of up to 21 km are still allowed. Bycatch of harbour porpoises in the

Baltic has been recorded mainly in salmon driftnets and bottom-set gillnets, and these fisheries are considered to pose the major threat to the critically small remaining porpoise population in the Baltic Sea (ASCOBANS 2002; see 2.2). Consistent with the recommendations of the Jastarnia Plan (see 3.3.4 and 5.2.2), the European Commission has proposed to restrict the length of driftnets in the Baltic to 2.5 km and to phase out their use completely by 2007 (CEC 2003a; see 5.4 below).

4. Measures to reduce Bycatch

4.1 Why cetaceans get caught

It is important to obtain details of when and where cetaceans get caught in fishing nets and also to investigate how and why this happens, in order to devise effective preventative measures. It has been emphasised that each operational interaction between small cetaceans and commercial fishing gear is likely to require a solution specific to that combination of animals and gear (Read 2000). In other words, a mitigation measure that is effective for one species in a particular fishery may not work for different species. Equally, a measure that effectively reduces bycatch of a species in one particular fishery may not be effective for that species in another fishery. It is also worth noting that in the United States, where bycatch reduction strategies have been devised and implemented since the mid-1990s, these have all involved a combination of several measures to address each bycatch problem (Read 2000; see also 5.1.2).

The problem of harbour porpoise bycatch in bottom-set gillnets has been studied in a wide variety of fisheries, as has the behaviour of these animals around nets. Most hypotheses about the mechanisms of their bycatch assume that animals that are foraging near the seabed may not detect the nets in time due to the limited acoustic detectability of these nets (Kaschner 2003). Therefore, most research into mitigation measures for this problem has focused on methods of increasing the acoustic properties of the nets, or acoustically alerting the animals to their presence.

In the case of dolphin catches in pelagic trawl nets there is clearly another mechanism at play. Pelagic trawls are very noisy underwater and it is therefore very unlikely that animals get caught because they do not detect them. Although little is known about the behaviour of small cetaceans around pelagic trawls, analysis of the stomach contents of bycaught animals indicates that, in at least some cases, they are predating on the same fish species as the fishing vessels are fishing for (e.g. Couperus 1997a; Gosselin 2001). It is also possible that dolphins actively approach and enter pelagic trawl nets for foraging purposes. In this case, the disorientation of animals caused by changes in net geometry that occur during hauling operations or changes in direction or speed of the towing vessels may be a possible reason for their capture (Couperus 1996; Connelly *et al.* 1997; de Haan *et al.* 1999). Most effort on mitigation to date has looked at how to exclude animals from the trawl net, through either physical or acoustic means.

Another strategy to reduce cetacean bycatch levels is to adjust how the problem fisheries are managed in terms of when and where the fishing takes place, the level of fishing effort and the fishing method used.

The following sections outline some of the key measures available or under development for the mitigation of cetacean bycatch.

4.2 Technical mitigation measures

4.2.1 Exclusion devices

Exclusion devices (also known as selection grids or Nordmore grids) are widely used in trawl fisheries to prevent unwanted fish and non-fish species bycatches. For instance, the turtle exclusion device is used to prevent turtle bycatches in many shrimp trawl fisheries. The device consists of a widely spaced metal grid (through which fish can pass), placed in the extension piece of the trawl (i.e. the long tube before the cod-end). The angle of the grid deflects large animals, such as dolphins, upwards to an escape hatch in the top of the trawl net, while fish continue through the grid into the cod-end (Northridge 2003b).

In response to the high common dolphin bycatch rate recorded in the UK's winter sea bass fishery in the western Channel, research to investigate possible mitigation measures was initiated in 2001 by the Sea Mammal Research Unit (SMRU) in collaboration with the Scottish Pelagic Fishermen's Association (Northridge 2003b). Initially, the use of pingers was trialled in 2001 (see 4.2.2 below). However, soon after this fishing season, work was started on the development of a dolphin exclusion device. After development of a prototype that was tested in a flume tank, an initial sea trial by one Scottish pair was conducted in the spring of 2002. The trial was to be recorded with an underwater camera mounted onto the trawl but this was curtailed by technical difficulties. However, fish were recorded passing success-

Figure 2. Schematic model of the exclusion grid

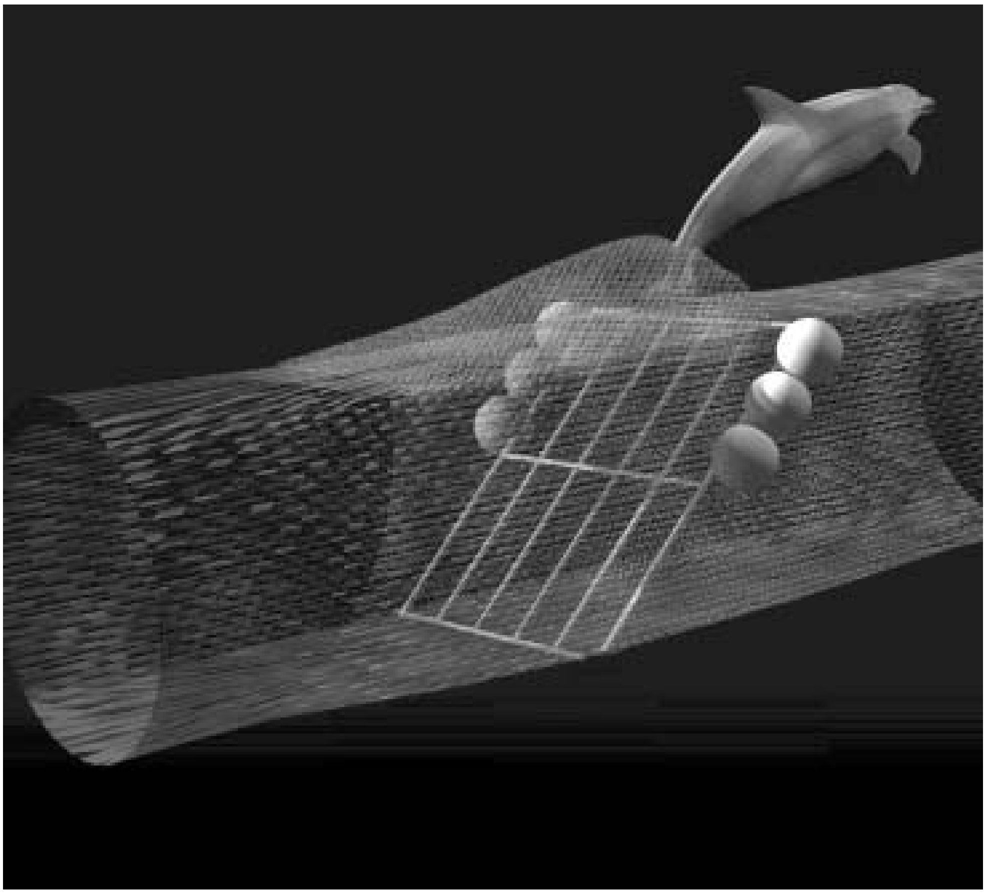


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Table 3.
Comparison of catches between pairs with standard tows and one fitted with a selection grid and associated experimental equipment

Non-grid	No. of tows	No. of dolphins caught	No. of tows with dolphin catches	Dolphin tows as % of total tows	Dolphins caught per tow
February	16	16	3	0.19	1.00
March	29	21	6	0.21	0.72
April	17	0	0	0.00	0.00
Total	37	9	0.15	0.60	
Grid pair					
March	40	2	1	0.03	0.05
April	42	0	0	0.00	0.00
Total	82	2	1	0.01	0.02

From Northridge 2003a

fully through the grid. In the event, no dolphins were seen during the grid's four-day trial in 2002, although a shark was recorded escaping through the hatch apparently without problem (Northridge 2003b).

In 2003, after some modification of the device, 42 days of sea trials were conducted and monitored with two cameras, one inside and one outside the trawl (although the latter was removed for part of the trial) (Northridge 2003a). An electronic grid sensor was also used to monitor the angle of the grid and the speed of water passing through the grid. During the trial, observers monitored bycatch in the Scottish pair fishing with the grid, and the others without it, all of which were fishing in the same general location.

The results from 2003 show that bycatch rates for the three pairs not using the grid were high, with 37 dolphins caught in 62 tows, a mean of 0.6 animals per tow. The highest bycatch rate was recorded in February (1 animal per tow). The grid pair was only operational during March and April, therefore the total bycatch rates are not comparable. However, in the 82 grid-tows observed only two dolphins were killed (Northridge 2003a; see Table 3).

The two dolphin fatalities occurred during a period when the camera was not functioning. However, it was evident that one of the dolphins had passed up to the escape hatch and then become caught by its beak in the mesh of the cover net (which is a flap designed to reduce fish losses). The second animal had become trapped behind the first. It was concluded that the two deaths were the result of using a mesh size for the cover flap that was too large and that the problem could be rectified by using a smaller mesh (Northridge 2003a).

