Fishing's phantom menace

How ghost fishing gear is endangering our sea life

#seachange

WORLD ANIMAL PROTECTION

We were known as WSPA (World Society for the Protection of Animals)

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Cover image: Female grey seal entangled in a ghost net, Devon, United Kingdom
Alex Mustard/naturepl.com

Executive summary

Ocean death trap

Our oceans are an unsafe place to live. Every year millions of animals, including whales, seals, turtles and birds, are mutilated and killed by 'ghost' fishing gear – nets, lines and traps that are abandoned, lost or discarded in our oceans.

This report shows the scale of this problem, and the particular threat ghost gear poses to our most iconic marine animals. Among the animals most frequently reported wounded and killed are fur seals, sea lions, and humpback and right whales.

Critically, we conclude that it is possible to solve the problem through cross-sectoral cooperation and action between the seafood industry, governments, intergovernmental and non-governmental organisations worldwide.

The United Nations Environment Programme (UNEP) and the Food and Agricultural Organization of the United Nations (FAO) conservatively estimate that some 640,000 tonnes of fishing gear are left in our oceans each year. In just one deep water fishery in the north-east Atlantic some 25,000 nets, totalling around 1,250km in length, were recorded lost or discarded annually. Each net is a floating death trap. For example, when 870 ghost nets were recovered off Washington State in the US, they contained more than 32,000 marine animals, including more than 500 birds and mammals.

Animals entangled may either drown within minutes, or endure long, slow deaths lasting months or even years, suffering from debilitating wounds, infection and starvation.

Analysing the current scientific evidence available, World Animal Protection estimates that entanglement in ghost gear kills at least 136,000 seals, sea lions and large whales every year. An inestimable number of birds, turtles, fish and other species are also injured and killed.

What lies beneath

Ghost fishing gear often travels long distances from its point of origin and accumulates in hotspots around oceanic currents. Even remote Antarctic habitats are not free from this pollution – every ocean and sea on earth is affected. A recent scientific expedition to southern Alaska's beaches found up to a tonne of garbage per mile, much of it plastic fishing nets and lines washed in by the tides.

The materials used to make fishing gear cause long-lasting dangers. The plastics used are very durable, some persisting in the oceans for up to 600 years. Some are almost invisible in the water, and they are extremely strong and resistant to biting and chewing by entangled animals so they cannot escape.

The net effect

As well as causing needless animal suffering and death, ghost fishing gear causes large-scale damage to marine ecosystems and compromises yields and income in fisheries. US researchers have estimated, for example, that a single ghost net can kill almost $20,000 (USD) worth of Dungeness crab over 10 years.

Governments and marine industries spend many millions of dollars annually to clean up and repair damage caused by ghost gear. It also threatens human life and health, particularly divers and those trying to navigate the oceans in both small and large vessels.

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1
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32,000
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Sea change in the oceans: campaign to save a million lives

Launching in 2014, World Animal Protection's Sea Change campaign aims to save 1 million marine animals by 2018. We will do this by measurably reducing the volume of ghost gear added to our seas, removing gear that is already there, and rescuing animals already entangled.

At the heart of our campaign approach is our plan to form a cross-sectoral Global Ghost Gear Initiative, uniting people and organisations with the knowledge, power and influence to deliver solutions for ghost-gear-free seas. With the Global Ghost Gear Initiative, we aim to forge an alliance of governments, industry, intergovernmental and non-governmental organisations, with a shared commitment to understanding and tackling the problem of ghost fishing gear.

The initiative will share data, intelligence and resources to understand global ghost gear abundance, causes, impacts and trends. Critically, it will enable the expansion and replication of the most effective solutions to reduce ghost gear at source and remove existing gear, as well as the development of new solutions. The initiative will direct and drive solution delivery in ghost gear hotspots, and create opportunities for provision of seed funding of solution projects using best practice models. It will also enable global monitoring and showcasing of the impact of solution projects to catalyse further change.

Our aim:
to save 1 million marine animals by 2018

Image: Workers repair nets aboard their fishing vessel, American Samoa
Wolcott Henry / Marine Photobank

1. Ghost fishing gear: the background

1.1 Ghost fishing gear: the background

The scale and impact of ghost gear has increased significantly in recent decades and is likely to grow further as oceans accumulate greater volumes of it.

When Norwegian explorer Thor Heyerdahl crossed the Atlantic Ocean in 1970, he encountered a huge amount of debris, litter and waste. What he saw left him gravely concerned, prompting his report to the 1972 United Nations Conference on the Human Environment in Stockholm. Since that time, a huge swell of reports, government actions and specific studies have shown the marine environment is accumulating an increasing volume of human-originated debris.

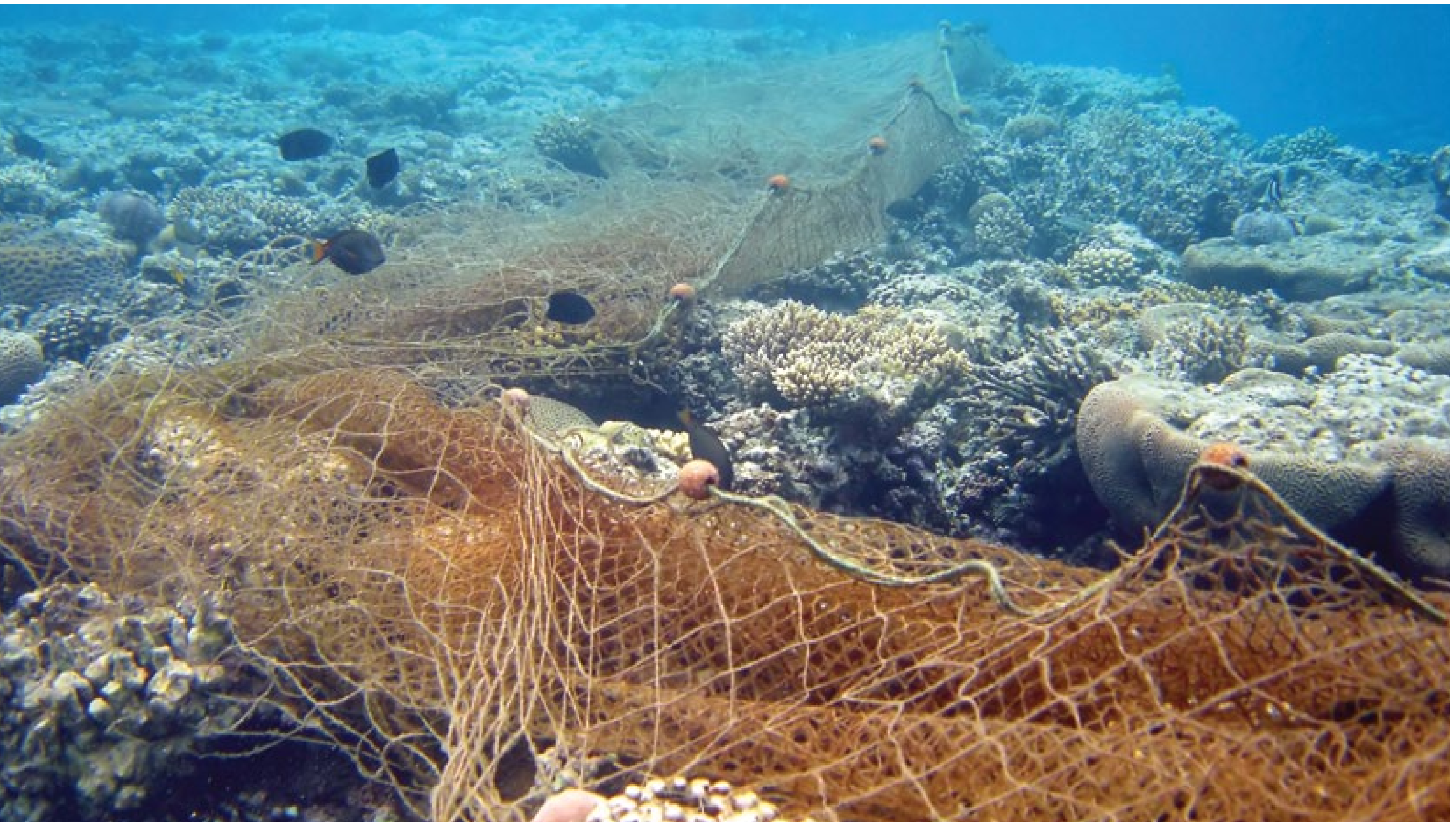
Estimates vary, but some indicate that up to 300,000 items of debris can be found per square kilometre of ocean surface (National Research Council, 2008). An estimated 8 million items of debris are dumped in the ocean every day, and around 6.4 million tonnes are disposed of in oceans and seas each year (United Nations Environment Programme, 2005).

Marine debris originates from either sea- or land-based sources and fishing activity is just one of many possible sources (Macfadyen et al., 2009). However, fishing-related debris – nets, line, rope, traps, pots, floats and packing bands – causes particular animal welfare concerns due to its proven capacity to entangle and trap marine animals.

There are no robust statistics regarding quantities of fishing gear abandoned, lost or discarded annually. However, it is conservatively estimated that 640,000 tonnes of fishing gear – around 10 per cent of total marine debris – is added to the oceans annually (Macfadyen et al., 2009).

Two studies reporting on material collected from US and UK beaches found that at least 10 and 14 per cent respectively was rope, fishing nets and line (Sheavly, 2007; Marine Conservation Society, 2012).

The volume and type of ghost gear varies geographically and depends on a number of factors. These include the nature of shore-based waste/gear handling, the type and extent of fishing activity, and the nature of topography and currents in marine environments.



1.1.1 The problem of plastics

Over the last 50 years, as technology has advanced and human demand has risen, there has been a dramatic increase in fishing effort in the world's oceans. During this time non-biodegradable fishing gear – primarily made from plastics – has also been introduced (Macfadyen et al. 2009). The mass production of plastics soared after the Second World War and items from that period are still being retrieved from the oceans today.

Many of the plastics used to make fishing gear are very durable; some are expected to last in our seas for up to 600 years. Many plastics are also buoyant, or very close to the density of seawater. They either float at the surface, sink only very slowly in the sea, or are easily carried by currents.

Some plastic fishing gear, for example monofilament line and monofilament gill nets, is almost invisible in water. It is also extremely strong and very resistant to biting and chewing by trapped animals. Monofilament line is so tough that many human divers are caught in it each year. Trainee divers are often taught how to release themselves from line entanglements with a diving knife.

Not only are fishing lines very strong in relation to their thickness, but their thin diameter can readily cut through skin, flesh and even bone if an animal becomes entangled. The sales presentation in the popular Fisherman's Outfitter online catalogue for Spectra – a brand of fishing line states:

"High Tensile Strength – the fiber [sic] is so strong that it is used in bulletproof vests; replacing Kevlar in that application. It is about 10 times as strong as steel, pound for pound. The finished line has a tensile strength of about 600,000 pounds per square inch versus monofilament which has a tensile strength of about 100,000 pounds per square inch.

"Long Life – the line has a very long life, it does not rot, and is not readily damaged by ultraviolet rays in sunlight, as is monofilament, it does not swell in water, nor does it lose strength when wet."

And the US-based Nylon Net Company claims their monofilament nets offer a number of advantages including being "almost invisible in any water". Prospective buyers are also cautioned that "monofilament is so effective it has been outlawed in some states!".

Plastic fishing gear and other debris in the oceans slowly break down to become the size of grains of sand – known as 'microplastics'. These minute plastic granules are found in water and sediments and may have a toxic effect on the food chain that scientists are only beginning to understand.

Image: Fishing net wraps around coral, Jordan
Malik Naumann / Marine Photobank

Many of the plastics used to make fishing gear are very durable; some are expected to last in our seas for up to 600 years.

1.1.2 What are the causes of ghost fishing gear and where does it end up?

The accidental loss of a certain amount of fishing gear is inevitable. This can be due to both the natural environment where fishing takes place (e.g. extreme weather conditions can cause gear loss) and the technology used. However, it is also clear that some fishing gear is intentionally discarded, and that some is abandoned when recovery might have been possible. The causes of ghost gear vary significantly within and between fisheries (Macfadyen et al., 2009).

A 2009 report by the United Nations Environment Programme (UNEP) and the Food and Agricultural Organization of the United Nations (FAO) (Macfadyen et al., 2009) summarises the main causes of ghost gear as follows.

Direct causes:

- enforcement pressure on fishermen to abandon gear (e.g. illegal fishing or illegal gear)
- operational pressure (e.g. too much gear for time) and environmental conditions (e.g. extreme weather) increasing the probability that gear will be abandoned or discarded
- economic pressure resulting in discarding unwanted fishing gear at sea rather than disposal onshore
- spatial pressures resulting in gear conflicts and consequent gear loss or damage.

Indirect causes:

- lack of onshore gear/waste disposal facilities
- inaccessible onshore gear/waste disposal facilities
- expensive onshore gear/waste disposal facilities.

This 2009 UNEP/FAO report asserts that most fishing gear is not deliberately discarded. It highlights the predominant causes of ghost gear are gear conflicts (e.g. when active trawlers pass through an area where static nets are positioned) and/or extreme weather or strong currents.

Fishing gear may be abandoned, lost or otherwise discarded in one part of the world and end up in another. Oceanic currents and winds can carry ghost fishing gear thousands of kilometres. There are accumulations of large densities of debris in ocean gyres.

The Great Pacific Oceanic Gyre (also known as the Great Pacific Garbage Patch) contains plastic, chemical sludge and debris, including ghost fishing gear, with an estimated mass of 100 million tonnes (Environmental Graffiti, 2012). It covers an area as large as France and Spain combined (Derraik, 2002; Sheavly, 2005).

Ghost fishing gear also accumulates, with other types of marine debris, in specific hotspots along coastlines, particularly in bays, where local currents have deposited it. Australia's Gulf of Carpentaria coast is one such hotspot (Gunn et al., 2010).

1.1.3 What problems can ghost fishing gear cause?

Ghost fishing gear, like all types of marine debris, has a wide range of adverse impacts. The UNEP Regional Seas Programme summarises the areas of concern in relation to marine debris as:

- the environment
- conservation of species
- human health
- tourism
- local economies.

Expanding on the social and economic cost of marine debris, UNEP (2001) further defines that it can:

- interfere with fishing and damage fishing boats and gear
- spoil the beauty of the sea and the coastal zone
- contaminate beaches, commercial harbours and marinas
- be a hazard to human health
- block cooling water intakes in power stations
- interfere with ships, causing accidents at sea
- damage local economies by contaminating fish catches and driving away tourists
- cost a significant amount to clean up.

Image: Rescuers untangle a gray whale from ghost drift net off the coast of California, United States
Bob Talbot / Marine Photobank

UNEP (2001) also describes the diverse impacts that marine debris – including ghost gear – can have on marine flora and fauna, including:

- harm to wildlife directly through entanglement and ingestion – the two main types of direct harm to animals
- smothering of the seabed and habitat disturbance
- persistent toxic chemical pollution in the ocean – particularly from plastics
- transportation of invasive species between countries, and between seas.

At present, there is little international focus on the specific threat that ghost gear poses to animal welfare. Our campaign seeks to remedy this.

Economic implications of ghost gear

Macfadyen et al. (2009) summarise the significant financial and economic costs of ghost fishing gear, which include:

Direct costs:

- time spent disentangling vessels whose gear/engine become entangled in ghost gear resulting in less fishing time
- lost gear/vessels because of entanglement as well as cost of replacement
- emergency rescue operations because of entanglement of gear/vessels
- time/fuel searching for and recovering vessels because of gear loss, which results in less fishing time
- retrieval programmes/activities to fishers, governments and industry to remove lost/discarded gear, or other management measures, e.g. time required for better communication, better marked gear, monitoring regulations intended to reduce ghost gear.

Indirect costs:

- compromised yields in fisheries
- reduced multiplier effects from reduced fishing income
- research into reducing ghost fishing gear
- potential impact on buying because of consumer fears/concerns about ghost fishing and ghost gear.

It is noted that the above costs are not evenly distributed between those involved or affected. In some situations, for example, where onshore waste disposal facilities are too expensive or inaccessible, fishers may have to resort to discarding unwanted gear. Certain technical ghost fishing mitigation measures may also result in associated costs to fishers (Macfadyen et al., 2009).

Image: Ghost nets collected from the Wadden Sea, Netherlands
Eleanor Partridge / Marine Photobank

2. How much ghost fishing gear is out there? A global snapshot

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There are four key types of ghost fishing gear reported to affect the welfare of marine animals:

- **Abandoned, lost or discarded fishing pots, traps and nets**
- **Fishing lines and hooks**
- **Rope**
- **Packing bands (commonly used around bait and packing boxes)**

Various studies have assessed and quantified the problem of ghost nets and other fishing gear, and some have also attempted to quantify the damage they cause to marine life. In countries where projects are already underway to recover ghost fishing gear, large amounts of nets are recovered regularly. Some examples follow.

2.1 North-east Atlantic

Around 25,000 nets may be lost or discarded in a deep water fishery in the north-east Atlantic each year, totalling around 1,250km in length (Brown et al., 2005).

Macfadyen et al. (2009) describes the recovery of 6,759 gill nets from Norwegian waters (Humborstad et al., 2003). The loss of 263 hake tangle nets per year from 18 vessels in the United Kingdom is also reported, where, on average, one-third of the lost nets were recovered.

In the hake wreck net fleets, whole fishing gear was rarely lost. It was more common for portions of net sheets and segments to be lost after snagging (884 incidences from a fleet of 26 vessels).

In a study on the Cantabrian region of northern Spain (around 645 vessels), an average annual loss of 13.3 nets per vessel was recorded (FANTARED 2, 2003).

2.2 North-east Pacific

A study in North-west Straits, Washington state (USA) recorded the recovery of 481 lost gill nets during a clean-up operation (Good et al., 2007). Most of the nets were still in good condition and were open, rather than folded or rolled up, and so capable of fishing. More than 7,000 animals were found trapped in these nets at the time of recovery.

