Marine health check

A report to gauge the health of the UK's sea-life

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Introduction

The UK's marine environment is in crisis. Our seas have been treated as a rubbish and chemical dump. Our coastal habitats have been ripped up and reclaimed for development and many of our fish stocks are over-exploited and heading towards commercial extinction. Yet despite the high level of threat facing our marine life, little information is publicly available about the health of our seas.

By examining 16 species and habitat indicators, WWF's ***Marine Health Check*** report is the first ever attempt to gauge the health of the UK's sea-life. The 10 species were selected because they represent a range of wildlife from different levels of the marine food chain. The six habitats represent the wide variety of marine habitats in UK waters. The species and habitats were also chosen on the basis that there was sufficient scientific information available for assessment of their condition to be possible.

The results of the ***Marine Health Check*** are deeply worrying. Despite improvements such as banning the dumping of rubbish and certain other pollutants at sea, and improvements in some wildlife populations, the big picture remains one of damage and decay. Two-thirds of our fish stocks are in decline, with many cod stocks heading towards commercial collapse, and the unsustainable nature of deep-water fisheries, such as the orange roughy, is a further cause for concern. All the key habitats examined, from saltmarsh to reefs, are damaged, and populations of bottlenose dolphins and harbour porpoises appear to be in significant decline. It is also of serious concern that plankton populations, upon which the entire marine ecosystem depends, are fluctuating in a way not previously recorded.

The research was carried out between June - August 2000. A summary of the key damage and threats to all 16 species and habitats is given below:

SUMMARY OF PRINCIPAL FINDINGS

The Harbour Porpoise

There has been a dramatic decline in harbour porpoise populations throughout Europe, including those in UK waters. A study into the numbers of harbour porpoises killed as a result of certain fisheries in the Celtic Sea suggested that the annual by-catch of harbour porpoises could be as much as 6 per cent of the total population. If such levels of by-catch persist, they are likely to result in the eventual extinction of this population. In general the proportion of porpoises dying after becoming entangled in fishing nets is reported to be increasing. Other research shows that pollution may damage the harbour porpoises' immune system, increasing their vulnerability to disease, which may have fatal consequences. New research reports that harbour porpoises in the Irish Sea have been found with elevated levels of certain radioactive elements in their bodies.

The Bottlenose Dolphin

There are three resident populations of bottlenose dolphin recorded around the UK. The best studied population, in the Moray Firth, may be in decline and could be extinct within 50 years.

There is anecdotal information that other populations may also be in decline. Dolphins are also seriously threatened by pollution. A bottlenose dolphin calf found washed up in Cardigan Bay, Wales, had among the highest levels of certain pollutants recorded anywhere in the world for a marine mammal. Other threats include entanglement in fishing nets and loss of prey as a result of over-fishing.

The Cod

Cod stocks are in serious decline, with many populations identified as being “outside safe biological limits” and some in danger of collapse. Due to fishing pressure, cod in the north-east Arctic are now reproducing two and half years earlier than normal. Additionally experimental research into the effects of polyaromatic hydrocarbons (PAHs, chemicals released from the burning of fossil fuels) has revealed that their toxicity to marine life, especially certain plankton species such as cod larvae, may be significantly increased through exposure to Ultraviolet light, a component of sunlight. In laboratory tests PAHs had lethal effects on cod larvae in the presence of ultra violet light at concentrations of PAHs and levels of UV light which are similar to those found within the marine environment. Climate change could be contributing to the decline in cod stocks. Due to fisheries mismanagement, 40 out of 60 of the commercial fish species in the north-east Atlantic are being fished unsustainably.

The Common Skate

The common skate is now believed to be extinct in the Irish Sea and rare in the central and southern North Sea. The common skate has a low reproductive rate and is very vulnerable to fishing activity. Although it is now seldom targeted directly by major fisheries due to its rarity, they continue to pose a major threat because the skate is still caught as by-catch. Other species of ray are under similar threat.