The very much reduced bycatch rate in the pair using the grid was clearly not achieved by the intended mechanism as no animals were observed to swim through the escape hatch. Instead, it seems that the experimental set-up had the effect of deterring animals from venturing too far down the trawl net (Northridge 2003a). Two possible reasons for this effect have been put forward. First, the grid sensor, which emits a loud noise at typical dolphin echolocation frequencies, may have caused the animals to turn back before they reached the final narrow section of the net. Second, the grid itself, which is made of solid stainless steel bars, would be easily detectable to dolphins either visually or acoustically and this alone may have deterred animals from entering the narrow tunnel. If the latter explanation is correct, it is suggest-ed that the simple placement of a large metal grate further forward in the net, at the start of the narrow tunnel section, might be sufficient to cause dolphins to turn round and escape before they enter the lethal part of the net. Further trials are planned for 2004 to try to elucidate how and why the grid appears to be working, and whether this effect is likely to present a long-term solution.

Concern has been raised that use of exclusion devices may lead to the injury of animals that pass through them, for instance as a result of impact with the grid. This has particularly been raised as an issue in New Zealand where exclusion devices are already in commercial use in the pelagic trawl fishery for squid which has a high bycatch of New Zealand sea lions. Post-mortem examination of sea lions that have passed through the exclusion device has found considerable injuries, including blunt trauma to the head and body (Duignan & Gibbs 2001). However, the cause of these injuries is not clear as the animals that passed through the exclusion device were retained within a cover net, in which they then died. There do not appear to be significant differences between the injuries sustained by the animals that were excluded and died in the cover net and those that died in the trawl net itself. Indeed, the injuries recorded in the sea lions appear to have been similar to those found in common dolphins that are assumed to have been bycaught in pelagic trawl nets in the UK.

However, it is vital that, if the exclusion device is found to provide an effective means of preventing dolphin bycatch in pelagic trawl nets, it must be clearly demonstrated that the animals are unharmed by the process. It is also important that any future use of such devices in commercial fisheries is closely monitored to ensure that they are being used correctly and are working effectively.

Also, as outlined in 3.2 above, different pelagic trawl fisheries and fleets use nets with different configurations and operational characteristics. Therefore, it will not necessarily be a quick or simple process to transfer a technological adaptation such as this from one fishery to another. Even within the sea bass fishery, further trials may be required to ensure that an exclusion device developed for the Scottish fleet could function effectively in the larger French fleet, for instance. Although the French industry has shown an interest in the UK's research on exclusion devices, and representatives attended a presentation of the preliminary results in April 2002, the French have not yet embarked on any collaborative work in this area.

4.2.2 Acoustic deterrent devices (pingers) in set nets

Acoustic deterrent devices, or pingers, are small electronic devices that are attached to fishing nets and emit sounds at the frequencies to which small cetaceans are most sensitive. The aim of pingers is to produce a sound that is either aversive to the animals or that alerts them to the presence of nets. The devices were first developed in the late 1980s to reduce entanglement of humpback whales in Newfoundland cod traps, but experiments with them in the Gulf of Maine during the early 1990s demonstrated that they are also effective in reducing the bycatch of harbour porpoises in gillnet fisheries (Read 2000).

Several different devices are now commercially available, with varying physical and acoustic characteristics. It has been emphasised that it is necessary to test the efficacy of any particular pinger in the context of the cetacean species of concern and the specific fishery (CEC 2002b). Numerous trials have now been conducted in North America, New Zealand and Europe demonstrating, for the most part, impressive reductions in cetacean bycatch rates of up to 92% (e.g. Kraus *et al.*. 1997; Dawson *et al.* 1998; Barlow & Cameron 1999; SMRU 2001; Larsen *et al.* 2002a). As a result, pinger deployment has been introduced as a mandatory management requirement in several fisheries (e.g. in the USA, the Gulf of Maine bottom-set gillnet fishery and the Californian driftnet fishery).

However, there are serious concerns about the use of pingers as a bycatch mitigation measure. The devices are expensive, require maintenance such as periodic battery changing, are prone to failure and may interfere with the setting and hauling of the nets. These factors make them generally unpopular with fishermen (Read 2000). There are also serious problems with monitoring and enforcing their use. The efficacy of pingers has been observed to decrease substantially when deployed in a commercial fishery rather than a controlled trial and also over time. For instance, porpoise bycatch in nets equipped with pingers in the Gulf of Maine gillnet fishery was found to increase from 0 porpoises per haul in 1997 to 0.3 porpoises per haul in 1999 (NMFS 2000). There is some evidence that porpoises may become habituated to pingers after prolonged exposure, showing lessened reactions (Cox *et al.* 2001). Finally, there is considerable concern that the continuous and widespread deployment of pingers may result in exclusion of harbour porpoises from critical habitats with potentially negative consequences for their conservation status (CEC 2002a).

In the north-east Atlantic region, trials to test the efficacy and practicality of pingers began in the Celtic Sea bottom-set gillnet fishery for hake in 1998. In this fishery, operated by English and Irish vessels, the trial initially used a UK-manufactured device, known as the PICE pinger, which had recently been successfully tested in Denmark (SMRU 2001). However, the devices suffered technical failure and had to be abandoned. In 1999, the project was restarted using American Dukane pingers and continued for six months. The results demonstrated that the porpoise bycatch rate in the pingered nets was 92% lower than that in the unpingered nets (SMRU 2001). However, the trial also revealed practical problems with attachment of the devices, observed damage to the pingers (27%) and failure of some devices as a result of poor connections. The researchers concluded that although they recorded a substantial reduction in bycatch rate, there are practical issues associated with pingers, such as attachment and battery changing as well as cost that might make the industry reluctant to adopt them. They also noted that effective monitoring and enforcement of pinger use will be very difficult and that any mandatory scheme must be accompanied by an independent observer programme to monitor the efficacy of the pingers (SMRU 2001).

In March 2003 the UK Government produced a consultation document outlining proposals for measures to reduce bycatch of small cetaceans in UK fisheries (DEFRA 2003). Amongst other measures, the strategy proposes the compulsory use of pingers in UK bottom-set gillnets in the western Channel and Celtic Sea area (outside the 6-mile limit), in all UK set-net fisheries using a mesh size greater than 220 mm in the central and southern North Sea, and in the North Sea wreck net fishery (on nets up to 300 m long). The development of these proposals is still under consideration by the Government. However, an immediate observation by the fishing industry was that they should not be expected to invest in expensive equipment if it is not clear which, if any, pingers would function effectively in their fishery. As a result, in September 2003 a pinger deployment trial was initiated in the Celtic Sea hake fishery, to test the practicality and durability of the four devices currently available (Airmar, Aquamark, Fumunda and Save Wave). The first phase of the trial was conducted over the course of one commercial fishing trip, during which most of the pingers were subjected to four shooting/hauling cycles. At the end of this phase only one of the four pinger models tested had performed satisfactorily. The manufacturers are planning improvements (Seafish 2003).

In Denmark, following various trials in the late 1990s, the Danish action plan to reduce bycatch of porpoises in the North Sea (Ministry of Environment and Energy 1998) was adopted. As part of this, a regulation was introduced in 2000 requiring pingers to be used in all Danish bottom-set gillnet fishing using nets up to 300m long in the North Sea from August to October (Larsen *et al.* 2002a). In effect, this requirement applies only to wreck-net fishing for cod, and in the period of highest observed porpoise bycatches. Observations during 2000 and 2001 recorded no porpoise bycatches in 129 wreck-net sets with pingers, whereas two porpoises were caught in 11 wreck-net sets without pingers during the same period in 2000 (Larsen *et al.* 2002a). The researchers conclude that the use of pingers in the Danish North Sea wreck-net fishery has eliminated bycatch of harbour porpoises, although they acknowledge that even with functional pingers on the nets they should expect to see some porpoise catches in future. They also note that it is important to continue monitoring the wreck-net fishery to assess the efficacy of pinger use and any signs of porpoise habituation.

Recently there has been some research into interactive pingers, where the deterrent sounds are triggered by the sonar clicks of the approaching porpoises (Amundin *et al.* 2002). This approach aims to address several concerns as it reduces noise pollution by only transmitting sounds when they are needed, and thus also delays habituation. To date, results of this work have only been reported from trials carried out using captive harbour porpoises in Denmark (CEC 2002a), although sea trials were scheduled for summer 2002.