In 2010, Good et al. reported the recovery of more than 32,000 marine animals from 870 gill nets recovered from Washington State's inland waters. Many of the nets had been at sea for many years. The marine animals found entangled included 31,278 invertebrates (76 species), 1,036 fish (22 species), 514 birds (16 species), and 23 mammals (four species). Fifty six per cent of the invertebrates, 93 per cent of the fish, and all the birds and mammals were dead when recovered.

It is likely that these figures significantly underestimate the true impact on animals. They only represent a snapshot of animal loss at the specific time of recovery, rather than the true long-term losses and animal suffering caused over the years.

2.3 North-west Atlantic

In the north-west Atlantic, in the Gulf of St Lawrence snow crab trap fishery alone, some 800 traps are estimated to be lost each year. It is suggested that each fisher may lose up to 30 per cent of their traps over the course of one year (NOAA Chesapeake Bay Office, 2007). This would equal losses of around 150,000 traps annually just in this one large bay. Among lobster fisheries in this region, the loss rate for lobster pots is estimated to be 10 per cent annually (Erin Pelletier, Gulf of Maine Lobster Association, personal communication, 2014; Sarah Cotnoir, Maine Department of Marine Resources, personal communication, 2014)*.

The number of licensed pots set annually in Maine waters alone reaches close to 3 million, leaving an estimated annual ghost pot accrual of 300,000 per year (Sarah Cotnoir, Maine Department of Marine Resources, personal communication, 2014).

2.4 Arabian Sea

It was estimated in 2002 that the United Arab Emirates (UAE) were losing approximately 260,000 traps per year (Gary Morgan, personal communication, cited in Macfadyen et al., 2009). The UAE authorities have since made degradable panels in traps mandatory.

2.5 South-east Asia and north-west Pacific

Ghost nets and ghost fishing are reported to be a significant issue in the Republic of Korea, Japan and Australia (Raaymakers, 2007). Limpus (personal communication, cited in Kiessling, 2003) estimated 10,000 lost nets – around 250kg of fishing net per kilometre – were littering the Queensland coastline in the Gulf of Carpentaria. These were found between the Torres Strait and the Northern Territory border.

During a 29-month recovery programme (the Carpentaria Ghost Net Programme), 73,444m of net was collected by November 2007 and analysed for its origin. Although 41 per cent was from unknown sources, 17 per cent was identifiable as Taiwanese, 7 per cent of Indonesian and Taiwanese or Indonesian origin, and 6 per cent from the Republic of Korea.

A survey in the Republic of Korea (Chang-Gu Kang, 2003) identified an estimated 18.9kg of marine debris per hectare, 83 per cent of which was composed of fishing nets and ropes. Another survey, of Korea's Incheon coastal area, identified 194,000 m^3 of marine debris over a six-month period, weighing 97,000 tonnes (Cho, 2004).

A follow-up programme resulted in the annual recovery of 91 tonnes of debris per km^2, of which 24 per cent was of marine (as opposed to coastal) origin. During the six-year period from 2000–2006, 10,285 tonnes of fishing-related debris was recovered from coastal areas through a coordinated coastal clean-up campaign (Hwang & Ko, 2007).

2.6 Caribbean and Gulf of Mexico

Of the 40,000 Caribbean traps around Guadeloupe, approximately 20,000 are lost each year during hurricane season, and continue to catch fish for many months (Burke & Maidens, 2004).

Of the 1 million traps fished commercially in the Gulf of Mexico, 25 per cent – 250,000 – are estimated to be lost (Guillory et al. 2001). These traps contribute to the loss of 4–10 million blue crabs to ghost fishing in Louisiana alone (Gulf States Marine Fisheries Commission, GSMFC, 2003). Meanwhile, in the Florida Keys, an estimated 10–28 per cent of lobster traps are lost each year (Matthews & Uhrin, 2009). Fishers reported losing even more of their traps than usual as a result of Hurricanes Katrina, Rita, and Wilma, suggesting trap losses of 50,000–140,000 annually.

Meanwhile, in the Florida Keys, an estimated 10–28 per cent of lobster traps are lost each year (Matthews & Uhrin, 2009). Fishers reported losing even more of their traps than usual as a result of Hurricanes Katrina, Rita, and Wilma, suggesting trap losses of 50,000–140,000 annually.

*The 10 per cent loss rate is an estimate based on the amount of replacement tags that licensed fishers apply for each year, although it represents a maximum allowable replacement figure, excluding a catastrophic loss. It is further verified by anecdotal testimonials from interviews with fishers in this region.

Table 1: Examples of fishing gear loss rates

Gear loss/abandonment/discard indicators from around the world		
Region	Fishery/gear type	Indicator of gear loss and data source
North Sea and north-east Atlantic	Bottom-set gill nets	0.02–0.09% nets lost per boat per year (EC contract FAIR-PL98-4338 (2003))
	Trammel nets (several species)	774 nets per year (EC contract FAIR-PL98–4338 (2003))
English Channel and North Sea (France)	Gill nets	0.2% (sole & plaice) to 2.11% (sea bass) nets lost per boat per year (EC contract FAIR-PL98-4338 (2003))
Mediterranean	Gill nets	0.05% (inshore hake) to 3.2% (sea bream) nets lost per boat per year (EC contract FAIR-PL98-4338 (2003))
Gulf of Aden	Traps	c.20% lost per boat per year (Al-Masroori, 2002)
ROPME Sea Area (UAE)	Traps	260,000 lost per year in 2002 (Gary Morgan, personal communication, cited in Macfadyen et al., 2009)
Indian Ocean	Maldives tuna longline	3% loss of hooks/set (Anderson & Waheed, 1988)
Australia (Queensland)	Blue swimmer crab trap fishery	35 traps lost per boat per year (McKauge, undated)
Gulf of Carpentaria	Trawl nets (59.2%), gill nets (14.1%), unknown (26.2%)	845 nets removed by rangers from approximately 1190km of north Australian coastline (GhostNets Australia, 2012)
North Pacific	Drift nets	0.06% set resulting in 12 miles of net lost each night of the season and 639 miles of net lost in the north Pacific Ocean alone each year (Davis, 1991, in Paul, 1994)
North-east Pacific	Bristol Bay king crab trap fishery	7,000 to 31,000 traps lost in the fishery per year (Stevens, 1996; Paul et al., 1994; Kruse & Kimker, 1993)
North-west Atlantic	Newfoundland cod gill net fishery	5,000 nets per year (Breen, 1990)
	Canadian Atlantic gill net fisheries	2% nets lost per boat per year (Chopin et al., 1995)
	Gulf of St Lawrence snow crab trap fishery	792 traps per year
	New England lobster fishery	10% traps lost per boat per year (Erin Pelletier, Gulf of Maine Lobster Association, personal communication, 2014; Sarah Cotnoir, Maine Department of Marine Resources, personal communication, 2014)
	Chesapeake Bay	Up to 30% traps lost per boat per year (NOAA Chesapeake Bay Office, 2007)
Caribbean	Guadeloupe trap fishery	20,000 traps lost per year, mainly in the hurricane season (Burke & Maidens, 2004)

Source: adapted from Macfadyen et al. (2009)

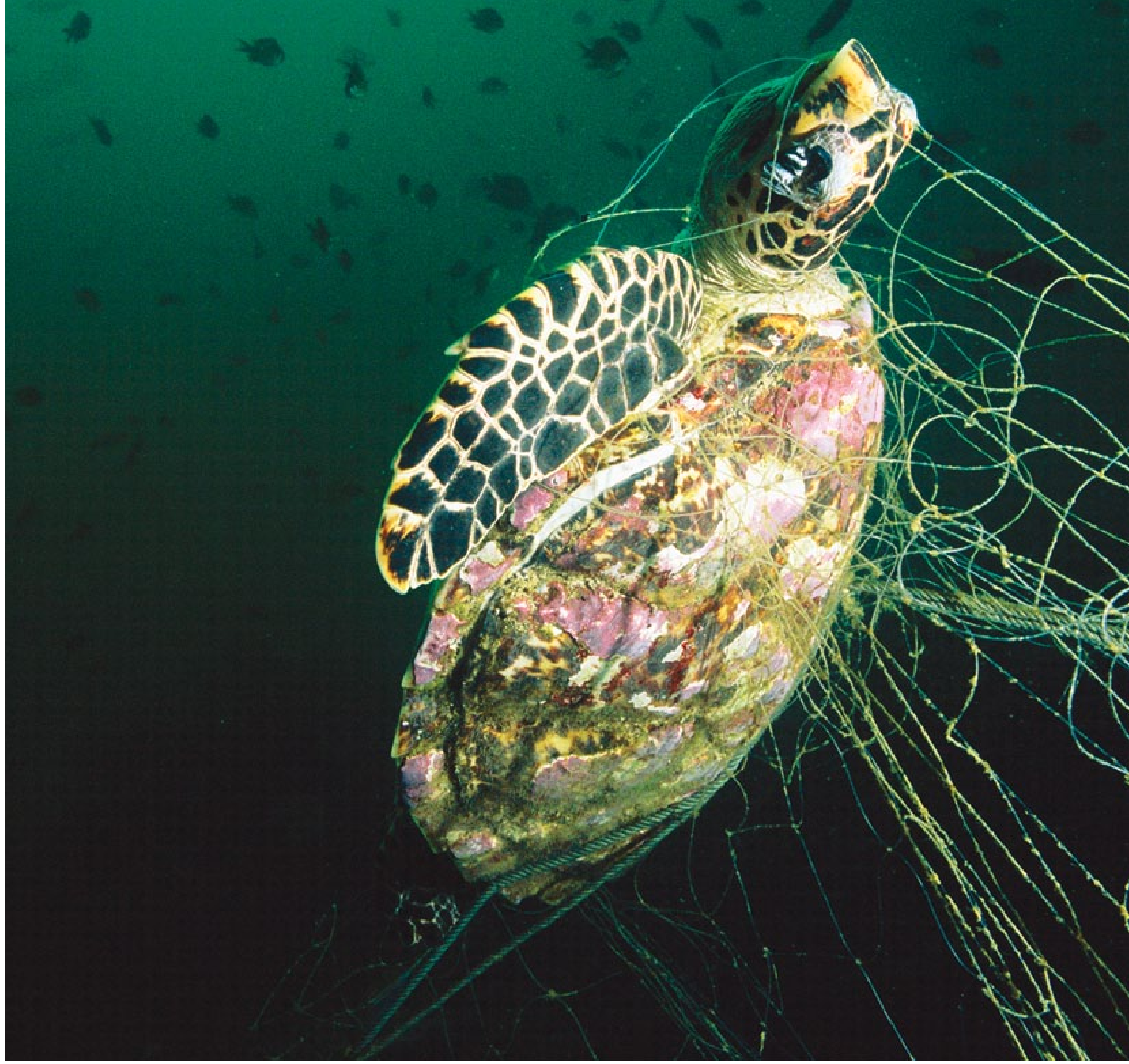


Image: Young hawksbill turtle (deceased) entangled in ghost net, Andaman Sea, Thailand
Georgette Douwma / naturepl.com

3. Which animals are affected by ghost fishing gear?

3. Which animals are affected by ghost fishing gear?

Plastic-based ghost fishing gear may carry on indiscriminately fishing for decades, catching any animal unfortunate enough to cross its path. Ghost nets will inevitably continue to trap and kill fish and a huge range of other species. Abandoned, lost or discarded lobster and crab pots and traps can both entangle wildlife with their lines and continue to trap their target and non-target species.

'Fishing's phantom menace' focusses on the effects of ghost fishing gear on marine mammals, birds and turtles. These are the species for which the welfare impacts are most clear and well documented scientifically.

One recent literature review found entanglement in (or ingestion of) marine debris affected all sea turtle species, about half of marine mammal species and one-fifth of seabird species (CBD, 2012). One of the most comprehensive reviews of the impacts of marine debris on marine animals (Laist, 1997) found that entanglement in marine debris affected 135 marine species. The type of marine debris most commonly associated with entanglement was ghost fishing gear from commercial fishing operations.

A snapshot of published scientific articles covering seals, sea lions and whales entangled in ghost fishing gear shows it is a sizeable threat to many species. Approximately 7.9 per cent of some sea lion populations, and 10.4 per cent of some humpback whale populations, are injured or killed by entanglement in ghost fishing gear and debris (Table 1, Annex 1).

Image: Hawaiian monk seal entangled in entangled ghost fishing gear of Kure Atoll, Pacific Ocean
Michael Pitts / naturepl.com

What is animal welfare?

Animal welfare is an area of significant scientific and societal interest. The term refers to the physical and psychological wellbeing of an animal. The welfare of an animal can be described as good or high if the individual is fit, healthy, free from suffering and in a positive state of wellbeing.

The Five Freedoms, first codified by the UK government's Farm Animal Welfare Council (FAWC, 1979), provide valuable general guidance on the welfare of an individual animal.

The Freedoms promote freedom from: hunger, thirst and malnutrition; fear and distress; physical and thermal discomfort and pain, injury and disease. They also promote the freedom to express normal patterns of behaviour (FAWC, 2009).

These measures of animal welfare have since been endorsed and expanded on by the World Organisation for Animal Health (OIE). An animal is in a good state of welfare if it is: "healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear and distress" (OIE, 2010).

By this definition, animals entangled in, injured or otherwise constrained by ghost fishing gear will be left in a poor state of both physical and psychological welfare.

3.1 What are the impacts of ghost fishing gear on the health and welfare of animals?

Animals are affected differently by entanglement in ghost fishing gear. The ways they are affected depend on various factors including the animal's physiology, feeding and other behaviours, and the types of ghost gear found in the animal's habitat.

For example, young seals may – perhaps in play or out of curiosity – put their heads through rope or monofilament loops. These then become firmly fixed around their necks or bodies, slowly cutting into their flesh or bone as the animals grow.

Whales and turtles may swim through a section of ghost fishing line or net. This may initially become snagged around the mouth, flippers or (in the case of whales) fluke, and may be acute – causing an immediate and severe welfare problem such as asphyxiation through drowning – or chronic – where the welfare impacts may increase over time.

Many animals become chronically entangled in ghost fishing gear for months or even years, and suffer a range of problems causing pain and suffering (Moore et al., 2005). Tight ligatures or oral entanglement in nets or ropes can prevent animals from feeding to the point of starvation.

By 2003, 195 tonnes of ghost fishing gear had been removed from the reefs of the north-west Hawaiian Islands.

Those animals towing large amounts of fishing gear can become exhausted due to the additional drag or constriction, and many ultimately drown or die of exhaustion. A distressed and exhausted gray whale freed from a net fragment off California in 2012 was found to be towing 50 feet of net. This net held other sea life including a sea lion, three sharks and numerous fish, rays and crabs (mailonline, 2012).

Rope and line ligatures can cause amputations and infected wounds that result in more suffering and further reduce the animal's chances of survival. Similarly, the constriction caused by pieces of plastic net and line can become severe enough to sever arteries and limbs and to cause strangulation.

Plastic is so durable in the marine environment that when one entangled animal dies, the debris still has the potential to trap another.

3.1.1 Acute or chronic suffering?

Animals entangled in ghost fishing gear suffer for short or very protracted periods as the following examples show.

A fur seal entangled in a submerged and anchored ghost net, preventing it from surfacing to breathe, suffers intense distress and panic before drowning after a period of minutes. The duration of this type of suffering is short when compared to that experienced by the same species if entangled in a monofilament noose. Such entanglement may cause an increasingly severe wound, resulting in pain, distress and possible infection over months or years.

A whale entangled in a long rope may suffer chronic and increasingly intense pain and distress (over months, or even years). This can be caused by the line cutting into its body compromising feeding and locomotion.

Starvation over days or weeks occurs when a bird's mouth, wings or legs become entangled in (for example) fishing line or rope, preventing it from feeding.

3.1.2 Seals, fur seals and sea lions (pinnipeds)

A large number of seal and sea lion species have been recorded as entangled, and the available literature reflects the global nature of this problem. Entanglement has been recorded in 58 per cent of all species of seals and sea lions (Boland & Donohue, 2003).

Species snapshot: monk seals

The Hawaiian monk seal is a critically endangered species. Its breeding colonies are limited to six small islands and atolls in the north-west Hawaiian Islands. From 1982 to 1998, the entanglement incidence among Hawaiian monk seals rose from 0.18 per cent to 0.85 per cent of the population (Donohue et al., 2001).

To help solve the problem of entanglement, a multi-agency effort was funded between 1996 and 2000 to remove ghost fishing gear from the reefs of the north-west Hawaiian Islands. Areas close to breeding sites were also cleaned (Boland & Donohue, 2003). By 2003, 195 tonnes of ghost fishing gear had been removed from this area.

Entanglement rates can also be influenced by weather changes and storms. One study (Donohue & Foley, 2007) highlighted that incidences of entanglement of monk seals increased during periods characterised by the changes in weather and ocean flows associated with El Niño.

A critically endangered population of Mediterranean monk seals in the Desertas Islands of Madeira is also threatened by both static and ghost fishing gear, in particular gill nets (Karamanlidis, 2000).

A distressed and exhausted gray whale freed from a net fragment off California in 2012 was found to be towing 50 feet of net which contained a dead sea lion and numerous sharks, rays, crabs and fish.

Figure 1: Major types of fishing-related debris causing animal welfare problems, key species affected and range of likely duration of suffering. Text in boxes are examples of the known welfare impacts at either end of the spectrum of duration of suffering, for each given debris type. At their shortest, acute effects may be experienced over minutes, whilst chronic effects may be experienced over years.