The Little Tern

The population has declined by approximately 40 per cent since the mid-1970s and now stands at only 1,700 breeding pairs. Development on beaches can destroy nesting sites. Sea level rise and storm surges, exacerbated by climate change, also pose a serious threat to nesting pairs. Flooding is likely to be particularly problematic in the little tern stronghold of East Anglia. Industrial fisheries may also pose a threat by reducing its food source.

The Orange Roughy

The orange roughy is a deepwater fish that does not become mature until it is at least 30 years old. It may live for up to 100 years and is believed not to breed every year. As a result of overfishing due to fisheries mismanagement, stocks are classified as “outside safe biological limits” and may be in danger of collapse. The catch has declined by 73 per cent to the west of Scotland and 76 per cent to the west of Ireland and south-west England since fisheries started only some 10 years ago. A recent scientific publication has cast serious doubt on whether the orange roughy should be fished at all due to its low reproductive rate.

The Native Oyster

In the last 100 years, oyster populations have been seriously depleted and commercial production has declined a hundred-fold. The oyster is threatened by several species of introduced sea snail. One, known as the oyster drill, can kill 20 oysters a day. Oysters in the UK may also be threatened by a microscopic parasite, *Bonamia ostrea*, which has killed oysters across Europe. Pollution has harmed the recovery of stocks. Organotin chemicals used in ship anti-fouling paint have caused deformed oyster shells and affected the oysters' ability to reproduce.

The Salmon

The Atlantic salmon is in serious decline. UK river catches have declined by 82 per cent in the last 25 years. Climate change is threatening stocks by altering water temperature, currents and affecting plankton levels. During summer 2000 there have been reports of increases in the number of young salmon returning to UK rivers. Scientists, however, caution that there remains evidence of long-term decline and these recent reports do not represent a change in the long-term pattern. The highly destructive virus that causes Infectious Salmon Anaemia (ISA) was recently introduced to farmed salmon in the UK from Norway. Recent research has revealed that the virus has also been found in wild stocks in Scotland. Trials involving the growing of GM salmon in tanks have already been undertaken in Scotland. The chemicals used to combat sea lice in farmed salmon pose a risk to the wider marine environment, and an agricultural herbicide, Atrazine, has been shown to impair salmon migrational breeding capability.

Plankton

Plankton acts as a sink for significant amounts of the world's atmospheric carbon. It is also an important source of oxygen in the air that we breathe. Recent research has discovered that plankton levels are fluctuating around the UK and there is evidence of a major ecological shift in the North Sea, both potentially as a result of climate change. Changes in levels of plankton may in turn exacerbate climate change if their ability to act as a carbon sink is compromised.

Wire Weed

Wire weed, a species of seaweed, is one of 53 alien species which have invaded UK waters. Many pose a threat to native species. In UK waters wire weed can grow up to 12 times bigger than normal and is known to compete with native species. It can now be widely found along the southern coast of England. It is has also spread to Strangford Lough in Northern Ireland, one of only three Marine Nature Reserves in the UK. Repeated attempts to remove it have failed.

Eelgrass Meadows

Eelgrass is a marine flowering plant that provides a vital habitat for many marine species, including seahorses. The outbreak of a wasting disease may have led to the loss of eelgrass meadows in 85 per cent of the UK's estuaries. Eelgrass meadows are seriously threatened by sea level rise due to climate change and are also vulnerable to high levels of pollution.

Maerl Beds

Maerl beds are an important marine habitat created by several species of red algae that form a coral-like structure. They are known to be present in less than 1 per cent of the UK's inshore waters and some maerl beds may be more than 8,000 years old. Many maerl beds around the UK have been impacted for many years and continue to be damaged by extraction and fishing activities. They are known to be at particular risk in the Fal Estuary and Firth of Clyde.

Mudflats

Mudflats are one of the most productive ecosystems on earth and hundreds of animal species depend on them for survival. Mudflats are in decline around the UK and at least 25 per cent have already been lost to land claim, which poses a continuing threat. The Tyne has lost 100 per cent of its mudflats. Sea level rise due to climate change and shellfish dredging are the most serious threats. Pollution by hormone disrupting chemicals in the UK's estuaries is leading to serious impacts on wildlife that depend upon mudflat habitat. A recent study has found that male flounder in many UK estuaries are displaying female sexual characteristics and even producing eggs.