4.2.3 Acoustic deterrent devices (pingers) in pelagic trawls

The potential for pingers to reduce bycatch of cetaceans in pelagic trawl nets has been investigated recently. In response to the high dolphin catch rate recorded in the UK sea bass pelagic pair-trawl fishery, pingers were deployed during 2001, the first year of mitigation trials. Dukane pingers were simply placed around the mouth of the trawl of one pair with the intention of deterring animals from entering (Northridge 2003b). However, the rate of dolphin bycatch was found to be higher in the 15 tows conducted with pingers than it was in the 37 tows without pingers. This trial was therefore abandoned. During further trials in the UK sea bass fishery in 2003, Aquamark pingers were deployed, this time placed well back in the trawl in order to deter animals from swimming into the rear part of the net. The pingers were intended to be removed and replaced on a daily basis on two of the observed pairs. However, rigorous trials were not completed because in both of the pairs, high catches of dolphins occurred in the first tow of the trial when no pingers were in place (20 animals in two tows with no pingers deployed), and both the skippers asked to have pingers installed and kept in place for the rest of the trial (catching eight dolphins in 32 tows with pingers deployed) (Northridge 2003a). Although the bycatch rate appears to be much lower in the pingered nets than in the unpingered nets, dolphins were caught in both cases and, because the trial was unbalanced, no conclusions could be drawn on the effect of the pingers on bycatch rates.

Pingers are also being investigated in the Irish pelagic pair-trawl fishery for albacore tuna (BIM 2003). The alarm system being developed looks at deterring dolphins from the vicinity of the trawl when the risk of cetacean bycatch is believed to be high, i.e. when there is a change in net geometry, for instance resulting from the vessel changing course or hauling the net. A prototype system was tested during the tuna season from July to September 2002, consisting of a control unit in the wheelhouse of the boat which communicates with an underwater pinger, via a through-water acoustic link.

The system is triggered manually from the wheelhouse to coincide with high-risk manoeuvres (BIM 2003), an approach which is predicted to reduce the risk of habituation of the cetaceans. The trials have also investigated the use of Aquamark pingers, which automatically emit signals at randomised intervals. Four pingers were placed round the trawl, about halfway back in the net.

Although the details of the Irish trials have not yet been published, the results are reported to be encouraging and suggest that the devices are effective in reducing cetacean bycatch (BIM 2003). However, the manually triggered device, although technically feasible, is considered to be risky as errors may occur. Further work in 2003 is to investigate the possibility of automatic or interactive activation of pingers when the vessel starts to manoeuvre or when an echolocating animal approaches (BIM 2003).

4.2.4 Net modifications

Several different approaches to reducing porpoise bycatch in gillnets by modifying the netting material have been investigated. Attempts have been made to increase the acoustic properties of the nylon used in gillnets by impregnating it with a dense material (such as barium sulphate). Such modified nets, described as "acoustically reflective nets", were trialled in the Bay of Fundy. No porpoise catches were recorded in 124 strings of modified nets, compared to at least one porpoise caught in seven of 242 control strings, but low bycatch rates in both the modified nets and the controls prevented any definitive conclusion being drawn about the efficacy of the modified nets (Trippel *et al.* 2000). No significant difference was observed in the catch rate of the target species in this trial.

A further study of impregnated nets was conducted in the Danish North Sea bottom-set gillnet fishery. Here, the netting was modified using iron oxide and described as "high density net" (Larsen *et al.* 2002b). The trial recorded no porpoises caught in the modified nets, compared to eight caught in the control nets. However, the sampled effort was insufficient to draw a clear conclusion because the trial was terminated prematurely. This occurred because of the significantly reduced (20%) catches of the target cod in the modified nets. Surprisingly, the Danish researchers found that the acoustic properties of the 'reflective' net were no different to the unmodified net. They conclude that the reduced porpoise catches, and indeed fish catches, are probably explained by the increased stiffness of the net rather than its acoustic detectability (Larsen *et al.* 2002b).

Whatever the mechanism, if high-density netting can be demonstrated to be effective at reducing bycatch, it has the potential to offer a simple and inexpensive mitigation measure. However, the heavier and bulkier nets and reduced fish catches are unlikely to make this an attractive option for fishermen.

The diameter of the twine used in gillnets may significantly affect the level of porpoise bycatch according to an analysis of observer-collected bycatch data from gillnet fisheries (Palka 2000). Lower bycatch levels seem to be associated with thinner twines, although it is not clear why this would be the case. The effect of twine diameter and other net characteristics on bycatch is currently being investigated in trials conducted by SMRU in the UK (Simon Northridge, SMRU, pers.comm.). A similar association seemed to be evident from differences in bycatch rates in monofilament and multi-monofilament nets (Northridge *et al.* 2001). However, when this factor was investigated experimentally, no differences in porpoise bycatch rate were found.

4.3 Management mitigation measures

4.3.1 Effort reduction

In general terms, the most direct way to reduce bycatch is to reduce the amount of fishing effort. However, this approach will produce the greatest bycatch benefit if the effort reduction can be targeted at those fishing sectors or gear types with the highest bycatch rates (CEC 2002b).

Reducing fishing effort is not likely to be a popular mitigation measure. However, when effort reduction is being introduced for other management purposes, such as fish stock conservation, the greatest reductions in cetacean bycatch could be achieved if such effort reduction was targeted at the vessels using the gears with the highest bycatch or within the times or areas with the highest bycatch. The danger in relying on effort reductions resulting from fish stock conservation measures to gain cetacean bycatch reductions is that, without other precautions in place, when fish stocks recover and fishing effort increases, the bycatch is likely to increase as well.

The European Commission has identified priority measures for the integration of environmental protection requirements into the Common Fisheries Policy (CFP), which include the reduction of fishing pressure on fishing grounds to sustainable levels (CEC 2002c). It specifies that *"this reduction should target fishing activities having adverse effects both on the sustainability of fish stocks and on the favourable conservation status of non-commercial species and habitats"*. However, there are as yet no examples of targeted effort reduction being introduced in the EU for the purpose of cetacean bycatch reduction.

4.3.2 Time and area restrictions

Addressing cetacean bycatch through restriction or closure of fisheries over a particular period or area is only likely to be effective when bycatch is known to occur predictably at higher levels at that time or in that area than at other times or places (Read 2000). In other words, time/area restrictions will be of little use where there is little spatial or temporal variation in the bycatch rate. Time closures need not be on a monthly or seasonal basis but, if a diurnal pattern of bycatch is evident, could be applied to the time of day or night that fishing occurs (CEC 2002 b).

There are potential pitfalls with the use of such partial restrictions. For instance, if an area is closed to a particular gear type either permanently or seasonally, fishermen may switch to a different gear type or continue fishing with the same gear elsewhere, possibly in waters adjacent to the closed area (CEC 2002b). The environmental effects of either of these outcomes need to be assessed before such management measures are introduced. This may militate against the introduction of such measures, if the consequences for either cetacean bycatch or other environmental parameters are found to be negative. Alternatively, it could result in the introduction of additional safeguards to ensure that the measure does not result in negative consequences elsewhere.

In the Gulf of Maine bottom-set net fishery, time/area closures were introduced in 1994 that actually resulted in an increase in harbour porpoise bycatches. A review of the measures concluded that they failed because the area and duration of the closure were not adequate to cover the variation in spatial and temporal distribution of bycatches, and because of the displacement of fishing activity and bycatch to outside the closed area (Murray *et al.* 2000).

Time/area restrictions can also be combined with the use of technical mitigation measures. The requirement on the use of pingers in the Danish North Sea cod wreck-net fishery only in the third quarter of the year (i.e. the period of highest porpoise bycatch) is an example of this approach. Observer monitoring of this measure demonstrated that porpoise catches were reduced to zero in the pingered fishery during the first two years (Larsen *et al.* 2002a). However, the report of this work does not include any assessment of the levels of fishing effort in the wreck-net fishery, or whether the pinger requirement may have resulted in any redistribution of effort into other periods or fishing métiers.

4.3.3 Alternative gear types

Some fishing gear types are inherently prone to cetacean bycatch and in some cases the most effective way to solve the problem is to stop their use and introduce alternative gear types. For instance, the plan drawn up for the recovery of harbour porpoises in the Baltic Sea (the Jastarnia Plan), recommends that trials of fish traps, fish pots and longlines should be conducted with the goal of replacing gillnets in the cod fishery (ASCOBANS 2002). It also suggests that driftnets used in the salmon fishery should be replaced with longlines in areas where porpoise bycatch is likely to occur.

However, it is important when prohibiting the use of one gear type that an adequate assessment is made of the alternative gears that may replace it and their potential impacts. For instance, the EU ban on driftnets used for tuna and other large pelagic fish was introduced in 2002 largely because of the high bycatch of dolphins and other wildlife species (see 3.4.1). However, one consequence of this has been a growth in the use of pelagic pair trawls to catch tuna, which may have a bycatch of dolphins even greater than the driftnets (see 3.2.4).

4.3.4 Emergency measures

It has been proposed that timetabled default management options should be adopted in the absence of effective implementation of bycatch reduction measures (ICES 2002). Such measures could include the restriction or closure of fisheries, for instance where critical new bycatch problems are identified, where other mitigation measures are unavailable or ineffective, or where bycatch reduction targets are not met. In particular, where there is evidence of a serious threat to the conservation of cetacean populations, such emergency measures could be introduced under the provisions of the new Framework Regulation on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy (see 5.3.1).