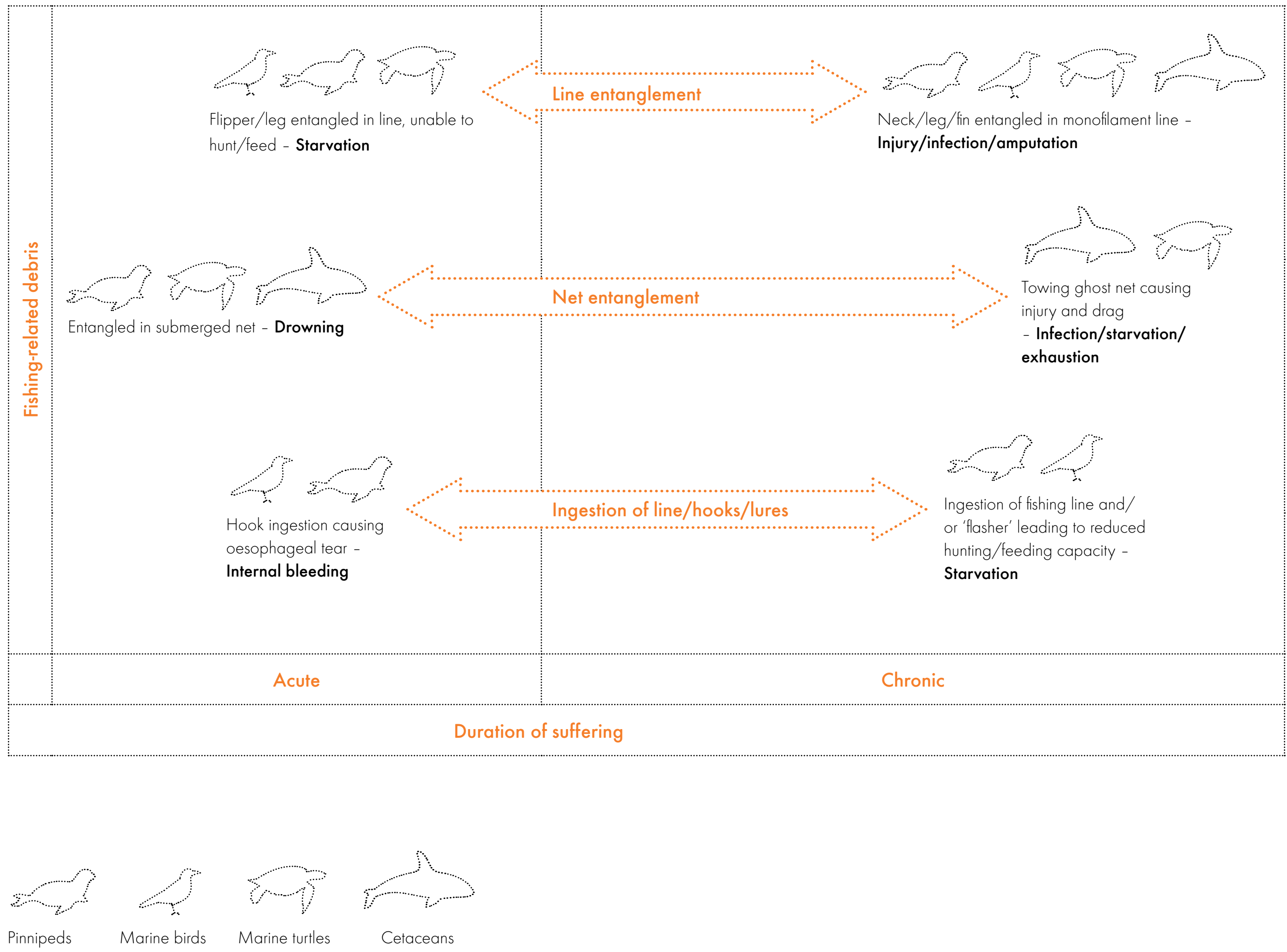


Image: This Californian sea lion with gill net cutting into its neck was helped by rescuers, Kanna Jones / Marine Photobank

Species snapshot: sea lions
Californian sea lions are badly affected by entanglement along the US coast and in the Gulf of California. One study estimated that up to 7.9 per cent of sea lions in the Baja California region become entangled (Harcourt et al., 1994). A further study, describing bird and seal/sea lion entanglement cases in California over six years, found 1,090 (11.3 per cent) of entanglements were related to fishing gear. The highest prevalence of fishing-gear-related injury in seals and sea lions was seen in the San Diego region (Dau et al., 2009).

A survey of 386 Steller sea lions entangled in south-east Alaska and north British Columbia (Raum-Suryan et al., 2009) looked at causes of entanglement. The most common neck-entangling material was plastic packing bands (54 per cent), followed by large rubber bands (30 per cent). Both are most commonly associated with materials relating to fisheries (e.g. bait boxes).

Animals were also found to be entangled with net (7 per cent), rope (7 per cent) and monofilament line (2 per cent). Local campaigns to 'Lose the loop!' promoted simple actions by fishers and coastal communities. These included cutting entangling loops of synthetic material and eliminating packing bands to help prevent entanglements.

Species snapshot: fur seals
In a 10-year study at Marion Island in the Southern Ocean, Hofmeyr et al. (2002) recorded 101 fur seals and five southern elephant seals entangled in marine debris. The study described how 67 per cent of materials causing entanglement originated from the fishing industry. Polypropylene packaging straps were the most common cause, followed by trawl netting. Incidences of longline hooks embedding in animals and fishing line entanglements began when longline fishing started in the waters around Marion Island in 1996.

In New Zealand, fur seals are most commonly entangled in loops of packing tape and trawl net fragments suspected to derive from rock lobster and trawl fisheries (Page et al., 2004).

The entanglement of Antarctic fur seals halved from 1990–1994 after the International Convention for the Prevention of Pollution from Ships (MARPOL) introduced Annex V (Regulations for the Prevention of Pollution by Garbage from Ships). However, polypropylene packing straps, fishing net fragments and synthetic string were still found to be common debris items entangling seals in all years (Arnould & Croxall, 1995).

A total of 1,033 Antarctic fur seals were observed entangled in marine debris at Bird Island, South Georgia, between November 1989 and March 2013. Eighty five per cent of these entanglements involved packing bands, synthetic line and fishing net (Waluda and Staniland, 2013).

Shaughnessy (1980) describes the number of Cape fur seals recorded as entangled in several colonies in Namibia between 1972 and 1979. Most of the entangling objects were found around the seals' necks. The highest incidence among seals was recorded at the Cape Cross colony.

Around 0.6 per cent of the population was observed entangled in fishing-related debris including monofilament line, fishing net, rope and plastic straps.

In the Kaikoura region of New Zealand, fur seals breed near a town with expanding tourist and fishing industries. They commonly become entangled in nets and plastic debris. The entanglement rates of seals in the Kaikoura region are reported to be in the range of 0.6–2.8 per cent of the population. The most common causes are green trawl net (42 per cent) and plastic strapping tape (31 per cent) (Boren et al., 2006).

A successful disentanglement programme with post-release monitoring showed that with appropriate intervention there was a strong likelihood that an animal released from the net or debris would survive. This included those with a significant entanglement wound (Boren et al., 2006).

Even on St George Island hundreds of kilometres from mainland Alaska, northern fur seals have been observed entangled in fishing net, lines and plastic packing bands (Zavadil et al., 2007). In 2005/06 the juvenile male entanglement rate was particularly high – 0.15 and 0.35 per cent – meaning that 10 or 20 animals are likely to suffer from entanglements every year.

Over 22 years (1976–1998) on south-east Farallon Island, northern California, 914 pinnipeds were recorded entangled. These included California sea lions, northern elephant seals, Steller sea lions, Pacific harbour seals and northern fur seals (Hanni & Pyle, 2000). Common entangling materials were monofilament line and net, trawl and other nets, salmon fishing lure and lines, fish hooks and lines, packing straps, and other miscellaneous marine debris.

Species snapshot: grey seals and common seals
Allen et al. (2012a) describe the entanglement rates of grey seals in Cornwall, UK, with a range from 5 per cent in 2004 to 3.1 per cent of the population affected in 2011. Of the 58 seals identified, 37 (64 per cent) had injuries that were causing a constriction, had formed an open wound, or both. During the period 1999 to 2013, between 3 and 9 per cent of gray seals in rookeries around Cape Cod, Massachusetts, had evidence of entanglements (Brian Sharp, International Fund for Animal Welfare, personal communication, 2014).

In a study of entanglement on the Dutch coast between 1985 and 2010, entanglement was more prevalent in grey seals than common seals – 39 versus 15 respectively (van Liere et al., 2012). Seals were entangled in pieces of ghost trawl nets and gill nets. The study's authors suggest that the numbers found were likely to be just a fraction of the true extent of mortality. They attribute this to the probable low rate of recovery of stranded animals when compared to those lost at sea.

Species snapshot: elephant seals
In a study of entanglement of southern elephant seals, monofilament line proved to be the main cause (Campagna et al., 2007). The elephant seals were caught, when possible, to remove the material. In every case, the material removed was a monofilament line, 1.3–1.5 mm thick, typically tied in a circle with a knot. In some animals, the line had jigs attached (coloured lures armed with a crown of hooks) – gear typically used by squid fisheries.

The scientists observed three to five new entangled animals per breeding season. They indicated, however, this was likely to be an underestimate since observations took place during a period when juveniles – the most affected group – were not present.

The study highlighted that entanglements can turn into chronic wounds that often bleed and become infected, with debilitating consequences. Judging from the depth of the wounds, the scientists noted that entangled seals can live for years with line cutting the skin and muscles of the neck. The wounds limit the movement of the neck and rest of the body, and can impair diving ability (Campagna et al., 2007).

3.1.3 Whales, dolphins and porpoises (cetaceans)

Whales, dolphins and porpoises of all sizes can become entangled in and killed by ghost fishing gear, though the problem is more widely reported for large whales. As with the findings for seals and sea lions, the literature reviewed for 'Fishing's phantom menace' (see Table 1, Annex 1) shows that entanglement affects cetaceans all over the world. Cetaceans appear particularly vulnerable in coastal waters where they more frequently come into contact with ghost fishing gear and other human-originated debris.

The large whales most commonly recorded as being entangled are the north Atlantic right whale and the humpback whale. However, observer effort and monitoring of affected species has mainly focussed on populations threatened with extinction due to entanglement, such as the north Atlantic right whale.

Scientists studying the scars on large whales suggest that non-lethal entanglements are extremely common in some species. It is estimated that half (48–65 per cent) of Gulf of Maine humpback whales have been entangled at least once in their lifetime. Eight to 25 per cent sustain new injuries each year (Robbins, 2009). However, humpback whale scar evidence suggests that only 3–10 per cent of entanglements are witnessed and reported (Robbins & Mattila, 2000, 2004). This indicates that, like other species, whales may succumb to entanglement and sink after death, before the event can be detected.

Reports also exist of small whales, dolphins and porpoises becoming entangled in ghost fishing gear. For example, in April 2002, 35 harbour porpoises were entangled in 30.2km of abandoned gill and trammel nets off the coast of Romania.

Species snapshot: right whales

The north Atlantic right whale population is estimated to be only 400 in the western north Atlantic. The apparent failure of the population to recover has in part been attributed to mortality from collisions with ships and entanglements in fixed fishing gear (Kraus, 2008).

One study, summarising post mortem reports for lethally entangled western north Atlantic right whales over 30 years, found that all whales examined had sustained entanglement and fishing gear wounds (Moore et al., 2005). In one case, fishing line had entangled the flippers, cut through all of the soft tissues and embedded itself several centimetres into the flipper bones.

In another case, a north Atlantic right whale first sighted entangled in fishing gear in May 1999 was found dead five months later. Reviewing the case, Moore noted, "The entangling rope and gill net had dissected off the blubber on its back while it was still alive." At its widest point, the missing section of skin and blubber measured 1.4m (Moore, 2014). The average time estimated for an entanglement to kill a right whale is 5.6 months (Moore et al., 2006). Some whales with potentially fatal entanglement injuries have survived considerably longer – up to 1.5 years (Knowlton & Kraus, 2001).

"The entangling rope and gillnet had dissected off the blubber on its back while it was still alive." (Moore, 2014)

By-catch or debris?

It is not always clear whether an animal has been caught in active fishing gear ('by-catch') or ghost gear or debris. Because of their size and mass, the larger whales may be able to break away from an anchoring entanglement in fixed fishing lines and gear. However, they may then remain entangled in thin but strong ropes, net and lines. Marine animal rescue teams also report disentangling seals and sea lions caught in segments of net (commonly trawl nets) where the rope shows signs of having been cut. A likely scenario to explain this is animals being cut out of active gear by fishers seeking to salvage their net but – for safety reasons – unable to get close enough to the animal's head to cut the entangling loop away from the neck.

One review noted that the inherent pain and suffering for the individual animals in the time between initial entanglement and final death is severely shocking (Moore and van der Hoop, 2012). Such chronic welfare impacts "would raise substantial concern with consumers of seafood were they to be aware of what they were enabling" (Moore, 2014).

Species snapshot: humpback whales

In 2006, Neilson assessed the prevalence of non-lethal entanglements of humpback whales in fishing gear in the northern part of south-east Alaska. The study, using a scar-based method, found that 52–78 per cent of whales had become entangled.

In Glacier Bay or Icy Strait, 8 per cent of the whales acquired new entanglement scars each year, and males seemed to be at higher risk than females. Calves were less likely to have entanglement scars than older whales. This is perhaps because young animals are more likely to die from entanglement than to survive and show scars. According to Johnson et al. (2005), common points for gear attachment in humpback whales are the tail (53 per cent) and the mouth (43 per cent).

Humpback whales also become entangled in Canadian and US Atlantic waters (Robbins & Mattila, 2001). Forty eight to 65 per cent of the whales photographed every year bear some evidence of previous entanglement.

About 12 per cent of the humpback whales in the Gulf of Maine appear to become non-lethally entangled. On average 19–29 (2–5 per cent of the local population) humpback whales may die as a result of entanglement annually (Robbins, 2009).

In northern south-east Alaska, caudal peduncle scars reveal that the majority of humpback whales have been entangled. The lowest scarring percentage (17 per cent) is in calves (Neilson et al., 2009). Neilson suggests that calves and juveniles have a higher mortality rate from entanglement than adult whales for two reasons. Firstly, this is because as the whale grows, gear is more likely to become embedded and lead to lethal infections or restricted circulation. Secondly, because of their smaller size, calves and juveniles may not have the strength necessary to break free from entangling gear.

In Peru, of 15 confirmed entanglements recorded between 1995 and 2012, 10 involved humpback whales. Gill nets were responsible for 80 per cent of these entanglements (Garcia-Godos et al., 2013).

Species snapshot: bottlenose dolphins

One study describes observations of a bottlenose dolphin calf becoming entangled in monofilament line during a play session with another juvenile (Mann et al., 1995). More recent studies on entangled bottlenose dolphins have shown that some newly developed (and very abrasive) fishing lines cut deep wounds into their tissues (Barco et al., 2010).

Species snapshot: minke whales

A study of the entanglement of minke whales in the East Sea of Korea found a total of 214 incidences between 2004 and 2007 (Song et al., 2010). Two hundred and

seven of these (96.7 per cent) were caused by fishing gear such as set nets, pots and gill nets. The others were associated with bottom trawls, purse seines and trawls. The most common body part to become entangled, in 63 cases, was the mouth.

According to Northridge et al. (2010), entanglement in fishing gear, primarily creel lines, is the most frequently documented cause of mortality in minke whales in Scottish and UK waters. The same study asserts that roughly half of all examined dead baleen whales from Scotland are thought to have died due to fishing gear entanglement.

3.1.4 Turtles

In Cape Arnhem, northern Australia, 29 dead turtles were found in ghost fishing nets over a four-month period. The threat to marine turtles posed by ghost fishing gear is thought to be equivalent to that posed by active fishing gear prior to the introduction of turtle exclusion devices in the region (Kiessling, 2003).

Between January 1998 and December 2001 in the Canary Islands, 88 loggerhead, three green, and two leatherback sea turtles were studied post mortem. Of these 69.89 per cent appeared to have died from human-induced causes.

These included entanglement in ghost fishing nets (25 per cent), ingestion of hooks and monofilament lines (19 per cent), boat-strike injuries (24 per cent) and crude oil ingestion (2 per cent) (Orós et al., 2005).

Skin lesions with ulceration were the most common injuries caused by entanglement. In 10.75 per cent of the studied animals, necrotising myositis (death of local areas of muscle) had been caused by entanglement in fishing nets. In 25.81 per cent of animals either one or two flippers had been amputated through entanglement in netting (Orós et al., 2005).

3.1.5 Birds

Birds that become compromised by entanglement in ghost fishing gear may not be able to dive, nest or fly and may suffer painful incisions into their limbs by rope or line. These wounds can then lead to infection or eventual amputation.

More than 1 million birds are estimated to die each year from entanglement in (or ingestion of) plastics (Laist, 1997). However, the impacts of entanglement in ghost fishing gear on different species are not very clear. For most seabird species there is only patchy information, and infrequent reports of rates of entanglement. Species commonly reported as entangled include: the northern fulmar; horned puffin; greater shearwater; sooty shearwater; common guillemot and laysan albatross (CBD, 2012).

Gill nets present a clear danger to birds, with 514 dead marine birds found in 870 ghost gill nets recovered in the north-west United States. Overall, dead marine birds occurred in 14 per cent of recovered gill nets (Good et al. 2009).

The situation is compounded by the fact that some birds, for example northern gannets and other seabirds, use fragments of ghost fishing gear and other debris to build their nests. This can result in the entanglement of both nestlings and adults.

A study by Votier et al. (2011) found that the proportion of nests incorporating fishing gear was related exponentially to the number of gill nets set around breeding colonies. The proportion of nests that incorporated marine debris decreased following a fishery closure.

On average, the gannet nests contained 469.91g (range 0–1293g) of plastic. This equates to an estimated colony total of 18.46 tonnes (range 4.47–42.34 tonnes) of plastic material. Most nesting material was synthetic rope, which the cormorants seemed to prefer. Around 60 birds were entangled each year, with a total of 525 individuals – mostly nestlings – seen entangled over eight years.

Anecdotal evidence and grey literature suggests that other bird species are also using large quantities of plastic in their nests. This is a very recent development, and one that is costing a significant number of birds their lives through entanglement.

Image above: A cormorant died as a result of entanglement in a ghost net, Cornwall, United Kingdom
Dave Peake / Marine Photobank

Image left: A ghost net, entangling 17 deceased sea turtles, was discovered days after a storm off the coast of Bahia, Brazil
Projeto Tamar Brazil / Marine Photobank

A paper from the Common Wadden Sea Secretariat (cited in OSPAR, 2009) showed that nylon fishing lines, ropes and pieces of fishing nets were the most common debris items. It reported that 48 per cent of beached birds were entangled in line or rope, 39 per cent in nets and 7 per cent with fishing hooks.