Reefs

Rocky and biogenic reefs (the latter produced by living organisms) are one of the most important marine wildlife habitats. In some areas the marine wildlife of the reefs has been degraded and destroyed and is under particular threat from fishing activity and oil and gas exploration. Lophelia coral reefs are under serious threat as oil and gas exploration and fisheries move into deeper waters. Dredge fisheries for scallops have caused widespread and long-term damage to horse mussel reefs. One of the world's most important sites of *Serpula* tube worm reefs at Loch Creren in Scotland may be under threat from trawling.

Saltmarsh

Saltmarsh comprises a range of salt-dependent plants that provide essential habitat for hundreds of species. There are only 45,000 hectares of saltmarsh left around the UK, when once there were more than 200,000 hectares in England and Wales alone. This represents an estimated decline of more than 75 per cent. It is estimated that 6 per cent of remaining saltmarsh will be lost over the next 20 years due to rising sea levels as a result of climate change. Pollution and oil spills are also serious threats. More than 10 highly toxic chemicals were found in one saltmarsh bed in Essex.

Sub-tidal Sand and Gravel

Sub-tidal sand and gravel is an essential habitat for many marine species but is being damaged by aggregate extraction and fishing activity. Extraction of sand and gravel from the sea seriously damages animal communities but the Westminster government plans to allow an increase in the level of extraction. High levels of lead and cadmium have been found in sea urchins, hermit crabs, worms, starfish and shrimps that live on sand and gravel habitat in the Dogger Bank.

The Harbour Porpoise

NATURAL HISTORY

The harbour porpoise is the smallest cetacean to be found in British waters, measuring between 1.5m and 2m. With a lifespan of up to 12 or 13 years, it lives in small groups, though larger groups have been observed in areas of high prey concentration.

The harbour porpoise reaches sexual maturity at five or six years and mates between June and August, with a gestation period which lasts 10 to 11 months. Females give birth to a single calf and the interval between births may be up to three years. Harbour porpoises mainly feed on small schooling fish species such as herring and sandeels.

STATUS

There have been dramatic declines in harbour porpoise populations throughout Europe, including those in UK waters. They have now disappeared from the Mediterranean and are rarely seen in the Bay of Biscay, the Channel and southern North Sea[1]. Elsewhere around the UK they are also becoming rare. For example, there has been a reported 90 per cent reduction in sightings off Cornwall during the last 50 years[2].

The most recent survey of harbour porpoises in the North and Celtic Seas estimates that there are some 340,000 animals present. Evidence indicates that these exist in distinct populations that show little intermixing, with the result that individual populations are highly vulnerable to extinction if significantly threatened by human activities. By-catch is one of the most serious threats, with one study observing a potential annual mortality of 6 per cent of the local population in the Celtic Sea.

THREATS

Fishing activity

Large numbers of harbour porpoises in the UK become entangled in fishing nets, threatening some populations with localised extinction. For example, a study into the numbers of harbour porpoises killed as a result of entanglement in bottom set nets in the Celtic Sea observed a by-catch level equivalent to 6 per cent per annum of the total population. If such levels persist, they are likely to result in the eventual extinction of the population[3]. It should be noted that this figure is based on the take from a single fishery, and the total rate, when other fisheries within the area are taken into account, could be even higher[4]. In the North Sea, survey work has estimated an annual by-catch of 2 per cent of the population each year – a level which poses a significant risk to this population[5]. It is important to recognise that by-catch problems are specific to certain fishing gear and should be looked at case by case.

A recent study has revealed that by-catch in nets is the most frequent cause of death among harbour porpoises found washed ashore in England and Wales. Disturbingly, the study also found that the proportion of porpoises killed in this way increased year on year during the study period[6].