4.4 Bycatch management framework

Experience from around the world has shown that bycatch reduction can be achieved most effectively if mitigation measures are tailored to individual fisheries and their particular circumstances, and that this tailoring is best done by a combination of relevant fishermen, scientists, managers and conservationists (ICES 2002). However, to achieve this case-by-case approach and to implement it effectively in the complex, multinational fisheries that occur in EU waters will require the creation of a formal and strategic management framework and prescribed procedures for identifying and responding to bycatch problems.

In its 2002 report to the European Commission on incidental catches of small cetaceans, the Subgroup on Fishery and Environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF) concludes that, in order for the issue be properly addressed, “a bycatch management framework should be established at an EU level at the earliest opportunity” (CEC 2002b). The subgroup goes on to list the vital components of such a management framework.

Identification of overall management goals is highlighted as a vital prerequisite for any management scheme. In the case of cetacean bycatches in the European context, the aim adopted by ASCOBANS of restoring or maintaining cetacean populations at or above 80% of their notional environmental carrying capacity (see 5.2.2) has been identified as an appropriate goal (CEC 2002b).

Within the overall management framework there must be a monitoring and surveillance programme to identify fisheries, or times and areas where cetacean bycatch is a problem and to quantify bycatch levels. Timely assessments of cetacean populations are necessary, as is an agreed means of determining the level of conservation threat. A formal institutional framework is required in which to devise bycatch reduction plans where these are necessary, with set bycatch reduction targets and time-frames. Further, there must be a means of implementing bycatch reduction plans, including effective enforcement and continuous monitoring and feedback to ensure that the overall objectives are met (CEC 2002b). An additional recommendation has been made by ICES that timetabled default management options should be applied if bycatch mitigation is not implemented effectively (ICES 2002). In other words, measures to reduce bycatch should be imposed (which could include restriction or closure of the fishery) if bycatch reduction targets are not met.

5. Bycatch regulation

5.1 Regulation of bycatch around the world

5.1.1 International treaties, conventions and agreements

A large number of international and regional treaties, conventions and agreements have a bearing on the protection of the marine environment; many of them cover fisheries or the exploitation of living marine resources, and several make specific commitments or resolutions on the matter of incidental capture of cetaceans. The United Nations Convention on the Law of the Sea (UNCLOS) of 1982 places a duty on states to make sure that species associated with or dependent on harvested species are not depleted to levels at which they would become seriously threatened. The problem of indiscriminate fishing methods has also been addressed within the Rio Earth Summit (1992), the UN Food and Agriculture Organisation Code of Conduct for Responsible Fishing (1994) and the Rome Consensus on World Fisheries (1995). In particular, the 1995 Agreement for the Conservation and Management of Straddling Fish Stocks requires that the catch of target and non-target species is reported along with compliance with regional organisations which have specific measures aimed at minimising catches of non-target species (Gillespie 2002).

The issue of bycatch has become prominent within the International Whaling Commission (IWC) which, as early as 1975, recommended that member nations begin to record the bycatch of small cetaceans. The Convention on Migratory Species of Wild Animals (CMS) has also taken a serious interest in bycatch, passing a resolution (Resolution 6.2) in 1999 which recognises bycatch as one of the major causes of mortality of migratory species in the marine environment and requires Parties to the Convention to minimise as far as possible the incidental mortality of migratory species (CMS 1999). This resolution was reaffirmed and reinforced in 2002 when the CMS Parties emphasised that bycatch remains one of the major causes of mortality from human activities in the marine environment and recommended a speedy implementation of CMS Resolution 6.2 (CMS 2002).

5.1.2 National legislation elsewhere

There are several notable examples from around the world of national legislation that has been introduced specifically, or is being applied, to address the problem of cetacean bycatch. While none is held up as the panacea, and bycatch still presents serious problems in these countries, the process that has been adopted in the United States and some of the principles being applied in New Zealand are progressive and provide important precedents that could be applied in the north-east Atlantic region.

In the United States, the incidental capture of cetaceans is regulated by the Marine Mammal Protection Act (MMPA), which was amended in 1994 to address interactions between marine mammals and commercial fisheries. The Act identifies the following goals:

i) reducing incidental mortality or serious injury of marine mammals occurring in the course of commercial fishing operations to below Potential Biological Removal (PBR, defined as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) within 6 months of enactment; and

ii) further reducing these mortalities and serious injuries to insignificant levels approaching a zero mortality and serious injury rate by 2001.

The MMPA requires assessments to be made of the status of marine mammal stocks, including stock structure, abundance, trends and levels of anthropogenic mortality. It further requires fisheries to be categorised according to their likelihood of catching marine mammals, which is assessed through compulsory carriage of observers (Read 2000). If the magnitude of bycatches, or other anthropogenic mortality, exceeds PBR for a stock of marine mammals, that stock is deemed to be strategic, and the MMPA requires that a take reduction plan be developed. Such plans must include regulatory and/or voluntary measures that will reduce mortality and serious injury levels to below PBR within six months of their implementation. The take reduction plans are developed by teams of stakeholders, including representatives from the commercial fishing industry, conservation groups, scientists, federal and state officials, and fisheries management councils. If the team cannot reach consensus on the plan, the Secretary of Commerce is required by the MMPA to develop a plan to reduce takes below PBR. This default provision has acted as an incentive for stakeholders of diverse backgrounds and interests to work together to develop bycatch mitigation strategies (Read 2000).

This system has been implemented in a range of fisheries throughout US waters and, while not without problems, it has made significant steps towards reducing bycatch in some of the fisheries addressed (see Read 2000 for individual case studies of four take reduction teams).

In New Zealand, the Government has acknowledged that increased fishing effort in recent years has resulted in the incidental capture of significant numbers of non-target species of marine wildlife protected under New Zealand law, including Hector's dolphin. As a response, the New Zealand Government introduced in 1996 a scheme to recover from the domestic commercial fishing industry the funding required to investigate and mitigate the impacts of fishing on protected species of marine wildlife (West *et al.* 1999). Conservation Services Levies are approved by the Minister of Conservation, administered by the Department of Conservation, and are collected by the Ministry of Fisheries. The levies are set annually following extensive consultation between the relevant government agencies and stakeholder groups. Levies are primarily used to boost observer coverage in selected fisheries, to monitor the status of protected species known to be incidentally taken in fishing operations, and to develop ways of mitigating the bycatch of species protected under the New Zealand Marine Mammals Protection Act 1978 and the Wildlife Act 1953. These levies give fishermen a strong financial incentive to address their interactions with protected species and thus negate the need for levies to be paid (West *et al.* 1999).

In Australia, the Environment Protection and Biodiversity Conservation Act 1999 is the primary instrument for actions to protect and assist the recovery of endangered species and ecological communities. Under this Act, endangered or vulnerable species can be listed along with key threatening processes, for each of which a Threat Abatement Plan must be prepared. In the case of bycatch, the plan outlines actions to implement mitigation measures that are known to be effective in reducing bycatch, provide for the development of new measures or improvements to existing measures, educate fishermen about threat mitigation and collect information to support future management decisions. Threat Abatement Plans are developed in consultation with the fishing industry, non-governmental conservation groups, scientists and government authorities responsible for conservation and fisheries management. However, Australia has temporarily exempted the major fishing operations from cetacean bycatch assessment under the current passage of the Act and none of the Act's provisions are being used to mitigate cetacean bycatch.

5.2 Existing obligations within the north-east Atlantic

5.2.1 Regional conventions and agreements

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention), which came into force in 1998, addresses the issue of bycatch, highlighting the need for more research and information on the effects of fishing on non-target species such as marine mammals, amongst other impacts, and for improvements in the monitoring and reporting of bycatch and discards (OSPAR 2000). Equally, the North Sea Conferences have repeatedly raised this issue. Most recently, in 2002 the Ministerial Declaration of the Fifth International Conference on the Protection of the North Sea (the Bergen Declaration) included agreement of a precautionary objective to reduce bycatches of marine mammals to less than 1% of the best available population estimate. The ministers also agreed to develop, and adopt as soon as possible, a recovery plan for harbour porpoises in the North Sea (Anon. 2002).

However, the fora that probably have most bearing on the issue of cetacean bycatch in the north-east Atlantic region are the CMS Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and the European Union (EU). These are addressed in more detail below.

5.2.2 ASCOBANS

The Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas was set up under the auspices of the Convention on Migratory Species of Wild Animals (CMS). It came into force in 1994 and currently has eight Parties (Belgium, Denmark, Finland, Germany, the Netherlands, Poland, Sweden and the UK). Other Range States, including France and Lithuania, are currently in the process of accession (ASCOBANS 2003c).