Of the literature reviewed for 'Fishing's phantom menace', most relating to the entanglement of birds cited fishing debris as the major cause. UNEP (2001) states that many birds, such as gulls and cormorants, are also entangled in six-pack rings and other encircling pieces of litter.

3.2 How many animals are likely to be affected by ghost fishing gear?

This section presents rough estimates of entanglements affecting the two marine animal groups for which data is most readily available: pinnipeds (seals and sea lions) and large whales.

The calculations have produced two totals:

- a sum total of marine animals reported to have been affected on an annual basis (pinnipeds and large whales), derived from annual entanglement figures provided in reviewed published studies (57,000 animals)
- an extrapolated total, derived by multiplying the recorded percentage entanglement rates (of pinnipeds and large whales) by population estimates (136,000 animals).

We propose that these figures represent a range; the lower figure (57,000) represents a conservative estimate and 136,000 an upper-level estimate.

We have not been able to calculate the number of birds or other marine animals that are entangled. It is very difficult to give meaningful estimates of the numbers affected by entanglement. This is due to the patchy nature of the data and the wide geographical spread of the most commonly affected species. It is very clear, however that the numbers are significant.

Table 2: Data used to estimate sum total of pinniped (seal and sea lion) and baleen (large) whale species affected by ghost fishing gear

Species/ Sub-species	Entanglement rate (incidence in population, % [if range then mean appears in brackets])	Population estimates (where multiple estimates mean is adopted)	Extrapolation: estimated animals affected by entanglement per annum (entanglement rate x population estimate, rounded to nearest whole number)	Sum: number of animals affected by entanglement annually, from specific studies and from specific restricted localities (if range given mean adopted)	Source of entanglement rate estimation
Kaikoura fur seal	0.6–2.8 (1.7)			19	Boren et al. (2006)
Australian fur seal	1.9				Pemberton et al. (1992)
Antarctic & Sub-Antarctic fur seal	0.24			10	Hofmeyr et al. (2002)
Antarctic fur seal	0.024–0.059 (0.041)			15,000	Boren et al. (2006)
Cape fur seal	0.1–0.6 (0.35)			84	Shaughnessy (1980)
Northern fur seal	0.08–0.32 (0.2)			40,000	Watson (Bering sea total); Zavadil et al. (2007) (entanglement rate)
California sea lion	3.9–7.9 (5.9)				Harcourt et al. (1994)
Steller sea lion	0.26				Raum-Sayuran et al. (2009)
California sea lion	0.08–0.22 (0.15)			28	Stewart & Yochem (1987)
TOTAL (otariid seals)	**Mean entanglement rate for otariid seals = 1.34%**	**Combined fur seal/ sea lion population estimate = 238,8000 (Trites et al., 1997)**	**52,774**	**55,141**	
Hawaiian monk seal	0.7			215	Henderson (2001)
Northern elephant seal	0.15			14	Stewart & Yochem (1987)
Southern elephant seal	0.001–0.002 (0.0015)				Campagna et al. (2007)
Harbour seal	0.09			2	Stewart & Yochem (1987)
TOTAL (phocid seals)	**Entanglement rate for phocid seals = 0.24%**	**Phocid seal population estimate = 22,070,500 (Trites et al., 1997)**	**52,969**	**231**	
Humpback whale	9.2	63,600 (IWC, 2010)	5,851	54	Robbins & Mattila (2004)
Western grey whale		26,400 (IWC, 2010), 21,100 (Trites et al., 1997)		19	Bradford et al. (2009)
Minke whale	2.6	970,000 (IWC, 2010), 860,000 (Trites et al., 1997)	23,790	7	Cole et al. (2006)
North Atlantic right whale	1.6	300 (IWC, 2010)	5	6	Cole et al. (2006)
Fin whale	0.8	33,200 (IWC, 2010), 12,000 (Lowry et al., 1997)	181	2	Cole et al. (2006)
Bryde's whale	0.2	20,500 (IWC, 2010), 11,200 (Trites et al., 1997)	32	1	Cole et al. (2006)
TOTAL (baleen whales)			**29,859**	**89**	
		Totals (pinniped and baleen whale species combined)	**135,602**	**56,976**	

Limitations of the data and estimates

There are clear variations in the geographical spread of research into the impact of ghost fishing gear and marine debris in general on animals. The Convention on Biological Diversity's 2012 status report (CBD, 2012) highlights and describes this geographical imbalance. It notes the number of reports it has reviewed from different regions: Americas (117), Australasia (56), Europe (52), Africa (12), Antarctic (7), Asia (6), and the Arctic (5).

Regional and species-based variability in recorded entanglement events means that it is important to be cautious when scaling up or extrapolating figures on the animal impacts of ghost fishing gear. When considering the figures presented overleaf, it is important to be aware of the following points.

- Estimates based on published reports can reflect only the areas where the reports were carried out. The level of research and interest is not uniformly spread across the globe.
- Estimates of animal entanglement generally rely on reports of animals seen alive (or recently deceased), and so are likely to seriously underestimate the scale of the problem. If animals are affected and die unseen (as is likely to be common), then they are not reported. As Cole et al. (2006) state: "Our greatest concern remains the number of animals we never saw... Evidence suggests that only 3 to 10 per cent of entanglements are witnessed and reported."
- Estimates for the number of animals affected at any point in time rely on an understanding of how long the animals in the survey period were likely to be affected. However, this is often not clear, since the time over which an animal is affected is highly variable. Some animals will be affected acutely and very severely, and die after a relatively short period. Others – for example, the large baleen whales – may be adversely affected by entanglement for many months or even years.

In combination, these 'estimates of estimates' lead to a high degree of uncertainty in overall numbers of animals affected. It is highly probable that the animal welfare impacts of ghost fishing gear are far greater than existing reports indicate.

Image: Juvenile gray whale entangled in ghost gear, North Pacific Ocean
Brandon Cole / naturepl.com

4. Country-specific case studies (Australia, UK, US and Canada)

4.1 Australia

4.1.1 Introduction

In its various forms marine debris is widely recognised as a serious threat to the Australian marine environment (Gregory, 2009).

Most of Australia's population (86 per cent in 1996) lives in the coastal zones surrounded by the Pacific, the Indian, the Southern Oceans as well as the Timor and Arafura seas. Consequently, a large fraction of studies and initiatives focus on the visible debris that is washed ashore along Australia's 36,700 km of coastline. The studies distinguish between debris originating from land-based activities and that derived from maritime activities (ANZECC, 1996).

In more densely populated eastern Australia, more than 133,000 items of debris were found on average on each square kilometre of beach (Criddle et al., 2009; Cunningham and Wilson, 2003). In the last decade, ghost fishing gear – a less visible aspect of marine debris – has received increasing scientific and political attention in Australia.

Ghost fishing gear is recognised as responsible for significant degradation of the Pacific's economic and ecological marine resources (APEC, 2004). While the magnitude of the problem is hard to measure, various attempts have been made to do so.

A 1997/1998 study documented more than 61 tonnes of debris on a 137km stretch of beach around north Australia's Groote Eylandt – 90 per cent of this featured ghost fishing nets (Sloane et al., 1998). Other studies report that between 70–80 per cent of retrieved marine debris are ghost nets (Kiessling, 2003).

On a larger scale, around 2,400 tonnes of fishing gear, including ghost nets, is estimated to be lost or discarded each year in Australian waters (Kiessling, 2004). More than 10,000 ghost nets have been collected since 2004 from the Gulf of Carpentaria in north Australia alone (Butler et al., 2013).

Image: A pied cormorant, Australia
Mike Guy / Marine Photobank

4.1.2 Species commonly found in ghost gear in Australian waters

As detailed in the box on page 30, quantifying the full extent of the problem that ghost gear causes animals is not easy. Estimates are highly likely to be underestimates. However, an increasing amount of scientific literature is developing around this important issue.

One study aiming to assess the impact of plastic debris on Australian marine wildlife concluded that at least 66 species were found to be affected by entanglement in plastic debris (C & R Consulting, 2009). This study included ingestion incidents, but suggested that most were caused by entanglement rather than ingestion. Furthermore, it specified the type of plastic debris entangling animals; in more than 60 per cent of cases the animals were caught in ghost fishing gear.

In southern parts of Australia and New Zealand, sea lions and fur seals have been reported to frequently become entangled in ghost fishing gear (Jones, 1995). According to a 1992 study, on average 1.9 per cent of Australian fur seals become entangled. Almost three in four fur seals are likely to be killed by this entanglement (Pemberton et al., 1992).

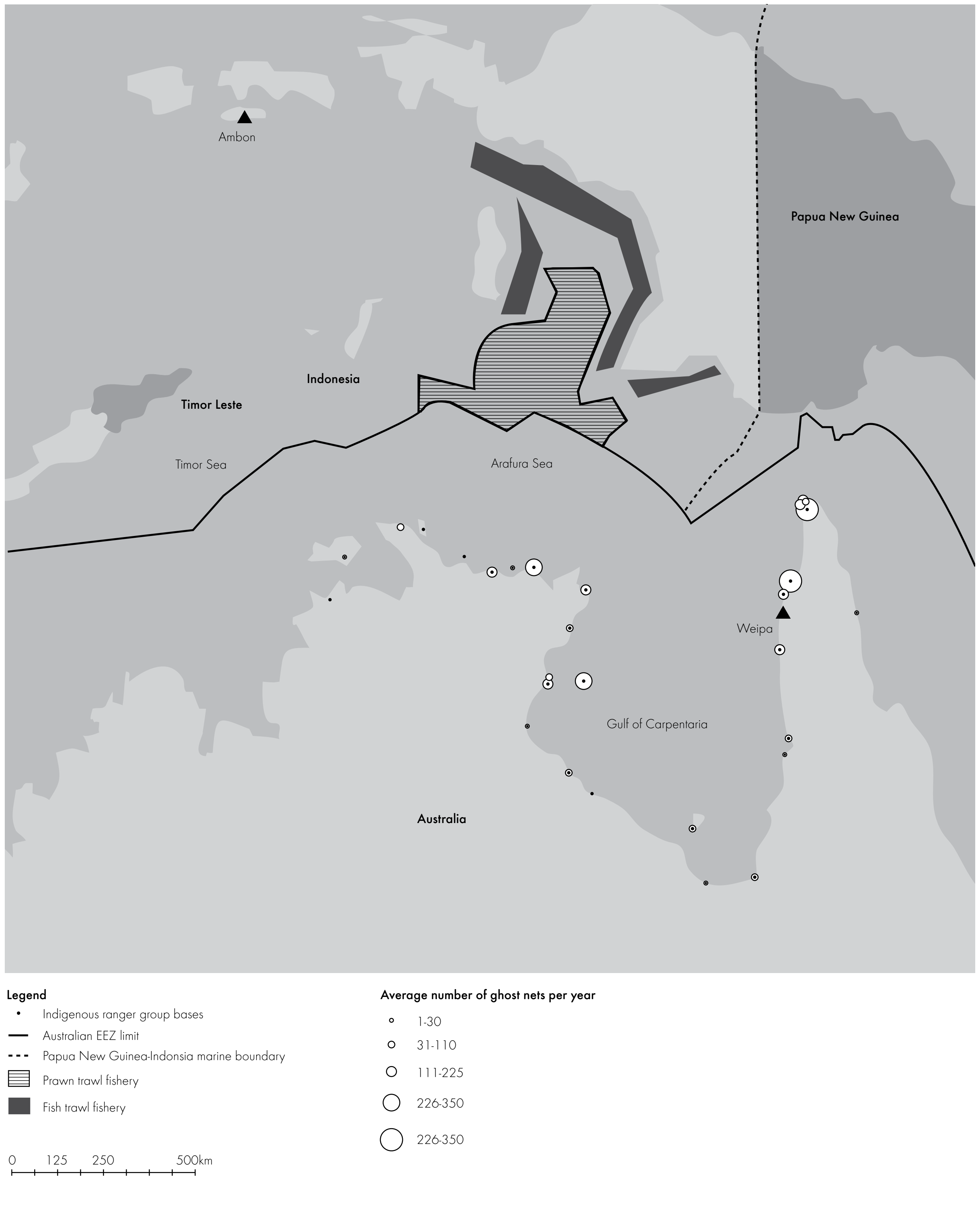
Evidence from northern Australia shows that ghost gear has been observed to entangle invertebrates, fish, sharks, turtles, crocodiles, and dugongs (Gunn et al., 2010). In just over three years more than 500 turtles were reported entangled along the Queensland coast, Gulf of Carpentaria (Kiessling, 2003) with studies suggesting ghost fishing gear as a primary cause (Leitch and Roeger, 2001).

In 2012, 100 marine animals were recovered from ghost nets – 63 were turtles and most of them dead (GhostNets Australia, 2012). Turtle species reported in various studies include mainly hawksbill turtles, followed by green turtles, then olive ridley and flatback turtles (Kiessling, 2003; Leitch and Roeger, 2001).

Australia's marine habitat is home to six of the seven threatened marine turtle species, including large portions of the remaining global populations for several species (Biddle and Limpus, 2011; Limpus and Fien, 2009).

Image: The Great Barrier Reef, Australia
ARC Centre of Excellent for Coral Reef Studies / Marine Photobank

Figure 2: The Arafura Sea and Gulf of Carpentaria, showing the littoral nations, and locations of Indonesian prawn and fish trawl fisheries, annual average ghost net retrievals in 2004-2011, and the 23 Indigenous ranger groups' communities and bases (Butler et al., 2013)



The threat to marine turtles from ghost gear and marine debris in northern Australia is thought to equal that posed by active fishing gear before turtle exclusion devices were introduced (Kiessling, 2003).

Other frequently reported entangled species include more than 30 dugongs in a two-year period and several incidences of whales, sharks and several larger fish species. Most were reported to be entangled in ghost nets (Kiessling, 2003).

A total of 96 incidents of cetaceans, mostly humpback whales, entangled in unspecified debris were reported between 1998 and 2008 in Australia. A further 110 cetaceans were killed by unknown causes.

As this study also points out, the frequency and geographic extent of records of affected species reflects the frequency of surveys conducted in each region. More remote areas – including the northern region of western Australia, the Great Australian Bight coastline, Tasmania's western coast and much of Cape York Peninsula – are not frequently monitored. This means that the numbers of animals affected in these areas are not yet known (C & R Consulting, 2009).

4.1.3 Types of ghost gear frequently causing entanglement and the worst affected areas

Northern Australia is especially vulnerable to accumulations of ghost fishing gear and other marine debris. This is due to high intensity commercial fishing operations and also ocean currents. Difficulties in surveillance and enforcement add further vulnerability to this region.

Ninety per cent of marine debris entering the coastal regions of northern Australia is related to fishing. Some parts of the debris collected could be traced back to Australian fishing vessels, especially prawn trawlers (Kiessling, 2004; WWF Australia, 2006). However, observations suggest that most ghost nets on northern Australian beaches and coastal seas originate from non-Australian fisheries. One study estimates that only 10 per cent of nets retrieved by rangers could be identified as Australian (GhostNets Australia, 2013).

But, a 2008 CSIRO study of drift simulations for ghost fishing nets suggests that nets do not travel extreme distances. The study found no evidence that nets stranding on the northern Australian shore were likely to have been lost or discarded farther away than the Arafura Sea (Griffin, 2008).

The Gulf of Carpentaria is considered a hotspot for ghost net accumulation due to climatic conditions that drag ghost fishing nets into this gulf. In general, remote areas seem to suffer more from debris resulting from commercial fishing activities. Areas closer to urban centres may have a higher frequency of consumer items such as packaging waste (Hardesty and Wilcox, 2011).

The types of commercial fishing activities that are commonly reported to result in ghost fishing are varied, although gill nets and green trawl nets are mentioned most frequently (Boren et al., 2006; Pemberton et al., 1992). In 2012, northern Australian rangers removed 845 nets – 59 per cent were trawl nets, 14 per cent were gill nets and 30 per cent were undetermined.

Taiwanese nets account for by far the largest portion of nets (24.9 per cent), followed by Indonesian nets (15.1 per cent), Australian (11 per cent) and Korean (7.4 per cent) (GhostNets Australia, 2012). This data confirms an earlier literature review on entanglement cases in northern Australia. The review identified drift, trawl and gill nets from Taiwanese, Indonesian and Australian vessels as responsible for most of these incidents (Kiessling, 2003). Plastic bags and crab pots are reported only marginally in those statistics.

Recreational fishing in Australia, especially the disposal of monofilament fishing lines or amateur bait nets, are also reported as an entanglement hazard to animals (Kiessling, 2003; Whiting, 1998). This is, however, at a lesser scale than ghost gear from commercial fisheries.

The figure overleaf shows the location of Indonesian fisheries, annual ghost net retrievals in 2004–2011 by location in northern Australia and the location of indigenous ghost net ranger bases (Butler et al., 2013).

4.1.4 Economic implications of ghost gear

The Asia Pacific Economic Cooperation (APEC) recognised that ghost fishing gear is a hazard to vessel navigation and can pose a threat to life and property. Anecdotal reports suggest that most people who regularly work in northern Australia's coastal waters will have been involved in at least one incident involving floating debris.

According to a US study at least five vessels were damaged in one year by floating debris in Australian waters (Kiessling, 2003). Furthermore, ghost fishing gear continues to function as designed; it catches species without economic benefit but with economic costs.

APEC concludes in their 2004 report that the dimensions of ghost fishing of commercial stock are undocumented and not integrated into stock management models. They assert that it potentially threatens the long-term sustainability of otherwise well-managed fisheries (APEC, 2004).

A study, published in 2009, estimated that during 2008 marine debris directly cost the APEC member economies approximately $1.265 billion (USD). Fishing, shipping and marine tourism industries were named as the industries most impacted. In the fishing industry damage includes accidents, collisions with debris, and entanglement of propellers with floating objects. The study estimated that the Australian fishing industry suffers an annual loss of $5.6 million (USD) (Campbell et al., 2009).

The aesthetic impact of marine debris on the Australian coastal environment and its tourism must also be considered. Clean-up costs are incurred by both government and the tourism industry, and marine debris is likely to adversely affect tourism by spoiling the beauty of coastlines (Gregory, 2009).