Prey depletion

In much of the UK's waters, poor fisheries management has led to the severe depletion of many fish stocks. Intensive levels of fishing are also believed to produce potentially far-ranging impacts upon the broader ecosystems of which fish form a part. This can result in a significant direct or indirect reduction in prey available to high-level predators such as the harbour porpoise. Concerns over the possible ecological consequences of extensive industrial fisheries in the North Sea, for example, have recently led the UK government to restrict such fisheries – which account for approximately 50 per cent of all fish landed from the region – in certain areas[7].

Pollution

As a top level predator, the harbour porpoise is seriously threatened by pollutants that magnify or accumulate up the food chain. Harbour porpoises tend to favour coastal waters, where concentrations of pollutants such as heavy metals and organic compounds are often at their greatest, putting the species at serious risk.

Research has identified the Irish Sea as being a "pollution hot spot" for the harbour porpoise. Significantly high levels of heavy metals such as lead and mercury have been found in porpoises in the Liverpool Bay area[8]. High levels of DDT, Dieldrin and polychlorinated biphenyls (PCBs) have also been detected in porpoises in the Cardigan Bay area[9].

There is evidence that pollution can indirectly result in the death of porpoises, so it potentially poses a significant threat to their survival. Recent research into harbour porpoises in UK waters has revealed that chronic pollution by PCBs was responsible for suppressing the animals' immune systems, leaving them highly vulnerable to infection and frequently resulting in their deaths[10]. Recent research has also revealed that harbour porpoises living in the Irish Sea have high levels of some man-made radioactive elements in their bodies[11].

Similar species under threat: bottlenose dolphin, common dolphin, long-finned pilot whale.

The Bottlenose Dolphin

NATURAL HISTORY

The bottlenose dolphin is one of the UK's best known dolphin species and can live for up to 50 years. The species exists in two forms: a larger type that lives offshore and a smaller one that favours inshore waters. Irrespective of its type, the bottlenose dolphin is highly social and is usually found in groups.

Bottlenose dolphins become sexually mature at around 12 years for females and 11 years for males. Mating in European waters takes place in the late spring or summer, with a gestation period of 12 months. The period between successive births may be between three and six years. Research into the diet of North Sea bottlenose dolphins shows that they feed mainly on herring, dogfish, haddock, john dory and sole. Invertebrates such as cuttlefish and squid are also known to form an important part of their diet.

STATUS

Evidence suggests that the bottlenose dolphin may be in decline in UK waters.

There are three main groups of "resident" bottlenose dolphins: in the Moray Firth, Scotland; in Cardigan Bay, Wales; and off the coasts of Devon and Cornwall. The first two groups comprise around 130 animals, while the latter group is smaller at around 45. As well as these "resident" populations, areas including the Western Isles, the central North Sea and the Celtic Sea are also important for the species.

The most widely studied bottlenose dolphin population in UK waters is located in the Moray Firth, Scotland. At present the population is estimated to stand at 129 animals[12]. A recent population analysis found that the bottlenose dolphin population in the Moray Firth may be declining by 5.7 per cent per year. If this trend continues, the population could be extinct within 50 years[13]. The model used was intentionally not over-pessimistic, so the rate of decline may be even greater and the time to extinction even shorter.

There is anecdotal evidence to suggest dolphins elsewhere may be in decline. Whereas bottlenose dolphins were known to inhabit a range of inshore waters and estuaries around the UK, they have either disappeared from these locations or are now rarely seen. For example, they have not been observed in the Bristol Channel since the 1940s.

THREATS

The bottlenose dolphin faces a number of threats common to other small cetaceans in UK waters. These include:

Pollution

The bottlenose dolphin is a top-level predator and is therefore highly vulnerable to pollutants that are magnified or accumulate up the food chain. Studies of bottlenose dolphins in UK waters have revealed high levels of pollutants including heavy metals and organic compounds such as PCBs in body tissues. A study in Cardigan Bay, Wales, revealed that a bottlenose dolphin washed ashore possessed a loading of organo-chlorine compounds that was among the highest recorded for any marine mammal anywhere in the world[14].