In the text of the Agreement, Parties recognise *"that small cetaceans are and should remain an integral part of marine ecosystems"* and that bycatches, along with habitat deterioration and disturbance, may adversely affect populations in the Baltic and North Seas. They therefore undertake to cooperate closely in order to achieve and maintain a favourable conservation status for small cetaceans. In particular, Parties agree to apply specific conservation, research and management measures which include *inter alia "the development, in the light of available data indicating unacceptable interaction, of modifications of fishing gear and fishing practices in order to reduce bycatches"* (ASCOBANS 1991).

The aim of ASCOBANS was agreed at the Second Meeting of the Parties (MoP) in 1997 as *"to restore and/or maintain biological or management stocks of small cetaceans at the level they would reach when there is the lowest possible anthropogenic influence"*. A suitable short-term practical sub-objective was specified: to restore and/or maintain stocks/populations to 80% or more of the carrying capacity (ASCOBANS 1997). The Parties also agreed that the general aim should be *"to minimise (i.e. to ultimately reduce to zero) anthropogenic removals within some yet-to-be specified time frame, and that intermediate target levels should be set"*.

The Second MoP defined a level of *"unacceptable interactions"* as being, in the short term, a total anthropogenic removal above 2% of the best available estimate of abundance (ASCOBANS 1997). However, when in 1999 the IWC-ASCOBANS Working Group on Harbour Porpoises was tasked with assessing their status in the North Sea and adjacent waters, it advised that, using a basic population model for harbour porpoises and assuming no uncertainty in any parameter, the maximum annual bycatch that achieves the ASCOBANS interim objective over an infinite time horizon is 1.7% of the population size in that year. If uncertainty is considered, such as in estimating population size, maximum annual bycatch must be less than 1.7% to ensure a high probability of meeting the objective. They further stated that meeting the objective in a shorter time will require that annual bycatch be reduced to an even lower fraction of the abundance (Anon. 2000).

As a result, at the Third MoP in 2000 a resolution was passed that *"defines, for the present … unacceptable interactions"* as being, in the short term a total anthropogenic removal above 1.7% of the best available estimate of abundance"(ASCOBANS 2000b). The resolution also notes that in the case of a severely reduced population, or of species other than the harbour porpoise, or where there is significant uncertainty in parameters such as population size or bycatch levels, then unacceptable interaction may involve an anthropogenic removal of much less than 1.7% (ASCOBANS 2000b). The Parties called on competent authorities to take precautionary measures to ensure that the total anthropogenic removal of marine mammals in the ASCOBANS area and adjacent waters is reduced as soon as possible to below an unacceptable interaction level. The meeting also identified the intermediate precautionary objective "to reduce bycatches to less than 1% of the best available population estimate" (ASCOBANS 2000b).

Although bycatch has been recognised by ASCOBANS as being the highest-priority threat to the conservation of small cetaceans, it was noted by the Chair of the Advisory Committee in 2000 that least progress has been made by the Agreement with respect to this factor (ASCOBANS 2000a). Indeed, at the Fourth MoP in August 2003, in a resolution passed on incidental take, Parties regretted "that the recommendations set out [at the Third MoP] to reduce bycatch to below 'unacceptable interaction' levels have probably not been fulfilled" (ASCOBANS 2003b). The Parties also noted the increasing levels of stranded cetaceans on coasts of the Celtic Sea and adjacent waters, which may be caused by interaction with pelagic trawling.

However, ASCOBANS has made some progress with respect to the harbour porpoise in the Baltic Sea. In 2002, the ASCOBANS Recovery Plan for Baltic Harbour Porpoises (Jastarnia Plan) was finalised (ASCOBANS 2002), the culmination of considerable political and scientific effort, managed under the auspices of ASCOBANS since 1997. In brief, the objectives of the plan are to:

a) implement precautionary management measures immediately to reduce the bycatch rate to two or fewer porpoises per year in the portion of the Baltic that was surveyed in 1995;
b) improve knowledge in key subject areas as quickly as possible; and
c) develop more refined (quantitative) recovery targets as new information becomes available on population status, bycatch and other threats.

The Jastarnia plan was supported by the Parties in a resolution passed at the Fourth MoP (ASCOBANS 2003b) and the Meeting emphasised the importance of Parties and Range States now implementing the Plan.

A further significant development at the Fourth MoP of relevance to bycatch was agreement of the extension of the ASCOBANS area. The new area encompasses waters west of the UK and Ireland to longitude 15º W, and southwards to include the Bay of Biscay and waters west of Spain and Portugal to latitude 36º N, where it meets the boundary of the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS). The name of the Agreement is, therefore, changed to the Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS 2003d).

However, the limited capacity of ASCOBANS to make commitments, or even influence policy, relating to fisheries management was highlighted at the Fourth MoP. It was emphasised in the resolution passed on incidental take that the European Community has exclusive competence for the conservation, management and exploitation of living aquatic resources in the context of the Common Fisheries Policy (ASCOBANS 2003b).

5.3 Existing EU legislation

5.3.1 Common Fisheries Policy

The CFP has evolved through a series of developments, initiated by the signing of the Treaty of Rome which established the European Economic Community in 1957 (Coffey 1995). Since this time, new Member States have joined the Community and various regulations and agreements have been introduced shaping policy, for instance with regard to access to Member States' territorial waters, 200-mile limits, and so on. In 1983, the introduction of Regulation 170/83 established a twenty-year system for the conservation and management of fisheries resources in EC waters. A mid-term review of the CFP followed in 1992, and resulted in a new system for fisheries and aquaculture under Regulation 3760/92.

In short, under the European Community's Common Fisheries Policy (CFP) only the Community has competence in fisheries matters. This means that only the European Commission can propose new legislation on fisheries and only the Council of Ministers can adopt that legislation. Member States can (within limits) apply more stringent national rules to the activities of their own vessels and within their own waters (DEFRA 2003).

In 2002, a major review of the CFP was conducted, with an explicit objective to minimise the impact of fishing activities on marine ecosystems, and in particular non-target species and sensitive habitats (CEC 2002d). This resulted in the adoption in December 2002 of a new Framework Regulation (EC) No. 2371/2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy. Article 2 defines the objective of the CFP as *"to ensure exploitation of living aquatic resources that provides sustainable economic, environmental and social conditions"*. It further states that "the Community shall apply the precautionary approach in taking measures designed to protect and conserve living aquatic resources, to provide for their sustainable exploitation and to minimise the impact of fishing activities on marine ecosystems. It shall aim at a progressive implementation of an ecosystem-based approach to fisheries management."

Among the many new provisions in the Framework Regulation are powers for the introduction of emergency measures. *"If there is evidence of a serious threat to the conservation of living aquatic resources, or to the marine ecosystem resulting from fishing activities and requiring immediate action, the Commission, at the substantiated request of a Member State or on its own initiative, may decide on emergency measures"* (Article 7). These can last for up to six months (extendable for another six months). Similarly, if there is evidence of such a serious and unforeseen threat resulting from fishing activities in waters falling under the sovereignty or jurisdiction of a Member State and where any undue delay would result in damage that would be difficult to repair, that Member State can take emergency measures, not exceeding three months (Article 8).

To date, only three pieces of EU legislation have been introduced under the CFP that relate specifically to cetacean bycatch. In 1992, Regulation (EC) No 345/92 restricted the length of driftnets to 2.5 km. In 1998, the introduction of Regulation (EC) 1239/98 provided for the phasing out of all driftnets used to catch tuna, swordfish and similar listed species, and their total prohibition from 1 January 2002. Both these provisions apply to all EU waters (with the exception of the Baltic Sea, which is exempt from both provisions) and, outside those waters, to all EU fishing vessels. In addition, Regulation (EC) No 973/2001 prohibits the encircling of schools or groups of marine mammals with purse seines, except in the case of vessels operating with a dolphin mortality limit (DML) under the conditions laid down in the Agreement of the International Dolphin Conservation Program in the Eastern Pacific Ocean.

5.3.2 The Habitats Directive

Council Directive 92/43/EEC on the Conservation of Natural Habitats and Wild Fauna and Flora (the 'Habitats Directive') was adopted in May 1992. Article 2 of the Directive places a duty on Member States to ensure that any measures taken under the Directive are designed to *"maintain or restore, at a favourable conservation status, natural habitats and species of wild fauna … of Community interest"* (which include all cetaceans). Article 11 requires Member States to undertake surveillance of the conservation status of these natural habitats and species. Article 12 requires Member States to establish a system of strict protection for the animal species listed in Annex IV(a) (which include all cetaceans).

Most specifically, Article 12.4 requires Member States to establish a system to monitor the incidental capture and killing of Annex IV(a) species. In the light of the information gathered, Member States are required to take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned.