The 2009 APEC study on economic costs of marine debris estimates that in 2008 the marine tourism industry of the APEC member economies suffered damages of $622 million (USD) (Campbell et al., 2009). Communities in areas suffering from tonnes of fishing gear washing regularly on to their shores also show growing antagonism towards the fishing industry as a whole (Sloane et al., 1998).

Image: A sea lion enters the water, Australia
Gerick Bergsma / Marine Photobank

4.1.5 Regional contribution to ghost net occurrence – Indonesia

The international nature of fishing fleets, their varying operating standards and drifting caused by ocean currents, mean the ghost gear affecting northern Australia has wider regional causes. A study on the origin of ghost nets in the Gulf of Carpentaria revealed only 4 per cent of nets originated from Australia. Although 45 per cent of nets' origins could not be identified, Taiwan and Indonesia each accounted for 6–16 per cent of ghost nets – possibly more (Gunn et al., 2010).

Although few efforts are underway to address this ghost net issue, Indonesia is developing various community-based projects introducing sustainable fishing methods to local fishermen. One of the largest is a $7 million (USD), two-year project by Rare aimed at introducing No Take Zones and educating fishermen about conservation-friendly fishing methods (Rare, 2012).

WWF Indonesia is aiming to reduce turtle by-catch in commercial and traditional fisheries in Papua New Guinea and Indonesia by supporting the implementation of better fisheries management and improving policy making (WWF Indonesia, n.d.).

The Indonesian government is working with CSIRO's Sustainable Ecosystems division on a new approach to better understand the consequences of their national policies on household decisions, e.g. the exploitation of natural resources (CSIRO Sustainable Ecosystems, 2011). This approach follows published recommendations (Mous et al., 2005) suggesting that Indonesia is overexploiting its fisheries. The recommendations state that for Indonesia's fish stocks to survive, a shift away from Maximum Sustainable Yield models towards eco-system based management is needed (Mous et al., 2005).

These projects do not include ghost gear reduction in their remit but there may be potential to complement the development of Indonesian sustainable fisheries with ghost fishing gear reduction efforts.

Apex International, an environmental NGO with expertise in oceanic whale and dolphin surveys, has also carried out various educational and conservation programmes in Indonesia. It recognises discarded plastics and fishing gear as a threat to Indonesia's cetaceans in riverine, coastal and oceanic habitats (Apex International, n.d.).

Very little data is available on the impact of ghost gear in Indonesia. This is most likely attributable to the lack of monitoring of beach debris and animal entanglements or strandings.

This is demonstrated by 45 per cent of all stranded cetaceans between 1987 and 2007 not having been identified (Mustika et al., 2009). Twenty five per cent of those stranding reports come from Bali, and in 2007 a 6.1m humpback whale became entangled in fishing nets off Tanah Lot Beach. The whale was hauled to a nearby beach where the nets were removed and the whale swam away. However, one week later the whale washed ashore after apparently having died offshore (Mustika et al., 2009).

4.2 United Kingdom

4.2.1 Introduction

More than 8,000 marine species, including whales, dolphins, porpoises, seals, seabirds and turtles live and breed around the coasts of the British Isles (Defra, 2013). They share these waters with the UK fishing fleet – the sixth largest fleet in the European Union. In 2012 it had more than 6,400 vessels and landed 600,000 tonnes of fish (Marine Management Organisation, 2014) for supply to UK consumers and overseas markets.

These commercial fisheries inevitably accidentally lose or may deliberately discard fishing nets and lines which either accumulate in the sea or wash up on beaches. The Marine Conservation Society's 2012 Beachwatch clean up and survey revealed that almost 14 per cent of the litter collected from nearly 240 beaches was fishing-related. Of over 90km of beaches cleaned, some 17,700 pieces of fishing net, line and rope were collected. Almost 1 in 4 items collected from Welsh beaches were fishing- related, in Scotland this figure was less than 1 in 10 (Marine Conservation Society, 2012). Although the scale of the ghost gear problem in UK waters remains poorly quantified, it is clear that entanglement in ghost fishing gear is a significant threat to the welfare of many animals.

"Net entanglement is a major issue for live seals, as they curiously play with storm damaged and discarded fishing net floating in the water." (Cornwall Seals Group, 2013)

4.2.2 Species at risk from ghost gear in UK waters

Whales, dolphins, porpoises, turtles and seabirds in UK waters may all become entangled in either active or ghost fishing gear. There is, at present, a lack of dedicated research to assess the magnitude of the ghost gear problem. As discussed in the box on page 30, it is likely that the number of animals seen entangled is a fraction of those actually affected.

Where data does exist, it shows that entanglement in ghost fishing gear is a persistent problem, causing suffering to numerous animals. In Cornwall, UK "net entanglement is a major issue for live seals, as they curiously play with storm damaged and discarded fishing net floating in the water column" (Cornwall Seals Group, 2013).

A recent five-year study (Allen et al., 2012b) of seals at a single haul out site in Cornwall, UK, found that on average between 3.6 per cent to 5 per cent of the animals at the site were entangled. A total of 58 animals were recorded entangled over the period 2004 to 2008.

The study concluded that the vast majority of these animals were entangled in fishing gear – monofilament line or net, or multifilament net. More than two thirds of the animals had injuries that were deemed life threatening, including open wounds and constricting neck ligatures. Furthermore, neck wounds on some seals from the netting entangling them had increased in severity for several years running, illustrating the chronic suffering that ghost nets can cause.

Seals are naturally inquisitive, and on a number of occasions juvenile grey seals were filmed playing with fragments of multifilament and monofilament net at the study site (Allen et al., 2012b). It is also thought that some seals entangled in active fishing gear are cut out of the net by the fishers, who sometimes leave a section attached (R. Allen, pers. Comm).

A recent case of a grey seal pup entangled in fishing line and hooks, in Norfolk, was described as particularly horrific by the RSPCA East Winch Wildlife Centre, where the pup was taken for treatment. The line had acted like a cheese wire around his muzzle and cut off his blood supply and nerves at the end of his nose" (RSPCA, 2008). Unfortunately, the pup could not be saved as his injuries were too severe.

Image: East Sussex Coastline, United Kingdom
Melanie Siggs / Marine Photobank

Image: Fishermen in East Sussex, United Kingdom
Marnie Bammert for MSC / Marine Photobank

Image: Ghost gear in Dorset, United Kingdom
Jon Chamberlain / Marine Photobank

Minke whales in Scottish waters have also been reported entangled in fishing gear (Northridge et al. 2010; HM Government, 2012) – predominantly creel lines. Fishing-related mortality (including active gear) is thought to be the cause of death in approximately half of all examined baleen whales. Furthermore, the UK Government has reported that the main pressures on marine turtles in UK waters comes from entanglement in fishing gear and ingestion of plastic debris (HM Government, 2012).

The true extent of the ghost fishing problem in the UK is likely to be far more serious than the available data suggests. For every animal reported entangled on land, an unknown number die at sea (Laist, 1997).

"The line had acted like a cheese wire around his muzzle and cut off his blood supply and nerves at the end of his nose." (RSPCA, 2008)

4.2.3 Volumes of ghost gear in UK waters

Studies on ghost gear in some UK fisheries have concluded that gear loss is a very frequent occurrence, with tens of kilometres of nets lost annually even by small fleets. In the hake fishery in the English Channel and Western Approaches, 12 vessels on average lost around five nets per year each measuring a total length of 12km. Around 50 per cent were recovered.

In the tangle net fishery off the southern tip of Cornwall it was found that 18 vessels lost 263 nets per year. This amounted to a total length of 24km; only around one third of nets were recovered. The 26 vessels operating on the wreck fishery lost sections of nets on every trip, due to snagging, in 884 incidents (FANTARED 2).

Investigations into deep water and slope gill net fisheries in the north-east Atlantic, north and west of the British Isles found that very large quantities of nets are lost (Hareide et al., 2005). As well as accidental losses there was also widespread evidence of illegal dumping of sheet netting.

This occurs usually when vessels are not capable of carrying their nets and the catch back to port (Hareide et al., 2005). Gear conflicts with bottom trawlers and long liners also contributed to gear loss.

The precise amount of lost and discarded nets by these vessels was unknown, however a crude estimate suggested it was in the region of 1,254km of sheet netting per year. Anecdotal evidence suggested up to 30km of damaged gear was routinely discarded per vessel per trip.

And although net loss may be attributed to fishing in deep water, high levels of loss by these fisheries was also linked with unsustainable fishing practices (Brown et al., 2005). Some management measures have since been put in place in these north-east Atlantic fisheries, to reduce the risk of net loss.

Although the above studies provide a snapshot of the ghost fishing problem in some key UK fisheries, the full picture is not clear. This is due to a lack of long-term, widespread studies that quantify both net loss and entanglement incidence.

4.2.4 What are the key drivers for the ghost gear problem within the UK?

There are key factors that predispose a gill net fishery to gear loss. These are listed below in decreasing order of relative importance (FANTARED 2):

- gear conflicts, predominantly with towed gear operators
- increasing water depth
- working in poor weather conditions and/or on very hard ground
- working very long fleets
- working more gear than can be hauled regularly.

In deep water gill net fisheries (e.g. in the north-east Atlantic) deliberate dumping of sheet netting is believed to be the most significant factor (Hareide et al., 2005).

Gear conflicts are a cause of gear loss in the hake net fishery in the English Channel and Western Approaches and the tangle net fishery around the Lizard peninsula in Cornwall (Brown et al., 2005; FANTARED 2). The high amount of netting used in the tangle net fishery was also found to contribute heavily to this problem (FANTARED 2).

A number of studies have found that gill nets lost on rough ground, or over a wreck, will form many snags. This extends the ghost fishing capacity beyond that of a gil lnet lost on open, smooth ground (FANTARED 2; Revill and Dunlin, 2003). It is particularly relevant in the case of ghost nets within the UK. The coastal waters of the north-east UK are rocky, exposed and contain many hundreds of submerged wrecks; and 'wreck netting' is traditional in the area (Collings, 1986; Revill and Dunlin, 2003).

Nets lost in deep water ghost fish for much longer than those lost in shallow water because of their slower rate of deterioration. Storm and tidal action in shallow waters roll up or break up nets, reducing their catching efficiency (Brown et al., 2005; Brown and Macfadyen, 2007; Large et al., 2006).

4.2.5 What are the economic implications of ghost gear for the government/industry?

In addition to entangling marine animals such as seals and birds, ghost nets also catch and kill significant volumes of fish, including commercially targeted species. Most work on ghost gear has focused on biological and technical aspects as opposed to the economic consequences (Brown and Macfadyen, 2007). There are however some economic data available.

In 2008, there were 286 rescues in UK water of vessels with fouled propellers, incurring a cost of between €830,000 and €2,189,000 (Mouat et al., 2010). These costs relate, however, to vessels fouled by all types of marine debris as opposed to just ghost fishing gear.

A cost-benefit analysis for a hypothetical EU gill net fishery (using data from a UK gill net fishery; Watson and Aoife, 2001, cited in Brown and Macfadyen, 2007) calculated the costs of ghost fishing per vessel at over €10,456/year. Ghost fishing costs for the fishing fleet as a whole were calculated at just under €420,000 (Brown and Macfadyen, 2007).

The analysis concluded that the costs of the retrieval programme (€46,500) outweighed the benefits (€22,664) of reducing ghost fishing for the fishery. It proposed that economic benefits could be more significant in fisheries with many vessels losing large quantities of gear and/or in deep water fisheries (Brown and Macfadyen, 2007). This indicates preventative management measures may be economically preferable to curative ones; they will prevent the potentially high levels of ghost catch occurring immediately after gear loss (Brown and Macfadyen, 2007).

The literature on the economic costs of ghost gear is very limited, and tends to quantify one type of economic cost at a time (Macfadyen et al., 2009). For example, 2002 lost gear and lost fishing time costs for the Scottish Clyde inshore fishery were $21,000 (USD) and $38,000 (USD) respectively (Watson and Bryson, 2003). Similarly, there is a lack of data on monitoring, control and surveillance costs, and rescue and research costs associated with ghost gear (Macfadyen et al., 2009).

Image: A fisherman works with his nets in East Sussex, United Kingdom
Valerie Craig / Marine Photobank

4.3 United States and Canada

4.3.1 Introduction

Ghost fishing is a major concern in the US and Canada due to their expansive coastal regions and vibrant fishing industries. In recent years, research into the causes and impacts of marine debris, as well as clean-up, rescue and abatement activities, has increased. This growth is an attempt to reduce or eliminate the harm caused by plastic pollution and ghost fishing.

4.3.2 Species at risk from ghost gear in US and Canadian waters

Whales, dolphins, seals, sea lions, turtles and birds are just some of the animals entangled in ghost fishing gear in US and Canadian waters. Different animals fall victim to ghost fishing depending on a number of factors – these include the region in question and the type of fishing gear deployed.

Comparisons of whale entanglements on Canada's Atlantic coast before and after the 1992 cod fishery moratorium highlight the links between fishing activity and numbers of animals affected (Benjamins et al, 2012).

After the moratorium, whale entanglements (mostly humpback and minke whales) in gill nets and fish traps drastically declined, but entanglements in fish pots increased substantially. The fish pot entanglement increase was caused by the snow crab fishery which substituted the previous cod fishery. Similarly, the presence of fishing gear in the nests of northern gannets around the Gulf of St Lawrence was much lower after the fishery closure than prior to 1992 (Bond et al., 2012).

Atlantic Canada is home to a huge fishing industry. In this area humpback and right whales are the species particularly vulnerable to entanglement, especially from hook-and-line gear, drift nets, traps, pots and gill nets (Benjamins et al, 2012; Vanderlaan et al, 2011). Entanglement is second only to vessel strikes as being the cause of documented right whale deaths (Vanderlaan et al., 2011).

Data collected between 1979 and 2008 on whale entanglements around Newfoundland and Labrador show 80 per cent of the 1,183 recorded entanglements involved humpback whales and 15 per cent affected minke whales (Benjamins et al, 2012).

In the north-east US, lobster pots and gill nets dominate the coastal zone. Approximately 150 humpback and northern right whales and around 50 leatherback turtles have been disentangled since 1995. In 2012 alone, 11 humpback and right whales and one basking shark were successfully disentangled (Delaney, 2013). More than 70 per cent of north Atlantic right whales have been entangled in fishing gear, predominantly in lobster pots (Provincetown Center for Coastal Studies, 2013).

In the mid-Atlantic region of the US, in Virginia's portion of the Chesapeake Bay, it is estimated that 1.25 million blue crabs are caught by abandoned or lost crab pots. These ghost crab pots catch an additional 30 species of marine animals, including large numbers of oyster toadfish, black sea bass, Atlantic croaker, spot and flounder and rare diamondback terrapins (Bilkovic et al., 2012).

In the Pacific United States, more than 300,000 animals, representing more than 240 unique species, were found entangled in ghost gear in Puget Sound. These species included porpoise, sea lions, scoters, grebes, cormorants, canary rockfish, Chinook salmon, and Dungeness crab (Northwest Straits Initiative, 2011). Based on these data, a mortality rate model for entangled animals in Puget Sound led to the following extrapolation developed by the SeaDoc Society at University of California at Davis.

Table 2: Mortality rate model for animals entangled annually in Puget Sound (Northwest Straits Initiative, 2011)"

Entangled animal	Daily	Annually
Marine mammals	3.53	1,289
Birds	63.87	23,311
Fish	232.81	84,974
Invertebrates	8,576.68	3,130,486

Ghost gear in the north-west Hawaiian Islands is believed to be the largest human-originated threat to the critically endangered Hawaiian monk seal. Annual rates of entanglement in fishing gear ranged from 4 per cent to 78 per cent of the total estimated population of 1,300 (SeaDoc Society, 2010).

In Cape Cod, Massachusetts, over a 14 year period (1999-2013) the International Fund for Animal Welfare reported 95 confirmed entanglements over three seal species (gray, harbour, harp). One female seal was found to have a netting neck constriction which had cut into her trachea, meaning she was unable to dive (and feed) without drowning. This animal was euthanised (Brian Sharp, International Fund for Animal Welfare, Personal Communication, 2014).

In addition to seals, entanglements have been documented for 31 humpback whales (NOAA, 2008) and all four species of sea turtles (olive ridleys, hawksbills, greens, and leatherbacks) found in Hawaiian waters (Timmers et al., 2005). In California, nearly 10 per cent of brown pelicans and gull species treated at marine wildlife rehabilitation centres are admitted due to fishing gear entanglement or ingestion injuries (SeaDoc Society, 2010).

In Canada, data from the Marine Mammal Response Program (MMRP) indicate that there were 112 incidents of marine animal entanglements in the period 2011–2012. Animals involved include: whale species; white-sided and white-beaked dolphins; harbour and Dall's porpoises; Steller sea lions; leatherback turtles, and basking sharks, among others (DFO, 2013).

Forty of these incidents occurred among species-at-risk (DFO, 2013). This data is by no means complete as it relies on reported incidents; the true number of gear-related injuries and mortalities is likely to be significantly higher.

Image: Waikiki Beach in Hawaii, United States
Wolcott Henry / Marine Photobank

4.3.3 What types of ghost gear cause the most entanglements?

Gill nets

Of the different types of fishing gear used by US fisheries, gill nets are considered the most harmful in terms of ghost fishing. Gill nets (and drift nets) have been described as 'the most deadly' due to the low visibility of the monofilament line which makes up these nets underwater (Lieber, 2013). Thirty six per cent of whale entanglements in the Gulf of Maine are caused by gill nets (McCaroon and Tetreault, 2012).

Although the state of California has banned gill nets, loopholes exist for certain fisheries, particularly herring. As a result, entanglement of whales, dolphins and turtles is a common occurrence in these fisheries (Lieber, 2013). In 2008, an abandoned 4,000-foot gill net was located four miles off the coast of Southern California. The first 100 feet of that gill net contained the carcasses and skeletons of 21 dead sea lions, a dozen cormorants, and several crabs (Lieber, 2013).

Similarly, British Columbia fishers report that gill nets are the most common type of lost or abandoned of fishing gear (CETUS, 2013).