Studies of the Moray Firth group have revealed that they have the highest level of skin lesions found among any such grouping of the species in the world. Although these lesions are believed to most likely result from natural conditions such as water temperature and salinity, scientists have not excluded the possibility that pollutants may be acting in combination with natural conditions to produce epidermal disease in these animals[15].

The species is also threatened by marine litter, which can be accidentally swallowed, as well as by noise pollution, which can cause stress as well as interference with echo-location, used by the species for hunting and navigation.

Incidental capture

Bottlenose dolphins are known to have become entangled in fishing nets. They are particularly vulnerable to “set” or “static” gill nets and are also caught in some towed gear, such as certain trawls. There is insufficient published information to allow the scale of this problem to be fully assessed.

Depletion of prey species

Commercial fisheries for species which form an important part of the bottlenose dolphin diet can result in a significant reduction in the amount of food available to them in specific areas. This could lead to food shortage for certain populations, leading to possible population decline or movements of populations in search of food.

Similar species under threat: harbour porpoise, common dolphin, long-finned pilot whale.

The Cod

NATURAL HISTORY

The cod is one of the most commercially important fish species to be found in UK waters and is at the heart of the UK's national dish – fish and chips. A cod can live for more than 10 years, grow as long as 1.8 metres and weigh up to 40kg, though such specimens are now rare due to intense fishing pressure.

The cod favours cool temperate water and is found all around the British Isles. In the north-eastern Atlantic its southern limit of distribution is the Bay of Biscay, extending north to the sub-arctic Norwegian waters. Around the British Isles, cod reproduce from the end of January to March. Key breeding areas include the mid and southern North Sea, the Bristol Channel, the Irish Channel, and west of Skye. A female cod will produce anything between half a million and nine million eggs during a single season. Cod feed on a wide range of creatures including shrimp, squid, sandeels, haddock and whiting.

STATUS

Cod populations in the waters surrounding the UK have undergone a significant and dramatic decline during the last few decades.

The figures below show that the spawning stock biomass – the amount of fish within a population capable of reproducing – has undergone a significant decline since the 1960s in all the UK's seas.

Recruitment – the number of newly-hatched fish joining a stock – also appears to be significantly below what would be expected in many areas. Looking at the UK's seas on a regional basis:

North Sea and Eastern Channel

In the North Sea and Eastern Channel, despite an increase in the number of mature cod from the record low observed in the mid 1990s, recruitment of new fish to the stock has been below average since 1987. The number of fish joining the stock in 1997 and 1998 is the lowest on record. The International Council for the Exploration of the Sea (ICES), the international organisation responsible for investigating fish stocks in the north-east Atlantic, considers cod stocks in these areas to be "outside safe biological limits". If the situation does not improve, these stocks are in danger of collapse. Fishing has been severely restricted in this area due to the crisis affecting this fish stock.

West of Scotland

The number of cod capable of reproducing to the west of Scotland has been declining since the early 1980s, reaching a record low level in 1999. ICES considers the stock here to be "outside safe biological limits".

Irish Sea

The cod stock in the Irish Sea is also considered by ICES to be “outside safe biological limits”. Eighty per cent of cod capable of reproducing comprise fish recruited in a single year, leading ICES to predict a continuing serious decline in the stock in the future. Fishing has been restricted in this area due to the crisis affecting this stock.

Western Channel and Celtic Sea

In the area of the western Channel and the Celtic Sea, while recruitment of new fish to the stock has recently been above average, levels of fishing mortality are still high and this stock is considered by ICES to be “outside safe biological limits”.

THREATS

Fisheries

The primary threat to cod in UK waters is undoubtedly over-fishing. A fundamental problem appears to be that ineffective management has failed to control fishing effort, including the number and capacity of fishing boats catching cod, in order to ensure that only sustainable levels of the species are caught. In the North Sea it is estimated that more than 70 per cent of cod reaching maturity each year are removed[16].