It is evident that Member States are not meeting their obligations under Article 12.4 of the Habitats Directive, and this fact has been acknowledged by the European Commission in the Explanatory Memorandum accompanying its proposal for a new Council Regulation on cetacean bycatch (CEC 2003a). This states that *"the Commission has come to the conclusion that the measures taken so far are insufficient or lacking in coordination"* and that *"additional Community action is needed in the fisheries sector to improve, in a consistent and cooperative manner, measures aimed at the conservation of small cetaceans."*

5.4 Proposed EU regulation on incidental catches of cetaceans

As part of the 2002 review of the CFP, the European Commission set out an Action Plan to integrate environmental protection requirements into the CFP. Part of this was a commitment to introduce a *"new set of technical conservation measures designed to reduce bycatch of cetaceans to levels guaranteeing favourable conservation status of cetacean populations before 31 December 2002"* (CEC 2002c).

In June 2003 the Commission published its Proposal for a Council Regulation laying down measures concerning incidental catches of cetaceans in fisheries and amending Regulation (EC) No 88/98 (CEC 2003a). This Proposal is based on advice provided by ICES (e.g. ICES 2002) and the Subgroup on Fishery and Environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries (STECF) (CEC 2002a and b) and also on various consultations.

The Proposal consists of three main measures:

1 restrictions on the use of driftnets in the Baltic Sea (Article 9: introducing an immediate length limit of 2.5 km, and phasing them out completely by 1 January 2007);
2 the mandatory use of acoustic deterrent devices in certain fisheries (Articles 2 and

3: Annex I specifies the fishing gear, areas and periods in which pingers are compulsory, including driftnets, bottom-set gillnets and tangle nets in the Baltic Sea, wreck nets and large-mesh bottom-set gillnets in the North Sea and bottom-set gillnets and tangle nets in the Celtic Sea; Annex II sets out the technical specifications of the devices and conditions of use), and

3 coordinated monitoring of cetacean bycatch through compulsory onboard observers for given fisheries (Articles 4 and 5: Annex II specifies the fisheries to be monitored and levels of coverage required, including driftnets in the Baltic Sea, North Sea and waters west of the UK and Ireland, pelagic trawls west of the UK, Ireland, France, Spain and Portugal as well as in the North Sea, high opening trawls, and fisheries required to use pingers as listed in Annex I; also Article 5 sets out the qualifications required of observers, their tasks and reporting requirements).

While the Proposal has generally been welcomed by conservationists as a good first step, a number of weaknesses and serious omissions have been highlighted (e.g. WDCS 2003). Broadly, these concern the degree of emphasis on pingers, the adequacy of proposed observer coverage levels, the lack of management objectives, targets or a management framework for bycatch reduction and, more specifically, the absence of any measures, or even stated intent, to reduce bycatch in pelagic trawl fisheries. These concerns are discussed in more detail in Chapter 6 below.

The proposed Regulation will go through a process of scrutiny and negotiations in Council Working Groups consisting of civil servants from the Member States, in the Fisheries Committee of the European Parliament, and then in the European Parliament itself before the final decision is made in the Council of Fisheries Ministers. This process is expected to extend well into 2004 and possibly beyond, and its outcome is likely to be affected by the level of public interest and concern in the matter.

In the meantime, the European Commission has issued a contract for a study, using trained observers, of the numbers of cetaceans bycaught in pelagic trawls in the north-east Atlantic (CEC 2003b). The study is directed to give priority to the winter and spring fisheries of the Western Channel and the Celtic Sea (various pelagic fish and spawning sea bass), to the summer albacore fishery in the north-east Atlantic, and to the year-round fishery for anchovy in the Bay of Biscay. The observation of fisheries is expected to begin early in 2004.

6. Conclusions and recommendations

6.1 Significance of cetacean bycatch

Fisheries bycatch clearly represents a major problem for populations of small cetaceans, probably **the** major problem in many parts of the world and in the north-east Atlantic in particular. Numerous studies have investigated the issue in the north-east Atlantic over the past two decades, albeit in a mostly piecemeal and small-scale fashion, resulting in probably hundreds of publications over many thousands of pages. These have been funded by various national governments and in many cases by the European Commission. Clear indications of problems have emerged, both from onboard observer monitoring and from strandings records, and in some cases good estimates of the scale of the problem have been produced. What is astounding, therefore, is the almost total lack of any policy or, more importantly, practical response to the issue at either national or EU level (beyond the driftnet ban adopted in 1998).

The cetacean species that are most affected by bycatch in the north-east Atlantic, in terms of absolute numbers, are the common dolphin and the harbour porpoise. Bycatch of common dolphins has been recorded in the greatest numbers in pelagic trawl fisheries, and that of harbour porpoises in bottom-set gillnet fisheries.

In the case of pelagic trawls, there has been too little monitoring to date to be able to assess total mortality levels. However, the number and scale of pelagic trawl fisheries operating in the Celtic Sea, Biscay and Channel area, coupled with the number of stranded bycaught common dolphins recorded on surrounding coasts, indicate that the total mortality figure is likely to be high and probably unsustainable.

More monitoring has been conducted of bottom-set gillnet fisheries, at least in some areas, and this has clearly demonstrated large and unsustainable levels of harbour porpoise bycatch, particularly in the Celtic Sea and North Sea. In areas where porpoise population levels are very low, such as the Baltic Sea and the southern North Sea/eastern Channel, even a very low level of bycatch is extremely serious in conservation terms.

For other species, although bycatches may be lower in absolute numbers, the impact may be equally or possibly even more significant. For instance, bycatches in pelagic trawl fisheries include Atlantic white-sided dolphins, striped dolphins, long-finned pilot whales and bottlenose dolphins, most of which are considered to be far less numerous in the region than common dolphins. As both population and bycatch estimates for these species are at best only partial, the significance of these mortalities for local populations is unknown, but they are a potential major cause for concern. The bottlenose dolphin, for instance, is only recorded in very small isolated populations in the waters off south-west England and is also at risk from inshore gillnets. Any incidental capture of this species would be highly significant.

It is important to recognise that populations of many of these species are probably being impacted by several different fisheries (as well as other anthropogenic causes of mortality). For instance, the populations of common dolphins in the Celtic Sea, Biscay and Channel area have already been subjected over many years to bycatch in the pelagic tuna driftnet fishery (which has recently been terminated) at levels that were probably unsustainable. The limited studies of pelagic trawl fisheries to date, combined with evidence from strandings data, suggest that common dolphin mortalities in these fisheries may well be unsustainable. In addition, common dolphins are caught, if to a lesser extent, in bottom-set gillnet fisheries (and possibly others) in this area.

Equally, the harbour porpoise population in the Celtic Sea is already known to have been subjected to bycatch rates that far exceed what could be considered sustainable (over 6% per annum) in English and Irish bottom-set gillnets alone, for probably more than a decade. Other gillnet fleets in the Celtic Sea have yet to be investigated. Plus, there is now evidence from stranded animals in the UK that this species may also be being impacted by the pelagic trawl fisheries in this area.

Therefore, judgement of whether any individual interaction is 'sustainable' must be made in the context of total known or suspected mortality across the range of fisheries (and other causes of mortality) operating in an area. It must also take account of the cumulative depletion of populations that will be caused by unsustainable mortality levels. In principle, if an unsustainable level of bycatch continues unchecked, the significance of that mortality will become more acute year on year as the population is gradually depleted.

Current bycatch levels for several species are being judged against abundance estimates that may now be significantly above the true population levels, given the mortality rates that are assumed to have occurred in the years since population surveys were last conducted. Current cetacean abundance estimates in the north-east Atlantic are at best speculative, as the only major survey was conducted in the early 1990s, covering the North Sea (and eastwards), but only the Celtic Sea to the west of Britain and mainland Europe. For most populations there has been no assessment of trends or conservation status. In this respect, the large-scale cetacean abundance survey (SCANS II) planned to cover the North Sea and north-east Atlantic, broadly out to EU fisheries limits, in 2005 and 2006 is welcome. However, more continuous surveillance of population trends is also required.

Given all the major areas of uncertainty, it is vital that extreme precaution is applied in assessing the significance of cetacean bycatch and, in particular, in defining conservation and management objectives. It is recommended that the intermediate precautionary objective identified by ASCOBANS, to reduce bycatches to less than 1% of the best available population estimate, be the absolute maximum threshold that should be applied, and that targets and timeframes to reduce bycatch to below this level, and ultimately towards zero, should be adopted.

6.2 Assessment and monitoring of fisheries

The collection of data on fisheries, including effort, gear and location, must be improved, and these data must be comparable between fleets, in order to allow the extrapolation of bycatch rates to individual fisheries and the estimation of total mortality levels within an area or population. Also, the accessibility of these data, much of which are currently only available for enforcement purposes, needs to be extended to allow proper assessment of the impacts of fisheries.

Routine and ongoing monitoring of fisheries for cetacean bycatch is clearly essential in order to assess the nature and scale of the problem and also to acquire the information needed to be able to devise appropriate mitigation strategies. This can only be achieved reliably through independent onboard observers, with alternative monitoring strategies only in the extreme circumstances where an observer physically cannot be carried on a vessel. Given the reluctance of many governments to introduce routine monitoring of incidental capture (despite an obligation to do this under the Habitats Directive), and the refusal of some skippers and even whole fleets to carry observers where this has been proposed, compulsory observer schemes are the only way to ensure effective and equitable monitoring.