Crab pots

In the US, Dungeness crab fisheries have the highest reported rates of lost fishing gear, and the greatest economic incentive to minimise its loss. A 2010 SeaDoc Society study shows a cost-benefit analysis, limited to Dungeness crabs caught by ghost fishing gear in Puget Sound, results in a cost-benefit ratio of 1:14.

Dungeness crabs are the main species harvested by fishers in British Columbia. Here regulations mandate that untreated cotton twine must be used to allow for deterioration, as a way to help prevent ghost fishing (CETUS, 2013).

Image left: Ghost fishing gear washed up on a beach in Hawaii, United States
Chris Pincetich / Marine Photobank

Image above: Mother dolpin and her calf
Alana Yurkanin / Marine Photobank

More than a million blue crabs, as well as up to 40 other marine species are caught by crab pots abandoned or lost in Virginia's portion of the Chesapeake Bay. The Virginia Institute of Marine Science (VIMS) partnered with the National Oceanic and Atmospheric Administration (NOAA) to locate and remove 32,000 ghost crab pots over four years (Bilkovic et. al. 2012).

Lobster pots

Fifty three per cent of all whale entanglements in the Gulf of Maine, where the gear type could be identified, were caused by fixed-gear pots. Lobster gear made up most of the cases attributed to pots (McCaroon and Tetreault, 2012).

4.3.4 Entanglement 'hotspots'

Hawaiian Islands

An estimated 52 tonnes of fishing gear is lost around the north-west Hawaiian Islands annually. In 2008, approximately six metric tonnes of ghost fishing nets were removed off the island of Oahu alone. In the last 15 years, federal and state agencies have removed 579 metric tonnes of ghost fishing nets from the north-west Hawaiian Islands (Dameron et. al. 2007). Additionally, NOAA removed 14 metric tonnes of debris from the waters surrounding Hawaii's remote Midway Atoll in 2013 alone (NOAA, 2013).

Southern California

More than 60 tonnes of ghost gear was retrieved from California's coastal ocean by the California Lost Fishing Gear Recovery Project between May 2006 and November 2012. The retrieval focussed, primarily on southern California and included the area around the California Channel Islands. The project has also cleaned more than 1,400 pounds of recreational fishing gear off public fishing piers, including more than 1 million feet of fishing line (SeaDoc Society, 2014).

Puget Sound, Washington

As of December 2013, the Northwest Straits Initiative (NWSI) has removed 4,605 ghost fishing nets, 3,173 crab pots, and 47 shrimp pots from Puget Sound. This has restored 661.5 acres of critical marine habitat. NWSI estimates 12,193 crab pots are lost annually in Puget Sound, each catching approximately 30 crabs a year until the pots deteriorate. Location research indicates that fewer than 900 ghost nets remain in the Sound (Northwest Straits Initiative, 2011).

In addition to these findings in local state waters, NOAA and NWSI commissioned Natural Resources Consultants to complete deep water exploration for ghost gear in Puget Sound. They have located 207 ghost nets, with strong indication "that further deepwater surveys would reveal significantly more ghost fishing nets than the 207 presently inventoried" (NOAA and NWSI, 2013).

4.3.5 Economic implications of ghost gear for the government and industry

There is no doubt that ghost fishing gear has an economic cost in terms of both its impact on the commercial fishing industry and on the marine environment. Losses to the fishing industry and harm to non-commercial species are sustained when catches inadvertently occur via ghost gear.

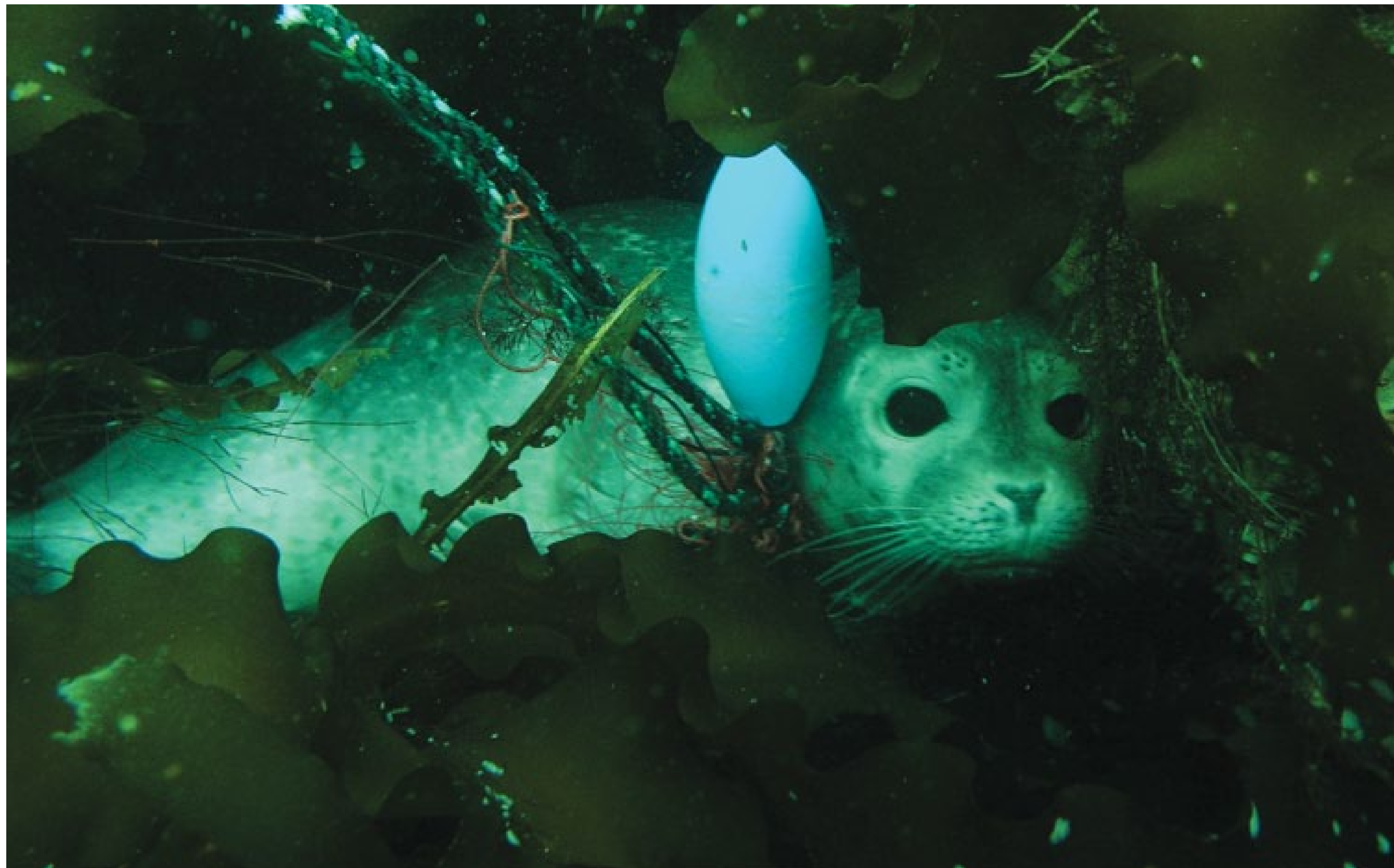
It has been estimated that an abandoned gill net can kill almost $20,000 (USD) worth of Dungeness crab over 10 years. However, the cost to remove that same net is only $1,358 (USD) (SeaDoc Society, 2010).

The 1.25 million blue crabs caught in ghost crab pots in Virginia Bay have a 2013 value of more than $400,000 (USD) (Blankenship, The Bay Journal).

The NWSI commissioned Natural Resources Consultants to conduct a cost-benefit analysis of ghost fishing gear removal in Puget Sound using data collected from 2004 to 2007. The study compared losses to the commercial and recreational fishery and operational removal/clean-up costs to the benefits of preventing further losses by recovering ghost gear (NWSI, 2007). The clean-up initiative resulted in a positive benefit – $6,285 (USD) per acre and $248 (USD) per pot/trap compared to a cost of $4,960 (USD) per acre of net removal and $193 per fishing pot/trap removal. These costs may be conservative – the durability of the equipment means ghost fishing could continue past the 10-year projection period of this study (NWSI, 2007; Macfadyen et al., 2009).

Image: Entangled Hawaiian monk seal and her pup in Hawaii, United States
NOAA, NMFS permit 932-1905

Image: A seal pup entangled in ghost gear, Isle of Shoals, United States
Steve Whitford / Marine Photobank



Although not included in the NWSI study analysis, further gains resulting from gear recovery include the indirect benefits to the ecosystem (animal welfare, habitat preservation and conservation). This is however difficult to measure monetarily.

Cost effectiveness of ghost fishing gear removal is evident when compared to typical expenditures on habitat restoration projects and rescuing animals caught in oil spills (NWSI, 2007).

The detrimental impact of ghost fishing on the marine environment in terms of harming marine animals can be considered an 'external cost'. This is because animal suffering and ecosystem effects are not usually included in the profit and loss assessments of typical economic models and are not easily quantified. Furthermore, the animal welfare impacts are rarely included when the negative impacts of ghost fishing are considered.

Image: A sea lion swimming
iStock. by Getty Images

5. Conclusions: the need for global action towards ghost-gear-free seas

Conclusions: the need for global action – towards ghost-gear-free seas

'Fishing's phantom menace' demonstrates the global scale of the ghost gear problem and the serious threat posed to marine mammals, reptiles, seabirds and other species. Ghost fishing gear represents a major challenge to our attempts to manage the oceans sustainably and humanely. It shows no sign of diminishing.

International recognition of this transboundary issue is evidenced by the significant number of governments and intergovernmental bodies who have marine debris, including ghost gear, on their agendas, and reduction targets in view. Around the world, a number of governments, non-governmental organisations and companies have set up inspiring and effective solution projects, tackling the problem at the local or national level. Yet there remains no global coordination framework to enable the problem of ghost fishing gear to be monitored and solved at scale.

World Animal Protection aims to help meet this need and opportunity. We aim to found a cross-sectoral initiative to unite people and organisations around the world who have the knowledge, power and influence to deliver solutions for ghost-gear-free seas, globally. By forming the Global Ghost Gear Initiative, we aim to forge an alliance of governments, industry, intergovernmental and non-governmental organisations, with a shared commitment to understand and tackle the problem of ghost fishing gear.

What could a Global Ghost Gear Initiative do?

- Enable effective cross-sectoral and global coordination to share data, intelligence and resources to understand global ghost gear abundance, causes, impacts and trends.
- Signify and promote a shared cross-sectoral commitment to support the expansion and replication of existing effective solutions to reduce ghost gear at source, remove existing gear, and develop new solutions.
- Share and promote learnings and resources from effective solution case studies, in both policy and practice, to enable replication and expansion.
- Direct and drive solution delivery in ghost gear hotspots, and create opportunities for the provision of seed funding of solution projects using best practice models.
- Enable global monitoring and showcasing of the impacts of solution projects to catalyse further change.

WSPA believes that uniting global efforts to tackle ghost fishing gear, and underlining our shared responsibility to redouble these efforts, is the best way to ensure ghost fishing gear does not pose an ever-growing threat to our oceans' animals, environment, and productivity.

Images from top:
Ghost fishing gear makes a bridge in Costa Rica
Sea Turtle Restoration Project / Marine Photobank

Green sea turtle rescued from entanglement in Hawaii
Amanda Cotton / Marine Photobank

Volunteers clear up ghost fishing gear in Hawaii
NOAA / NMFS

Covanta SEMASS facility in Massachusetts, US, where ghost fishing gear is recycled

World Animal Protection believes that uniting global efforts to tackle ghost fishing gear, and underlining our shared responsibility to redouble these efforts, is the best way to ensure ghost fishing gear does not pose an ever-growing threat to our oceans' animals, environment, and productivity.

Which functional elements could the Global Ghost Gear Initiative incorporate?

Data hub: to record and analyse ghost gear volumes, geography and trends to more accurately describe and quantify the problem. Data could be used to underpin and direct mitigation responses, and allow monitoring of solution project impacts against baselines.

Virtual communication platform: to facilitate the sharing of intelligence and challenges and to showcase existing effective solutions in policy and practice. The platform could represent and empower a global virtual community of people and organisations committed to tackling ghost fishing gear. It could also act as a global repository of information to inspire and enable the growth of solutions.

Action catalyst: to identify hotspot areas in need of priority action and to then facilitate the formation of strategic partnerships to deliver effective solutions with measurable impacts.

Steering group: to drive and oversee the development and operation of the initiative. The initiative could benefit from biennial meetings to evaluate progress towards shared goals, and to agree recommended priorities for future action by partners.

References

Allen, J. A., Sayer, S. Jarvis, D., & Mills, C. (2012a). Entanglement of grey seals (Halichoerus grypus) at a haul out site in Cornwall, UK. 'Marine Pollution Bulletin' 64(12), 2815-2819.

Allen, J. A., Sayer, S. Jarvis, D., & Mills, C. (2012b). 'A welfare issue: entanglement of Cornish grey seals'. Presentation. Cornwall College, Newquay, Cornwall Seal Group, BDMLR, University of Exeter. Abstract retrieved 10 October 2012 from http://www.cornwallsealgroup.co.uk

Al-Masroori, H.S. (2002). 'Trap ghost fishing problem in the area between Muscat and Barka (Sultanate of Oman): an evaluation study' (M.Sc. thesis). Sultan Qaboos University, Sultanate of Oman.

Anderson, R. C. & Waheed, A. (1988). 'Exploratory fishing for large pelagic species in the Maldives'. Main report. Bay of Bengal Programme BOBP/REP/46 – FAO/TCP/ MDV/6651.

ANZECC. (1996). 'The Australian marine debris status review: a summary report'.

APEC. (2004). 'Derelict fishing gear and related marine debris: an educational outreach seminar among APEC partners'. Honolulu.

Apex International, n.d. Threats to Indonesia's cetaceans. Retrieved 4 March 2014 from http://www.apex-environmental.com/IOCPImpacts.html

Arnould, J. P. Y., & Croxall, J. P. (1995). Trends in entanglement of Antarctic fur seals (Arctocephalus gazella) in man-made debris at South Georgia. 'Marine Pollution Bulletin', 30(11), 707-712.

Barco, S. G., D'Eri, L. R., Woodward, B. L., Winn, J. P., & Rotstein, D. S. (2010). Spectra® fishing twine entanglement of a bottlenose dolphin: A case study and experimental modeling. 'Marine Pollution Bulletin', 60(9), 1477–1481.

Benjamins, S., Ledwell, W., Huntington, J. & Davidson, A. R. (2012). Assessing changes in numbers and distribution of large whale entanglements in Newfoundland and Labrador, Canada. 'Marine Mammal Science', 28, 579–601.

Biddle, T.M., Limpus, C.J. (2011). Marine wildlife stranding and mortality database annual reports 2005-2010. 'Marine Turtles'. Queensland Environmental Protection Agency.

Bilkovic, D.M., Havens, K.J., Stanhope, D.M., & Angstadt, K.T. (2012). Use of fully biodegradable panels to reduce derelict pot threats to marine fauna. Center for Coastal Studies, Virginia Institute of Marine Science, College of William & Mary. 'Conservation Biology', Volume 27, No. 6, 957–966.
Blankenship, K. (8 June 2013) Ghost pots estimated to kill 1.25 million blue crabs in VA's bay waters. 'The Bay Journal'. Retrieved 26 March 2013 from http://www.bayjournal.com/article/ghost_pots_estimated_to_kill_1.25_million_blue_crabs_in_vas_bay_waters

Boland, R. C. & Donohue, M. J. (2003). Marine debris accumulation in the nearshore marine habitat of the endangered Hawaiian monk seal, ('Monachus schauinslandi') 1999-2001. 'Marine Pollution Bulletin', 46, 1385–1394.

Bond, A. L., Montevecchi, W. A., Guse, N., Regular, P. M., Garthe, S. & Rail, J. F. (2012). Prevalence and composition of fishing gear debris in the nests of northern gannets (Morus bassanus) are related to fishing effort. 'Marine Pollution Bulletin', 64, 907–911.

Boren, L. J., Morrissey, M., Muller, C. G., & Gemmell, N. J. (2006). Entanglement of New Zealand fur seals in man-made debris at Kaikoura, New Zealand. 'Marine Pollution Bulletin', 52, 442–446.

Breen, P. A. (1990). A review of ghost fishing by traps and gillnets. 'Proceedings of the 2nd international conference on marine debris, 2–7 April 1989', Honolulu, Hawaii, USA. NOAA Technical Memorandum 154: 561–599.

Brown, J., and Macfadyen, G. (2007). Ghost fishing in European waters: impacts and management responses. 'Marine Policy', 31, 488–504.

Brown, J., Macfadyen, G., Huntington, T., Magnus, J., and Tumilty, J. (2005). Ghost fishing by lost fishing gear. Final report to DG Fisheries and Maritime Affairs of the European Commission, Fish/2004/20. Institute for European Environmental Policy/Poseiden Aquatic Resource Management Ltd Joint Report. Retrieved 1 July 2013 from http://ec.europa.eu/fisheries/documentation/studies/ghostfishing_en.pdf

Burke, L., & Maidens, J. (2004). 'Reefs at risk in the Caribbean'. Report by the World Resources Institute, Washington D.C. Retrieved 10 October 2012 from http://www.wri.org/publication/reefs-riskcaribbean

Butler, J.R.A., Gunn, R., Berry, H.L., Wagey, G.A., Hardesty, B.D., Wilcox, C. (2013). A value chain analysis of ghost nets in the Arafura Sea: identifying trans-boundary stakeholders, intervention points and livelihood trade-offs. 'Journal of Environmental Management' 123, 14–25.

Campagna, C., Falabella, V., & Lewis, M. (2007). Entanglement of southern elephant seals in squid fishing gear. 'Marine Mammal Science', 23(2), 414–418.

Campbell, H.F., McIlgorm, A., Rule, M.J. (2009). 'Understanding the economic benefits and costs of controlling marine debris in the APEC region'.

CETUS Research and Conservation Society. (2013). 'Derelict fishing gear in the waters of Southern Vancouver Island: feasibility study'. April 2013.