As a result of over-fishing, all cod stocks in UK waters are severely depressed and many are close to collapse.

High fishing mortality is also affecting the genetic make-up of cod stocks by artificially selecting smaller fish that mature younger. Fast-growing fish tend to be selectively removed from the population, as do those that reach sexual maturity at a later stage in life – large fish do not readily slip through the net and high fishing mortality among young fish means that late maturing individuals fail to reproduce[17]. This is a trend observed in other cod stocks exposed to intense commercial fishing pressure, such as the north-east Arctic cod which has been shown to have exhibited a reduction in the mean age of the spawning stock of 2.5 years during the 20th century[18].

Pollution

At various stages of their life, cod may be vulnerable to the effects of pollution. As highlighted in the section of this report addressing plankton, recent concerns have been expressed about the combined toxic impacts of PAHs (chemicals released from the burning of fossil fuels) and UV-light upon planktonic cod larvae.

Climate change

It is believed that both the abundance and composition of plankton in the seas surrounding the UK may have been affected by climate change during the last 50 years. This in turn may have a significant influence upon the state of fish stocks, including cod[19]. Climate change may therefore impact the future distribution and status of cod stocks in the North Atlantic.

Similar species under threat: A recent report by the OSPAR Commission found that 40 out of 60 commercial fish stocks in the North-east Atlantic, including those for haddock, whiting, saithe and mackerel, are being fished at unsustainable levels.

The Common Skate

NATURAL HISTORY

The common skate is the largest European member of the skate and ray family – a group of fish closely related to sharks. It can grow to more than two metres in length, weigh up to 100kg and can live for up to 50 years.

The common skate inhabits areas of soft-sediment seabed at water depths ranging from 5m to 600m and mainly feeds on bottom-living animals such as crabs and scallops. It can also move to mid-water to feed on mackerel, herring, whiting, hake and dogfish.

Males mature at approximately 10 years of age, but the age of maturity for females is unknown. However, it *is* known that the number of eggs produced by the female is relatively low, amounting to a maximum of around 40 in any one year. These are deposited during the spring and summer and it is believed that females may lay eggs as infrequently as once every three years.

STATUS

As the name suggests, the common skate was once found in all UK waters. However, mainly as a result of intense fishing pressure, the species is now so rare that too few are caught by research vessels to make analysis of population levels possible. The common skate is now believed to be commercially extinct in the Irish Sea and extremely rare in the central and southern North Sea[20].

THREATS

Fisheries

The common skate's low rate of reproduction and late age of maturity makes it highly vulnerable to fishing activity. It is now so rare in the UK's seas that it is scarcely directly targeted. Even so, it still impacted by fishing activity because it is caught as by-catch by fisheries targeting other species. The fact that the fish is relatively large when mature also results in juveniles having very little chance of reaching maturity in areas that are heavily fished: even young fish are susceptible to being caught as by-catch.

Because of the threat posed by fishing, it has been suggested that the species may become biologically as well as commercially extinct in many areas around the UK[21].

Similar species under threat: thornback ray, spotted ray.

The Little Tern

NATURAL HISTORY

The little tern is the smallest member of the tern family to be found in the British Isles, measuring just 23-26cm in length. Visiting the UK during spring and summer to breed, the little tern inhabits coasts and estuaries where it nests by forming a scrape in gravel or shingle shores. The female lays two or three eggs that are incubated by both sexes for up to 22 days. The chicks fledge 15-17 days after hatching.

The little tern feeds on a range of small fish and crustaceans. Hunting is done alone or in flocks of up to 50 birds. The little tern is generally widely distributed throughout the UK and Ireland, but populations are concentrated in areas where suitable breeding sites are situated. These include the Dee Estuary, the Thames Estuary, the Tees Estuary, the Wash, Langstone Harbour in Hampshire, and Pagham Harbour in Sussex.

STATUS

The little tern population in the UK has been in long-term decline since the late 1970s. From a peak population of 2,800 breeding pairs recorded in 1975, it has been falling by an average 1.23 per cent each year. The UK population recorded in 1998 comprised just 1,700 breeding pairs, which represents a 40 per cent decline in numbers since 1975[22].