Monitoring of fisheries must continue after the introduction of mitigation measures in order to assess the adequacy of their implementation, and the efficacy of the measures in terms of bycatch reduction. Where there is potential for the mitigation measures themselves to have wider environmental impacts, as in the case of pingers, it is essential that there is proper investigation and monitoring of these and, of course, withdrawal of the measure if the wider impact is found to be unacceptable.

While the need to assess the impact of existing fisheries is now acknowledged and is being dealt with to some extent, no proposals have yet been forthcoming for the prior assessment of the environmental impact of new fisheries or changes in fisheries policy in order to prevent new problems from arising. While environmental impact assessment (EIA) and now also strategic environmental assessment (SEA) are routine procedures for many other sectors of industry, the fisheries industry has yet to be included. Clearly, until proper prior assessment is made of new fisheries developments or the wider implications of policy decisions, fisheries managers and politicians will continue to be fire-fighting. Dealing with problems after they have become entrenched becomes much harder politically, and results in greater and unnecessary environmental impact and also, ultimately, in a greater social and economic burden for the fishing communities involved.

6.3 Proposed new EU regulation

The European Commission's initiative to introduce the Proposal for a Council Regulation on incidental catches of cetaceans is an extremely important and welcome development, not least for its formal acknowledgement of the importance of cetacean bycatch as a major conservation threat and the inadequacy of the measures taken so far to address it. The proposed Regulation has some significant weaknesses that must be addressed, but it is important that the Regulation is adopted and implemented as soon as possible. However, even if the Proposal is adopted reasonably intact, it will not solve the EU's bycatch problems in itself. It will need to be built on with further and more far-reaching measures and this must be done quickly if the momentum of the initiative and the work that has led to it is not to be lost. Therefore, the following comments relate both to the measures put forward in the current proposal and to measures that are still required.

The proposed restrictions on driftnets in the Baltic Sea are extremely important. The Baltic population of harbour porpoises is severely threatened and is estimated to number as few as 600 animals, with fisheries bycatch in both bottom-set gillnets and driftnets presenting the major threat. The proposed immediate restriction on driftnet length to 2.5 km brings the Baltic very belatedly into line with the rest of the EU, and their proposed total prohibition by 2007 reflects the critical needs of this struggling porpoise population. These time frames should not be allowed to slip.

While the potential for effective deployment of pingers dramatically to reduce harbour porpoise bycatch in gillnets under certain circumstances is acknowledged, serious concerns remain over their practicality and efficacy in the longer term, their enforceability and their potential negative impacts through habitat exclusion. Therefore, although compulsory use of pingers may offer the best means of reducing the current unacceptable level of bycatch in the short term, they should not be considered or presented as a long-term solution. Indeed, the current proposal places too much emphasis on pingers to the exclusion of other potential mitigation measures and more selective fishing methods. It should be made clear that the pinger requirement is subject to review and will be time-limited. In the meantime, the Regulation should make provisions for a) comprehensive observer monitoring of vessels using pingers to assess both efficacy of deployment and bycatch rates; b) monitoring of cetacean populations in the affected areas to investigate any potential exclusion effects; and c) a parallel programme of development of other forms of mitigation and alternative fishing methods with an explicit view to phasing out pingers within a set timeframe.

The Commission's proposed requirement for at-sea observer schemes in fisheries that present a risk of cetacean bycatch is essential. This measure is fundamental to any efforts to quantify and address the bycatch problem across the broad range of fisheries in which it occurs. However, the levels of observer coverage set out in the Proposal represent only the minimum levels recommended by the scientific advisers (SGFEN) and in some cases fall below this. For instance, SGFEN recommended that observer coverage should be a minimum of 5–10% in the pelagic trawl fisheries in the Biscay, Celtic Sea and Channel areas, and "as high as feasible" during the December to March period when mass dolphin strandings occur. The Commission proposes only 5% coverage in these fisheries and 10% during these critical months. While even the proposed levels of observation would represent a major improvement in most fisheries, political and budgetary expediency must not be allowed to compromise the proper assessment of the scale and nature of the bycatch problem.

The Commission states in the accompanying documents that "scientists consider that mitigation of cetacean bycatch can be primarily addressed through an overall reduction in fishing pressure" and that this "is expected as a result of other community measures aimed at ensuring the sustainability of fisheries". While measures being planned and introduced to reduce fishing effort within the CFP are to be welcomed, effort reduction targeted at those fishing sectors and gear types causing the greatest impact should be more actively used as a bycatch reduction measure in its own right.

The Commission's Proposal does not identify any management objectives or targets for bycatch reduction. Nor are any management options identified in the event that reduction of bycatch levels is not achieved. Although the Commission acknowledges the need for a management framework within which a comprehensive strategy can be set up, it contends that this cannot be put together at this stage *"given the absence of precise information on bycatch patterns [etc]"*. On the contrary, a management framework is precisely the tool required to identify monitoring and surveillance requirements, assess the data that are collected, devise appropriate management responses for each specific fishery or area (bycatch reduction plans with clear targets and timeframes), oversee their implementation and enforcement, and evaluate their efficacy and impacts. Indeed, the first and key recommendation in the SGFEN final report is that "a management framework … needs to be implemented at an EU and other appropriate levels if cetacean bycatch is to be addressed adequately" (CEC 2002b). This must be introduced without delay.

6.4 Pelagic trawl fisheries

Although the Commission acknowledges that gillnets and pelagic trawls appear to contribute most cetacean bycatch in European fisheries, the proposed Regulation makes no provisions regarding the pelagic trawl sector beyond observer monitoring. To date, only a limited number of these pelagic fisheries have been monitored in any depth, so the compulsory observer monitoring provisions are extremely important. However, high dolphin bycatch rates have been recorded already in the Dutch mackerel and horse mackerel single-trawl fishery, the Irish albacore pair-trawl fishery and the UK sea bass pair-trawl fishery. The Community must make clear its intention to introduce without delay measures to reduce bycatch in those pelagic trawl fisheries where bycatch levels are found to be problematic.

While the UK's work to develop an exclusion device may show promising early results, these are currently only based on a very small dataset. There is still considerable uncertainty as to why the device appears to be working and whether this effect will continue in the longer term and without detriment to the dolphins. Therefore, there should be a parallel programme of research to investigate possible alternative mitigation measures or fishing methods for these fisheries.

In the absence of any other effective measures for the mitigation of bycatch in pelagic trawls, the Community must be prepared to introduce management measures including the suspension or closure of fisheries where necessary. In particular, where there is evidence of a serious threat to the conservation of cetacean populations, the Commission should introduce emergency measures, as provided for by Article 7 of the new Framework Regulation of the CFP ((EC) No 2371/2002).

Finally, the proposals put forward to date apply only to fisheries that operate within EU waters. However, there is evidence of substantial cetacean and other protected species bycatch occurring in the EU's considerable distant water fisheries such as the pelagic trawl fisheries off Mauritania. It is therefore, essential that provisions made for bycatch monitoring and mitigation (as well as the requisite provisions for surveillance and enforcement) are also reflected in the Community's regulation of its distant water fleets.