Chang-Gu Kang. (2003). 'Marine litter in the Republic of Korea'. Retrieved 5 August 2013 from http://marine-litter.gpa.unep.org/documents/marine-litter-Korea-Kang.pdf

Chopin, F., Inoue, Y., Matsuhita, Y., & Arimoto, T. (1995). Sources of accounted and unaccounted fishing mortality. In B. Baxter & S. Keller (Eds.), 'Proceedings of the solving bycatch workshop on considerations for today and tomorrow' (pp.41–47). University of Alaska Sea Grant College Program Report No. 96–03.

Cole, T., Hartley, D., & Garron, M. (2006). 'Mortality and serious injury determinations for baleen whale stocks along the Eastern Seaboard of the United States, 2000-2004'. US Department of Commerce, Northeast Fisheries Science Center Reference Document: 06–04.

Collings, P. (1986). 'The divers guide to the north east coast'. Collings and Brodie. ISBN 095116810X.

Convention on Biological Diversity (CBD). (2012). Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF (2012). 'Impacts of marine debris on biodiversity: current status and potential solutions', Montreal, Technical Series No. 67. Retrieved 5 August 2013 from http://www.cbd.int/doc/publications/cbd-ts-67-en.pdf

C & R Consulting. (2009). 'Impacts of plastic debris on Australian marine wildlife'. Department of the Environment, Water, Heritage and the Arts, Australia.

Criddle, K.R., Amos, A.F., Carroll, P., Coe, J.M., Donohue, M.J., Harris, J.H., Kim, K., MacDonald, A., Metcalf, K., Rieser, A. (2009). 'Tackling marine debris in the 21st century'. The National Academies Press, Washington, DC, USA. ISBN.

CSIRO Sustainable Ecosystems, 2011. 'Analysing pathways to sustainability in Indonesia resources'. Retrieved 7 February 2014 from http://www.csiro.au/en/Organisation-Structure/Divisions/Ecosystem-Sciences/Indonesian-Pathways-Resources.aspx

Cunningham, D.J., Wilson, S.P. (2003). Marine debris on beaches of the Greater Sydney Region. 'Journal of Coastal Research' 421–430.

Dau, B. K., Gilardi, K. V., Gulland, F. M., Higgins, A., Holcomb, J. B., Leger, J. S., & Ziccardi, M. H. (2009). Fishing gear-related injury in California marine wildlife. 'Journal of Wildlife Diseases', 45(2), 355–362.

Davis, L.A. (1991). North Pacific pelagic drift netting: untangling the high seas controversy. 'Southern California Law Review', 64,1057.

Delaney, Richard; Provincetown Center for Coastal Studies, personal communication, 19 July 2013

Department for Environment, Food and Rural Affairs (Defra). (2013). 'Policy: protecting and sustainably using the marine environment'. Retrieved 1 July 2013 from https://www.gov.uk/government/policies/protecting-and-sustainably-using-the-marine-environment

Department of Fisheries and Oceans (DFO). (2010). Potential impacts of fishing gears (excluding mobile bottom-contacting gears) on marine habitats and communities. 'Canadian Science Advisory Report'.

Department of Fisheries and Oceans (DFO). (2013). 'Marine mammal response program, annual report 2011-2012'. Retrieved 5 December 2013 from http://www.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/publications/6-eng.htm

Derraik, J. G. B. (2002). The pollution of the marine environment by plastic debris: a review. 'Marine Pollution Bulletin', 44(9), 842–852.

Donohue, M. J., Boland, R. C., Sramek, C. M., & Antonelis, G. A. (2001). Derelict fishing gear in the Northwestern Hawaiian Islands: diving surveys and debris removal in 1999 confirm threat to coral reef ecosystems. 'Marine Pollution Bulletin', 42(12), 1301–1312.

Donohue, M. J., & Foley, D. G. (2007). Remote sensing reveals links among the endangered Hawaiian monk seal, marine debris, and El Nino. 'Marine Mammal Science', 23(2), 468–473.

Environmental Graffiti. (2009). 'North Pacific Gyre: The ocean's hidden garbage dump'. Retrieved 15 November 2012 from http://www.environmentalgraffiti.com/waste-andrecycling/news-plastic-graveyard-soup-unwanted-junk-ourocean#4qbxIel7QMgFLS2U.99

FANTARED 2. (2003). 'A study to identify, quantify and ameliorate the impacts of static gear lost at sea'. EC contract FAIR-PL98-4338. ISBN 0-903941-97-X. Retrieved 1 July 2013 from http://www.seafish.org/media/Publications/FANTARED_2_COMPLETE.pdf

Farm Animal Welfare Council (FAWC). (1979). Press Statement. Retrieved 5 August 2013 from http://www.fawc.org.uk/pdf/fivefreedoms1979.pdf

Farm Animal Welfare Council (FAWC). (2009). Five Freedoms. Retrieved 7 February 2014 from http://www.fawc.org.uk/freedoms.htm

Fishermans Outfitter. Retrieved 7 February 2014 from http://www.fishermansoutfitter.com/c-39-Spectra

Garcia-Godos, I., Van Waerebeek, K., Alfaro-Shigueto, J., & Mangel, J. C. (2013). Entanglements of large cetaceans in Peru: few records but high risk. 'Pacific Science', 67(4), 523–532.

Ghostnets Australia. (2012). '2012 Annual Report'. Retrieved 7 August 2013 from http://www.ghostnets.com.au/pdf/2012%20ANNUAL%20REPORT_final_090413.pdf

GhostNets Australia. (2013). 'What is GhostNets Australia?' Retrieved 28 April 2013 from www.ghostnets.com.au

Gilardi, K. V., Carlson-Bremer, D., June, J.A., Antonelis, K., Broadhurst, G., Cowan, T. (2010). Marine species mortality in derelict fishing nets in Puget Sound, WA and the cost/benefits of derelict net removal. 'Marine Pollution Bulletin', 60, 376–382.

Good, T. P., June, J. A., Etnier, M., & Broadhurst, G. (2007). Quantifying the impact of derelict fishing gear on the marine fauna of Puget Sound and the Northwest Straits. 'Proceedings of the International Council for the Exploration of the Sea Annual Science Conference'. September 17–21, Helsinki. Retrieved 10 October 2012 from http://www.ices.dk/products/cmdocsindex.asp

Good, T. P., June, J. A., Etnier, M., & Broadhurst, G. (2009). Ghosts of the Salish Sea: threats to marine birds in Puget Sound and the Northwest Straits from derelict fishing gear. 'Marine Ornithology, 37, 67–76.

Good, T. P., June, J. A., Etnier, M., & Broadhurst, G. (2010). Derelict fishing nets in Puget Sound and the Northwest Straits: patterns and threats to marine fauna. 'Marine Pollution Bulletin', 60, 39–50.

Gregory, M.R. (2009). Environmental implications of plastic debris in marine settings–entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. 'Philosophical Transactions of the Royal Society'. B 364(1526), 2013–2025.

Griffin, D. (2008). 'Pilot investigation of the origins and pathways of marine debris found in the northern Australian marine environment'. Department of the Environment, Water, Heritage and the Arts, Australia.

Guillory, V., McMillen-Jackson, A., Hartman, L., & Perr, H. (2001). 'Blue crab derelict traps and trap removal programs'. Publication 88, Gulf States Marine Fisheries Commission. Retrieved 5 August 2013 from http://www.gsmfc.org/pubs/ijf/derelicttraps.pdf

Gulf States Marine Fisheries Commission (GSMFC). (2003). 'Derelict crab trap removal program: programs in other gulf states'. Retrieved 10 October 2012 from http://www.derelictcrabtrap.net/background5.html

Gunn, R., Hardesty, B. D. & Butler, J. (2010). Tackling 'ghost nets': local solutions to a global issue in northern Australia. 'Ecological Management a Restoration', 11, 88–98.

Hanni, K. D., & Pyle, P. (2000). Entanglement of Pinnipeds in synthetic materials at South-east Farallon Island, California, 1976-1998. 'Marine Pollution Bulletin', 40(12), 1076–1081.

Harcourt, R., Aurioles, D., & Sanchez, J. (1994). Entanglement of California sea lions at Los Islotes, Baja California Sur, Mexico. 'Marine Mammal Science', 10, 122–125.

Hardesty, B.D., Wilcox, C. (2011). 'Understanding the types, sources and at-sea distribution of marine debris in Australian waters'. CSIRO.

Hareide, Garnes G., Rihan D., Mulligan M., Tyndall P, Clark M., Connolly P., Misund R., McMullen P., Furevik D. M., Humborstad O-B, Høydal K. and Blasdale T. (2005). 'A preliminary investigation on shelf edge and deep water fixed net fisheries to the west and north of Great Britain, Ireland, around Rockall and Hatton Bank'. Bord Iascaigh Mhara, Fiskeridirecktoratet, NEAFC, Sea Fish Industry Authority, Joint Nature Conservation Committee, Marine Institute Foras na Mara. 47 pp. Retrieved 1 July 2013 from http://brage.bibsys.no/imr/bitstream/URN:NBN:no-bibsys_brage_27415/1/N0705.pdf

HM Government. (2012). Marine Strategy Part One: UK Initial Assessment and Good Environmental Status. Retrieved 24 March 2014 from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69632/pb13860-marine-strategy-part1-20121220.pdf

Hofmeyr, G. J. G., De Maine, M., Bester, M. N., Kirkman, S. P., Pistorius, P. A., & Makhado, A. B. (2002). Entanglement of pinnipeds at Marion Island, Southern Ocean: 1991–2001. 'Australian Mammalogy', 24, 141–146.

Humborstad, O-B., Løkkeborg, S., Hareide, N-R. & Furevi, D.M. (2003). Catches of Greenland halibut ('Reinhardtius hippoglossoides') in deep water ghost-fishing gillnets on the Norwegian continental slope. 'Fisheries Research', 64(2–3), 163–170.

Hwang, S. T., & Ko, J. P. (2007). 'Achievement and progress of marine litter retrieval project in near coast of Korea, based on activities of Korea Fisheries Infrastructure Promotion Association'. Presentation to regional workshop on marine litter, June 2007, Rizhao, The People's Republic of China. North West Pacific Action Plan.

Jones, M.M. (1995). Fishing debris in the Australian marine environment. 'Marine Pollution Bulletin' 30, 25–33.

Karamanlidis, A. A. (2000). Monitoring human and Mediterranean monk seal activity in the National Marine Park of Alonnissos and Northern Sporades, Greece. 'The Monachus Guardian', 3(1).

Kiessling, I. (2003). 'Finding solutions: derelict fishing gear and other marine debris in Northern Australia. Report prepared for the National Oceans Office for the Key Centre for Tropical Wildlife Management. Darwin, Australia: Charles Darwin University.

Kiessling, I. (2004). 'Marine debris in Australia – the international dimension: case study abstract'. National Oceans Office, Australia.

Knowlton, A. R., & Kraus, S. D. (2001). Mortality and serious injury of northern right whales (Eubalaena glacialis) in the western North Atlantic Ocean. 'Journal of Cetacean Research and Management', Special Issue 2, 193–208.

Kraus, S. D. (2008). 'The urban life of the north Atlantic right whale: The cumulative effects of traffic, fishing, noise, pollution, and disease in the coastal zone of North America'. The Third Florida Marine Mammal Health Conference. April 22–25, Florida. Abstract retrieved 6 August 2013 from http://www.conference.ifas.ufl.edu/marinemammal/pdfs/abstract_book.pdf

Kruse, G. H. & Kimker, A. (1993). 'Degradable escape mechanisms for pot gear: a summary report to the Alaska Board of Fisheries'. Regional Information Report 5J93–01. Alaska Department of Fish and Game (ADFG).

Laist, D. W. (1997). Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In J. M. Coe & D. B. Rogers (Eds.), 'Marine Debris, Sources, Impacts, and Solutions' (pp. 99-139). New York, NY: Springer–Verlag.

Large, P. A., Randall, P., Doran, S., and Houghton, C. (2006). 'Programme 12: western edge ghost nets (gillnet retrieval)'. Fisheries Science Partnership Report. Retrieved 1 July 2012 from http://www.cefas.defra.gov.uk/media/40274/fsp200607prog12gillnetrerievalsurveyfinalreport.pdf

Leitch, K., Roeger, S. (2001). 'Entanglement of marine turtles in netting: northeast Arnhem Land'. Northern Territory, Australia. Dhimurru Land Management Aboriginal Corporation, Nhulunbuy.

Lieber, K. (2013). The Deadliest Ghosts. Report prepared for Mission Blue (Sylvia Earle Alliance).

Limpus, C.J., Fien, L. (2009). 'A biological review of Australian marine turtles – green turtle'. Queensland Environmental Protection Agency.

Macfadyen, G., Huntington, T., & Cappell, R. (2009). 'Abandoned, lost or otherwise discarded fishing gear'. UNEP Regional Seas Reports and Studies, No. 185; FAO Fisheries and Aquaculture Technical Paper, No. 523. Rome: UNEP/FAO.

Mailonline. (28 March 2012) Free Willy! Dramatic rescue of gray whale tangled in 50ft fishing net filled with dead sea animals for a week. Retrieved ((insert date)) from http://www.dailymail.co.uk/news/article-2121390/Free-Willy-Dramatic-rescue-Gray-whale-tangled-50ft-fishing-net-filled-dead-sea-animals-week.html#ixzz2rzMcvVGf

Mann, J., Smolker, R .A., & Smuts, B. B. (1995). Responses to calf entanglement in free-ranging bottlenose dolphins. 'Marine Mammal Science', 11(1), 100–106.

Marine Conservation Society (MCS). (2012). 'Beachwatch Big Weekend 2012: results of the UK's biggest beach clean and survey'. Retrieved 1 July 2012 from http://www.mcsuk.org/downloads/pollution/beachwatch/2012/Beachwatch_summary_2012.pdf

Marine Management Organisation (MMO). (2014). 'UK sea fisheries statistics 2012'. Retrieved 23 January 2014 from http://www.marinemanagement.org.uk/fisheries/statistics/annual.htm

Matthews, T. R., & Uhrin, A. V. (2009). Lobster trap loss, ghost fishing, and impact on natural resources in Florida Keys National Marine Sanctuary. In Morison, S. and Murphy, P. (Eds.), 'Proceedings of the NOAA submerged derelict trap methodology' detection workshop. June 2–4. NOAA Technical Memorandum NOSOR&R-32.

McCaroon, Patrice and Tetreault, Heather, (2012). 'Lobster pot gear configurations in the Gulf of Maine'. Report prepared for the Consortium for Wildlife Bycatch Reduction, Maine Lobstermen's Association, and the New England Aquarium.

McKauge, K. (Undated). 'Assessing the blue swimmer crab fishery in Queensland'. Retrieved 15 November 2012 at www 2.dpi.qld.gov.au/extra/pdf/fishweb/blueswimmercrab/GhostFishing.pdf

Moore, M. J. (2014). How we all kill whales. ICES Journal of Marine Science, doi.10.1093/icesjms/fsu008. Retrieved 18 February 2014 from http://icesjms.oxfordjournals.org/content/early/2014/02/12/icesjms.fsu008.full#ref-32

Moore, M., Knowlton, A., Kraus, S., McLellan, W. and Bonde, R. (2005). Morphometry, gross morphology and available histopathology in north-west Atlantic right whale ('Eubalaena glacialis') mortalities (1970 to 2002). 'Journal of Cetacean Research and Management', 6, 199–214.

Moore, M. J., Bogomolni, A., Bowman, R., Hamilton, P. K., Harry, C. T., Knowlton, A. R., Landry, S., Rotstein, D. S., & Touhey, K. (2006). 'Fatally entangled right whales can die extremely slowly'. OCEANS Conference, 18-21 September, Boston, MA.

Moore, M. J., & van der Hoop, J. M. (2012). The painful side of trap and fixed net fisheries: chronic entanglement of large whales. Journal of Marine Biology 2012, doi: 10.1155/2012/230653. Retrieved 18 February 2014 from http://www.hindawi.com/journals/jmb/2012/230653/

Mouat, J., Lopez Lozano, R. and Bateson, H. (2010). 'Economic impacts of marine litter'. Project report, KIMO International. Retrieved 23 January 2014 at http://www.kimointernational.org/WebData/Files/Marine%20Litter/Economic%20Impacts%20of%20Marine%20Litter%20Low%20Res.pdf

Mous, P.J., Pet, J.S., Arifin, Z., Djohani, R., Erdmann, M.V., Halim, A., Knight, M., Pet-Soede, L., Wiadnya, G., 2005. Policy needs to improve marine capture fisheries management and to define a role for marine protected areas in Indonesia. 'Fisheries Management and Ecology' 12, 259–268.

Mustika, P.L.K., Hutasoit, P., Madusari, C.C., Purnomo, F.S., Setiawan, A., Tjandra, K., Prabowo, W.E., 2009. Whale strandings in Indonesia, including the first record of a humpback whale ('Megaptera novaeangliae') in the Archipelago. 'Raffles Bulletin of Zoology' 57, 199–206.

National Research Council (NRC). (2008). 'Tackling marine debris in the 21st Century'. Committee on the effectiveness of international and national measures to prevent and reduce marine debris and its impacts. Retrieved 5 August 2013 from http://docs.lib.noaa.gov/noaa_documents/NOAA_related_docs/marine_debris_2008.pdf
National Oceanic and Atmospheric Administration (NOAA) Chesapeake Bay Office. (2007). 'NOAA Chesapeake Bay Office partners with Maryland Department of Natural Resources in study of derelict fishing gear'. Retrieved 5 August 2012 from http://dnr.maryland.gov/fisheries/crab/derelictfactsheet.pdf

National Oceanic and Atmospheric Administration (NOAA), National Marine Sanctuaries, Hawaiian Islands Humpback Whale National Marine Sanctuary (2008). 'A Tangled Web: Marine Debris and Hawaii's Marine Mammals'. Retrieved February 14, 2013 from http://hawaiihumpbackwhale.noaa.gov/res/marine_debris.html

Natural Resources Consultants, Inc. (2007). 'A Cost-Benefit Analysis of Derelict Fishing Gear Removal In Puget Sound, Washington'. Report prepared for Northwest Straits Foundation. Retrieved 7 February 2014 from http://www.nwstraits.org/uploads/pdf/Derelict%20Gear%20 Cost-Benefit%20Analysis%202007.pdf

Natural Resources Consultants, Inc. (2013). 'Deepwater derelict fishing gear removal protocols'. Report prepared for National Oceanic and Atmospheric Administration and Northwest Straits Marine Conservation Foundation.