THREATS

Although it has been suggested that this decline may partly result from predation by foxes, crows and rats[23], human activities are also responsible. These include:

Disturbance

Little terns nest primarily on mainland beaches. The increased use of such sites since the 1960s for human recreation and development has disturbed little terns while nesting, or has caused damage to their eggs. This has almost certainly contributed to increased rates of breeding failure in the UK[24].

Climate change

As little terns often nest very close to the high water mark, their eggs and chicks are prone to flooding during extreme tidal and weather conditions. Such flooding is predicted to worsen as a result of climate change, which will lead to rising sea levels and increasingly severe storm conditions and associated storm surges. It is predicted that there will be at least a 10 per cent increase in the occurrence of summer gales this century due to climate change[25]. This is highly likely to increase inundation of little tern nests, as they nest during the spring and summer months in the UK.

Flooding is likely to be particularly problematic in the little tern stronghold of East Anglia. Here, rates of sea level rise are predicted to be particularly high, and strong sea defences prevent coastal habitats from re-forming further inshore[26]. Overall, this threat is likely to result in a reduction in breeding sites for the species and increase the vulnerability of those sites that remain.

Fisheries

Many bird species are reliant on fish such as sandeels, which are targeted by industrial fisheries for fishmeal and fish oil. Industrial fisheries are now removing significant quantities of such small fish species, which account for about half the tonnage of fish landed from the North Sea each year[27]. Concerns that such fisheries are affecting the viability of seabirds and other marine animals has recently led the UK to close certain areas to industrial fisheries during seabird breeding seasons[28].

Recent scientific analysis has indicated that as a result of its ecology and behaviour[29], the little tern may be highly vulnerable to localised depletion in its food sources, whether these be through fishing or other causes.

Similar species under threat: Other seabird species vulnerable to localised depletion of sandeels in the vicinity of their breeding grounds include arctic terns, common terns, arctic skuas and black-legged kittiwakes[30].

The Orange Roughy

NATURAL HISTORY

The orange roughy is a deepwater fish usually found at water depths of 1,000m or more. The species is a deep orange-red in colour and has been recorded to grow more than half a metre in length and 5kg in weight. The orange roughy is extremely slow-growing and long-lived. It may not become mature until it is 30 years old and may live for up to 100 years. It is believed to produce a low number of eggs compared with other, shallow sea fish species and it is thought that even when a fish is sexually mature, it does not breed every year.

In the eastern Atlantic the orange roughy is widely distributed from Europe to southern Africa. The species is found on the continental slope to the west of the British Isles, including the Rockall Trough and the Porcupine Sea Bight.

STATUS

As a result of poor fishing management, stocks of orange roughy are considered by ICES to be over-exploited and "outside safe biological limits"[31].

THREATS

Fisheries

The main threat to this species is from fishing. The orange roughy is late maturing and has a low rate of reproduction, making it vulnerable to over-exploitation in a short period of time.

In Australia and New Zealand there are well documented cases of stocks of orange roughy being initially high, only to dramatically decline after a few years. The same pattern is now occurring in UK and Irish waters. In the deep-sea area to the west of Scotland, the population of orange roughy was estimated in 1998 to be 73 per cent lower than the virgin unexploited stock.

Catch levels have mirrored this considerable decline in stocks. A French fishery started in 1991 peaked at 4,462 tonnes in 1992 but has since declined to around 1,300 tonnes. The orange roughy stock to the west of Ireland and south-west England declined by up to 76 per cent by 1998[32]. These significant declines in stock levels are caused by fisheries that are less than 10 years old.

A recent scientific publication has cast serious doubts on the sustainability of fisheries for deep-sea species such the orange roughy. The report identifies these species as being particularly vulnerable because reproduction levels are so low. There are also few top level predators at these depths to which fish have had to adapt, making deep-sea fish populations much more vulnerable than other fish stocks to over-exploitation by fisheries. The report concludes that exploitation of deep water fish should be considered as a mining operation rather than a fishery, and that recovery may not be possible[33].