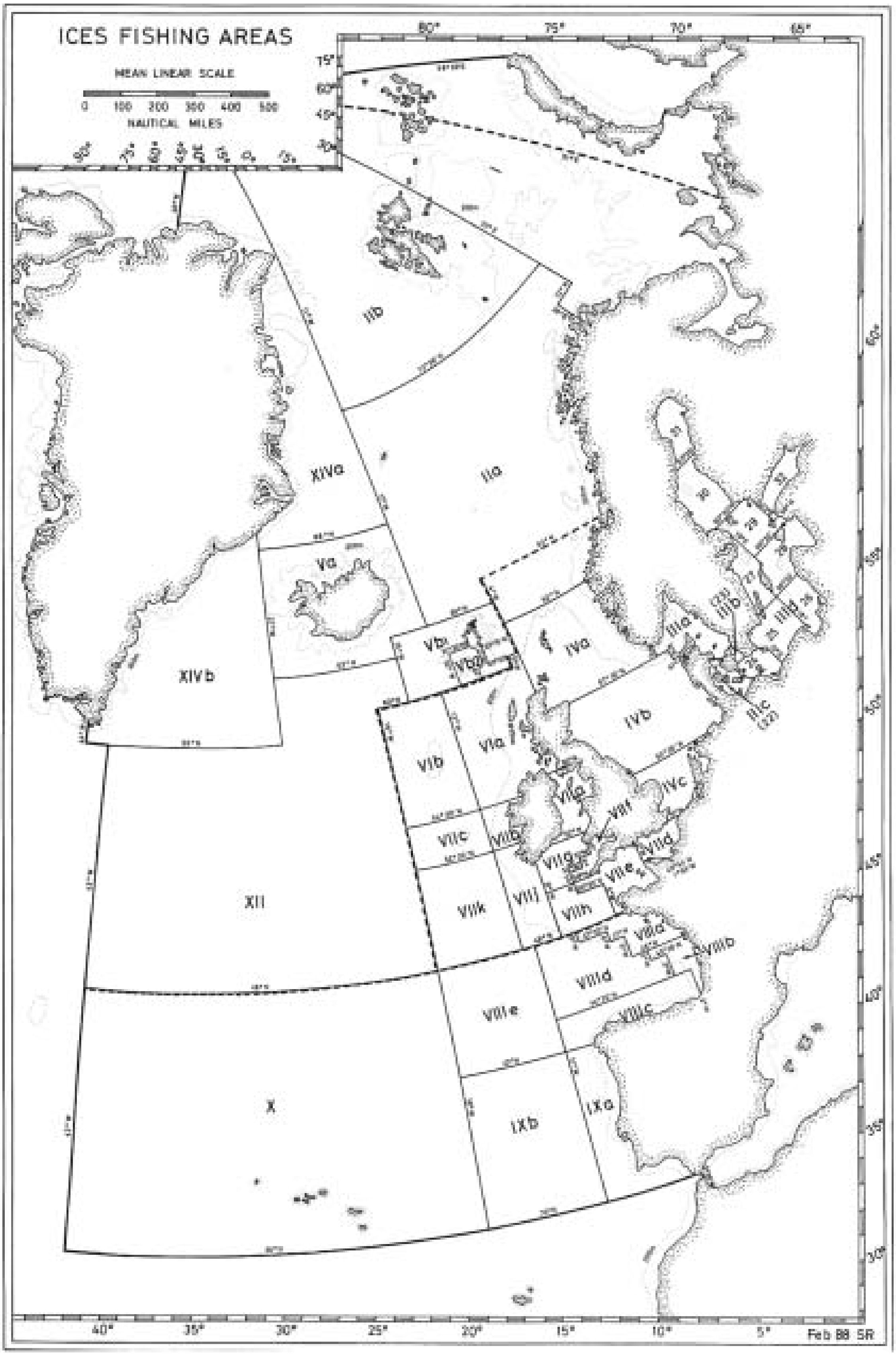
Acknowledgements

We would sincerely like to thank Marie-Pierre Gosselin for her assistance in researching this report. We are also grateful to Kristin Kaschner and Simon Northridge for their valuable input and to Henrique Cabral, Marina Sequeira, Carina Vonk, Stella Turk, Jan Haelters and Alfredo López for providing much useful information. We would like to thank many WDCS staff for their assistance, particularly Mark Simmonds, Jo Clark, Simon Keith, Kate O'Connell and Gina Davies. We also thank Doug Parr and others at Greenpeace for their support of this project.

This report was funded by Greenpeace Environmental Trust.

Appendix 1

ICES Fishing Areas in the north-east Atlantic



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Appendix 2

Breakdown of the French pelagic fleet for 1992

	1992			
	Quarter 1	**Quarter 2**	**Quarter 3**	**Quarter 4**
Northern Biscay	**Total:** 147 boats, working in pairs targeting horse mackerel or hake.	**Total:** 150 boats, working in pairs targeting sardine, hake and horse mackerel. (Also small activity in the Celtic Sea.)	**Total:** 137 boats, targeting anchovy and sardine.	**Total:** 79 boats, targeting anchovy.
	77 boats, pair trawlers with mesh size >20mm, targeting hake, sea bass and horse mackerel.	78 boats, working in pairs and targeting hake and horse mackerel (with some trips to the Celtic Sea).	90 boats, working in pairs, targeting small pelagic species such as anchovy, sardine and horse mackerel.	34 boats, working in pairs, targeting anchovy.
	62 boats, pair trawlers working with several gears, targeting horse mackerel, cephalopods and pollack.	42 boats, targeting sardine and mackerel.	47 boats, working with panel trawls (one trawl /single boat), targeting anchovy.	17 boats, working in pairs, targeting sardine and herring.
		33 boats, working in pairs using various types of trawls, targeting cuttlefish and pollack.		32 boats, targeting anchovy, using panel trawl.
Southern Biscay	**Total:** 103 boats, targeting anchovy and occasionally whiting.	**Total:** 108 boats, targeting sea bream, squid, anchovy, hake, Norway pout and other species.	**Total:** 131 boats, targeting tuna and swordfish. (Also offshore.)	**Total:** 48 boats, targeting tuna species and swordfish. Also capture other species including squid. (Sometimes work offshore.)
		16 boats, targeting sea bream and bass, and also capture herring and mackerel.*	22 tuna boats, working offshore, targeting tuna and swordfish.	16 boats, targeting horse mackerel, swordfish, tuna, squid and hake. (Some offshore trips for tuna species)
		35 boats, working in pairs, targeting horse mackerel, sea bream and hake. (They sometimes use small-mesh trawls for anchovy.)*	49 boats, targeting tuna and hake.	13 boats, targeting Norway pout and other species, using several trawls.
		37 boats, targeting various other species with several trawls for a single boat. (Fisheries of Norway pout, whiting and squid also take place.)*	60 boats, targeting Norway pout, mullet, bass, squid, cuttlefish, sea bream and others, using various types of trawl (including bottom trawl).	
Western English Channel	44 boats with several trawls for a single boat, targeting sea bream. (Also targeting of whiting in the Bay of Biscay, with captures of Norway pout and other species).			15 boats, targeting sea bream (and targeting tuna and swordfish offshore).
Notes	250 boats used pelagic trawls during this quarter. 67 boats, targeting anchovy in the Bay of Biscay, working in pairs.	258 boats used pelagic trawls during this quarter. 17 boats, targeting anchovy in the Bay of Biscay with panel trawl. * These boats also work in the English Channel.	268 boats used pelagic trawls during this quarter.	127 boats used pelagic trawls during this quarter.

Appendix 3

Table of scientific names of species referred to

Common Name	Scientific Name
Cetaceans	
Atlantic white-sided dolphin	*Lagenorhyncus acutus*
Bottlenose dolphin	*Tursiops truncatus*
Blue whale	*Balaenoptera musculus*
Common Dolphin	*Delphinus delphis*
Fin whale	*Balaenoptera physalus*
Harbour Porpoise	*Phocoena phocoena*
Hector's Dolphin	*Cepalorhynchus hectori*
Humpback whale	*Megaptera novaeangliae*
Minke whale	*Balaenoptera acutorostrata*
Orca (also known as killer whale)	*Orcinus orca*
Pilot whale (long-finned)	*Globicephala melas*
Pilot whale (short-finned)	*Globicephala macrorhyncus*
Risso's dolphin	*Grampus griseus*
Sei whale	*Balaenoptera borealis*
Sperm whale	*Physeter macrocephalus*
Striped Dolphin	*Stenella coeruleoalba*
Vaquita	*Phocoena sinus*
White-beaked dolphin	*Lagenorhyncus albiostris*
Fish	
Albacore	*Thunnus alalunga*
Anchovy	*Engraulis encrassicolus*
Bigeye tuna	*Thunnus obesus*
Black Bream	*Spondyliosoma cantharus*
Blue whiting	*Micromesistius poutassou*
Bluefin Tuna	*Thunnus thynnus*
Bogue	*Boops boops*
Cod	*Gadus morhua*
Dogfish	*Scyliorhinus canicula*
Gobies	*Gobiidae*
Hake	*Merluccius merluccius*
Herring	*Clupea harengus*
Horse mackerel (also known as 'scad')	*Trachurus trachurus*
Lantern fishes	*Myctophidae*
Lumpfish	*Cyclopterus lumpus*
Mackerel	*Scomber scombrus*
Norway pout	*Trisopterus esmarkii*
Pearlsides	*Maurolicidae*
Pilchard (also known as 'sardine')	*Sardina pilchardus*
Plaice	*Pleuronectes platessa*
Poor cod	*Trisopterus minutus*
Rays	*Raja spp.*
Saithe	*Pollachius virens*
Salmon	*Salmo salar*
Sandeels	*Ammodytidae*
Sea bass	*Dicentrarchus labrax*
Silvery pout	*Gadiculus argenteus ssp. thori*
Skate	*Raja batis*
Skipjack tuna	*Katsuwonus pelamis*
Sole	*Solea solea*
Sprat	*Sprattus sprattus*
Swedish pollack	*Pollachius pollachius*
Swordfish	*Xiphias gladius*
Trout	*Salmo trutta*
Turbot	*Psetta maxima*
Whiting	*Merlangius merlangus*
Yellowfin tuna	*Thunna albacares*
Other species	
Grey seal	*Halichoerus grypus*
New Zealand sea lion	*Phocarctos hookeri*
Spider crab	*Maia squinado*

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Published by Greenpeace Environmental Trust

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Harbour porpoise, Boswinger Beach, Cornwall, January 2004