Neilson, J. L., Straley, J. M., Gabriele, C. M., & Hills, S. (2009). Non-lethal entanglement of humpback whales (Megaptera novaeangliae) in fishing gear in northern Southeast Alaska. Journal of Biogeography, 36, 452–464.

Northridge, S., Cargill, A., Coram, A., Mandleberg, L., Calderan, S., & Reid, B. (2010). 'Entanglement of minke whales in Scottish waters: An investigation into occurrence, causes and mitigation'. Sea Mammal Research Unit. Final report to the Scottish Government CR/2007/49.

Northwest Straits Initiative. (2011). Program accomplishments 2002–Present. Retrieved 8 April 2014 from http://www.derelictgear.org/ Progress.aspx

Nylon Net Company. Mono Gill Net (Complete Ready to Fish) – #69 – 1-1/2"Str. Mesh – 6Ft Deep - Item No. MG104. Retrieved 7 February 2014 from http://www.nylonnet.com/merchandise/?item_id=1687&cat=236&top_cat=&cat_nav=&sub_cat=&sub2_cat

Oros, J.,Torrent, A., Calabuig, P., & Deniz, S. (2005). Diseases and causes of mortality among sea turtles stranded in the Canary Islands, Spain (1998–2001). 'Diseases of Aquatic Organisms', 63, 13–24.

'Oslo and Paris Conventions for the protection of the marine environment of the north-east Atlantic' (OSPAR). (2009). Marine litter in the North-east Atlantic region. London: OSPAR Commission. Publication number 386/2009. Retrieved 6 August 2013 from http://www.ospar.org/documents/dbase/ publications/p00386_marine%20litter%20in%20the%20north-east%20 atlantic%20with%20addendum.pdf

Page, B., McKenzie, J., McIntosh, R., Baylis, A., Morrissey, A., Calvert, N., Haas, T., Berris, M., Dowie, D., Shaughnessy, P. D., & Goldsworthy, S. D. (2004). Entanglement of Australian sea lions and New Zealand fur seals in lost fishing gear and other marine debris before and after Government and industry attempts to reduce the problem. 'Marine Pollution Bulletin', 49, 33–42.

Paul, J. M., Paul, A. J., & Kimker, A. (1994). Compensatory feeding capacity of two Brachyuran crabs, Tanner and Dungeness, after starvation periods like those encountered in pots. 'Alaska Fishery Research Bulletin', 1, 184–187.

Pemberton, D., Brothers, N.P., Kirkwood, R. (1992). Entanglement of Australian fur seals in man-made debris in Tasmanian waters. 'Wildlife Research' 19, 151–159.

Raaymakers, S. (2007). 'The problem of lost and abandoned fishing gear - global review and proposals for action'. Draft report to the Food and Agriculture Organization (FAO) of the United Nations and the United Nations Environment Programme (UNEP). EcoStrategic Consultants, Cairns.

Rare, 2012. 'The rising tide of community-led conservation'. Strengthening local fisheries management in the coral triangle. Retrieved 6 February 2014 from www.rare.org

Raum-Suryan, K. L., Jemison, L. A., & Pitcher, K. W. (2009). Entanglement of Steller sea lions (Eumetopias jubatus) in marine debris: Identifying causes and finding solutions. 'Marine Pollution Bulletin', 58, 1487–1495.

Revill, A., and Dunlin, G. (2003). The fishing capacity of gillnets lost on wrecks and on open ground in UK coastal waters. 'Fisheries Research', 64, 107–113.

Robbins, J., and D. K. Mattila. (2000). 'Monitoring entanglement scars on the caudal peduncle of Gulf of Maine humpback whales': 1997-1999. Center for Coastal Studies. Order number 40ENNF900253. 24 p.

Robbins, J., & Mattila, D. (2001). 'Monitoring entanglements of humpback whales (Megaptera novaeangliae) in the Gulf of Maine on the basis of caudal peduncle scarring'. Unpublished report to the Scientific Committee of the International Whaling Commission: SC/53/NAH25.

Robbins, J., & Mattila, D. (2004). 'Estimating humpback whale (Megaptera novaeangliae) entanglement rates on the basis of scar evidence'. Report to the Northeast Fisheries Science Centre National Marine Fisheries Service, Woods Hole, MA 02543 43EANF030121.

Robbins, J. (2009). 'Scar-based inference into Gulf of Maine humpback whale entanglement: 2003 2006'. Report to the National Marine Fisheries Service. Provincetown (MA): Provincetown Center for Coastal Studies.

RSPCA. (2013, 16 August). Seal suffers horrendous injuries from fishing line. Retrieved 6 February 2013 from http://news.rspca.org.uk/2013/08/16/seal-suffers-horrendous-injuries-from-fishing-line/

Safina, C. (1 July 2013). Alaskan beaches blighted by up to tonne of garbage per mile. 'Theguardian.com'. Retrieved 12 February from http://www.theguardian.com/environment/2013/jul/01/alaskan-beaches-tonne-garbage

SeaDoc Society (2010). 'Net gains: The economics of removing derelict fishing gear'. Report to the Wildlife Health Center, UC Davis School of Veterinary Medicine.

SeaDoc Society. (2014). California Lost Fishing Gear Recovery Project. Retrieved 9 April 2014 from http://www.seadocsociety.org/ california-lost-fishing-gear-removal-project/
Shaughnessy, P. D. (1980). Entanglement of Cape fur seals with man-made objects. 'Marine Pollution Bulletin', 11, 332–336.

Sheavly, S. B. (2005). 'Marine debris – an overview of a critical issue for our oceans'. Paper presented at the sixth meeting of the UN Open-ended Informal Consultative Process on Oceans and the Law of the Sea. June 6-10, 2005. New York, NY. Retrieved 5 August 2013 from http://www.un.org/Depts/los/consultative_process/ consultative_process.htm

Sheavly, S. B. (2007). 'National marine debris monitoring program: final program report, data analysis and summary'. Prepared for U.S. Environmental Protection Agency by Ocean Conservancy, Grant Number X83053401-02. 76 pp. Retrieved 5 August 2013 from http://act.oceanconservancy.org/site/DocServer/NMDMP_ REPORT_Ocean_Conservancy__2_.pdf?ocID=3181

Sloane, S., Wallner, B., Mounsey, R. (1998). 'Fishing debris around Groote Eylandt in the Western Gulf of Carpentaria: A report on the Groote Eylandt fishing gear debris project', 1998. AFMA.

Smolowitz, R. J. (1978). Trap design and ghost fishing: an overview. 'Marine Fisheries Review', 40(5–6), 2–8.

Song, K., Kim, Z. G., Zhang, C. I., & Kim, Y. H. (2010). Fishing gears involved in entanglements of minke whales (Balaenoptera acutorostrata) in the East Sea of Korea. 'Marine Mammal Science', 26(2), 282–295.

Stevens, B.G. (1996). Crab bycatch in pot fisheries. 'Solving bycatch: considerations for today and tomorrow', 151–158. Alaska Sea Grant Program Report 96-03. University of Alaska, Fairbanks, Juneau, Alaska.

Timmers, M.A., Kistner, C.A., Donohue, M.J. (2005). 'Marine debris of the Northwestern Hawaiian Islands: Ghost net identification'. Sea Grant Publication: UNIHI-SEAGRANT-AR-05-01

UNEP. (2001). 'Marine litter: trash that kills'. Retrieved 5 August 2013 from http://www.unep.org/regionalseas/marinelitter/publications/ docs/trash_that_kills.pdf

UNEP. (2005). 'Marine litter: an analytical overview'. Retrieved 4 March 2014 from http://www.unep.org/regionalseas/marinelitter/ publications/docs/anl_oview.pdf

van Liere, D. W., Hekman, R., & Osinga, N. (2012). Entangled and fish-hooked seals, stranded in the Netherlands during the period 1985-2010. 'Proceedings of the Untangled Symposium: Exploring the impact of marine debris on animal welfare and seeking animal-focused solutions, 4–6 December 2012, Miami, Florida, USA'. Retrieved 6 August 2013 from http://www.wspa-international.org/Images/ Untangled%20Symposium_Proceedings_tcm25-33906.pdf

Vanderlaan, A. S. M., Smedbol, R. K. & Taggart, C. T. (2011). Fishing-gear threat to right whales (Eubalaena glacialis) in Canadian waters and the risk of lethal entanglement. 'Canadian Journal of Fish and Aquatic Science', 68, 2174–2193.

Votier, S. C., Archibald, K., Morgan, G., & Morgan, L. (2011). The use of plastic debris as nesting material by a colonial seabird and associated entanglement mortality. 'Marine Pollution Bulletin', 62, 168–172.

Waluda, C. M., & Staniland, I. J. (2013). Entanglement of Antarctic fur seals at Bird Island, South Georgia. 'Marine Pollution Bulletin', 74, 244–252.

Watson, J., & Aoife, M. (2001). 'Economic survey of the UK fishing fleet'. Seafish Report. ISBN 0-903941-75-9.

Watson, J.M. & Bryson, J.T. 2003. 'The Clyde Inshore Fishery Study'. Seafish Report. ISBN 0-903941-51-1.

Weisskopf, M. 1988. Plastic reaps a grim harvest in the oceans of the world (plastic trash kills and maims marine life). Smithsonian 18, 58.

Whiting, S.D. (1998). Types and sources of marine debris in Fog Bay, Northern Australia. 'Marine Pollution Bulletin' 36, 904–910.

World Organisation for Animal Health (OIE). (2010). 'Introduction to the recommendations for animal welfare'. Retrieved 6 August 2013 from http://web.oie.int/eng/normes/mcode/en_chapitre_1.7.1.pdf

WWF Australia. (2006). 'Marine debris in Northern Territory waters' 2004.

WWF Indonesia, n.d. 'Sustainable fisheries - by catch'. Retrieved 12 February from http://www.wwf.or.id/en/about_ wwf/whatwedo/marine_species/how_we_work/sustainable_ fisheries/by_catch/

Zavadil, P. A., Robson, B. W., Lestenkof, A. D., Holser, R., & Malavansky, A. (2007). 'Northern fur seal entanglement studies on the Pribilof Islands in 2006'. For National Oceanic and Atmospheric Administration Prescott Stranding Grant Program and Alaska Regional Stranding Network Coordinator.

Annex 1

Table 1 Overview of literature containing data on entanglement of pinnipeds and cetaceans

Species/ Sub-species	Region (FAO statistical areas [FAO 2012])	Entanglement rate (incidence in population, %)	Entanglement rate (by animal or by % of population observed with entanglement scars)	Types of debris (%)			Mortality estimate (%)*	Source
				Plastic	Net	Fishing line (pinnipeds) pot gear (cetaceans)		
Pinnipeds								
Australian fur seal	Eastern Indian Ocean	1.9		30	40		73	Pemberton et al. (1992)
Antarctic & Sub-Antarctic fur seal	Western Indian Ocean	0.24		41	17	c. 10		Hofmeyr et al. (2002)
Californian sea lion	Eastern Central Pacific	3.9–7.9			50	33		Harcourt et al. (1994)
Hawaiian monk seal	Eastern Central Pacific	0.7		8	32	28	16	Henderson (2001)
California sea lion	Eastern Central Pacific	0.08–0.22		25	19	14		Stewart & Yochem (1987)
Northern elephant seal	Eastern Central Pacific	0.15		36	19	33		Stewart & Yochem (1987)
Harbour seal	Eastern Central Pacific	0.09		33				Stewart & Yochem (1987)
Northern fur seal	Eastern Central Pacific	0.24			50			Stewart & Yochem (1987)
Steller sea lion	Eastern Central Pacific			0	4	4	23	Hanni & Pyle (2000)
Northern fur seal	North-east Pacific	0.40		19	65		61	Fowler (1987)
Northern fur seal	North-east Pacific	0.08–0.35		37	39	9		Zavadil et al. (2007)
Steller sea lion	North-east Pacific	0.26		54	7	2		Raum-Sayuran et al. (2009)
Kaikoura fur seal	South-west Pacific	0.6–2.8		31	42			Boren et al. (2006)
Grey seal	North-west Atlantic	3.1–5					64	Allen et al. (2012)
Antarctic fur seal	South-east Atlantic	0.024–0.059		18	48		50	Hofmeyr et al. (2006)
Cape fur seal	South-east Atlantic	0.1–0.6		50				Shaughnessy (1980)
Southern elephant seal	South-west Atlantic	0.001–0.002		c. 36		c. 64	28	Campagna et al. (2007)
Antarctic fur seal	South-west Atlantic	0.4		46–52			80	Arnould & Croxall (1995)
Cetaceans								
Humpback whale	Western Central Atlantic				50	41	10	Johnson et al. (2005)
Humpback whale	North-west Atlantic	2.4					26	Cole et al. (2006)
Humpback whale	North-west Atlantic	8–10.4	48–57					Robbins & Mattila (2004)
Humpback whale	North-east Pacific	8	52–78					Neilson et al. (2007)
Western grey whale	North-west Pacific		18.7					Bradford et al. (2009)
Minke whale	North-east Atlantic		5–22					Northridge et al. (2010)
Minke whale	North-west Pacific				69	31	0.9	Song et al. (2010)
Minke whale	North-west Atlantic	2.6					37	Cole et al. (2006)
North Atlantic right whale	North-west Atlantic		57		67	25	12	Kraus (1990)
North Atlantic right whale	North & central west Atlantic	1.6 (2 from IWC 2010 population estimate of 300)					27	Cole et al. (2006)
North Atlantic right whale	North & central west Atlantic	1.15 (IWC 2010 population estimate: 300)			14	71	29	Johnson et al. (2005)
Fin whale	North-east Atlantic		5					Sadove & Morreale (1990)
Fin whale	North-west Atlantic	0.8					44	Cole et al. (2006)
Blue whale	North-west Atlantic							Cole et al. (2006)
Bryde's whale	North-west Atlantic	0.2						Cole et al. (2006)

*Percentage of entangled animals estimated to be killed by their entanglement

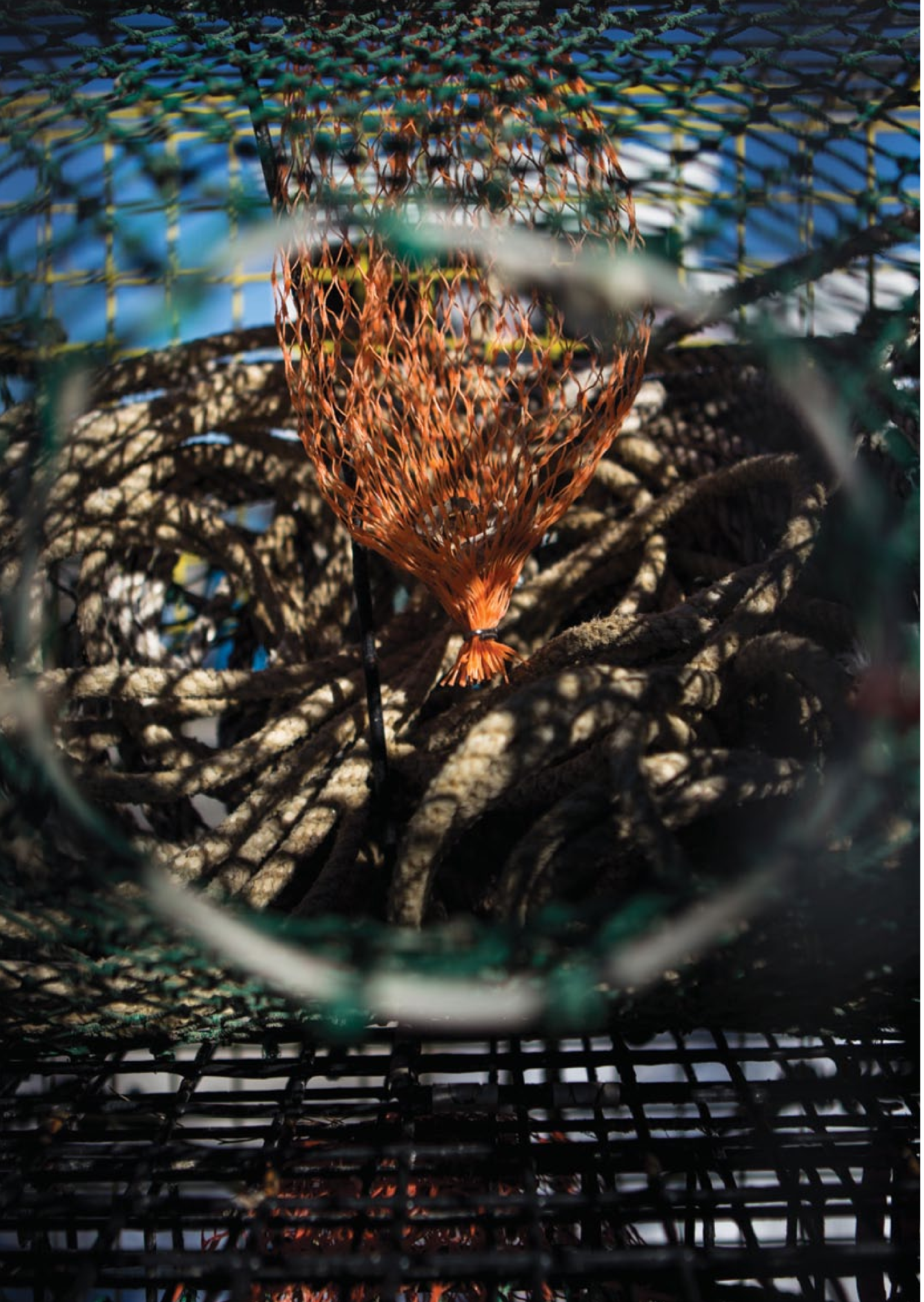


Image: A lobster pot, New England, United States

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