Similar species under threat: blue ling, deepwater monk fish, black scabbard fish, grenadier.

The Native Oyster

NATURAL HISTORY

The native or flat oyster is the only oyster species that is native to the UK and Europe. It is a two-shelled mollusc which favours estuarine and inshore marine habitats. Adult oysters remain attached to the seabed that they settle upon as juveniles and feed by filtering plankton.

Oysters generally become sexually mature in their third year. They are hermaphrodite, and while they do not possess both sexes at the same time, they regularly alternate between male and female. Breeding usually takes place during the summer and larvae develop in the shell of the female before being released. They spend around two weeks in the plankton before settling on the seabed, often in the vicinity of other oysters, and this results in the establishment of oyster beds.

STATUS

Since the late 1800s there has been a dramatic decline in the native oyster population in UK waters. In the last 100 years, commercial production has declined a hundred-fold to the current level of 100-200 tonnes per annum[34]. The main UK stocks are found in estuarine and coastal areas including the River Thames, the Solent, the River Fal, Pembrokeshire, the west coast of Scotland, the Orkney Islands and Loch Foyle in Northern Ireland.

THREATS

A number of human activities have contributed to the decline and continuing depressed levels of native oysters in UK waters.

Over-exploitation

Demand for oysters increased markedly during the 19th century as transport links improved rapidly with the advent of the railways[35]. This led to over-exploitation of established oyster grounds, resulting in a catastrophic decline in stocks. It is likely that stocks fell so low that spawning activity was not high enough to rebuild them. Commercial harvesters also introduced a bigger foreign oyster to replace the native oyster in commercial fisheries.

Introduced species

A number of other non-native species have been introduced into UK waters, and have subsequently had a destructive impact upon the native oyster.

The American oyster drill is a sea snail introduced into the UK along with an American species of oyster, which was imported to bolster the declining UK native species. It kills oysters by drilling through their shells and injecting them with poison before consuming them. A single animal can consume up to 20 young oysters a day, so the presence of even a small number of oyster drills can have a serious impact. However, the fact that the species does not produce planktonic larvae has limited its spread in the UK, and it has also been impacted by the toxic TBT chemical used in anti-fouling paint.

The slipper limpet is another alien snail species introduced into the UK. Although it does not feed on oysters, it is also a filter feeder competing with the oyster for food. In addition, the species grows extensively on oyster beds, producing a smothering effect. The presence of the slipper limpet can also result in oyster beds becoming loaded with fine sediment, which prevents juvenile oysters from settling.

Native oysters have also suffered from the introduction of a parasitic protozoan (a microscopic single-celled animal) called *Bonamia ostrea*. It has killed a large number of oysters across Europe and is now found off the coasts of England and Wales. Infection by the parasite causes lesions in the gills and digestive glands of the oyster, leading to its death. Stringent control conditions have so far limited the spread of this parasite in the UK.

Pollution

As filter-feeding animals, oysters require good-quality water. High levels of pollution in the UK's coastal waters may have significantly contributed to the decline in oyster stocks during the 20th century. Organotin compounds, used in anti-fouling paints on ship's hulls, have had a serious impact upon oysters, resulting in deformed shells and impairing their ability to reproduce.

Similar species under threat: mussels, cockles, dog whelks.

The Salmon

NATURAL HISTORY

The Atlantic salmon, often described as “the king of fish”, is distributed in the northern Atlantic area. It favours temperate waters and is an unusual fish species in that it hatches in freshwater, migrates to the sea, and returns to freshwater to spawn. Spawning occurs during late autumn and early winter in the UK, after which 90-95 per cent of adults will die without returning to the sea. The salmon fry hatch from the gravel of the river bed after three or four weeks and will remain in freshwater, feeding and growing, for up to three years. In the spring of their second, third or fourth year the young salmon migrate to the sea. Adult salmon feed on fish and crustaceans during their time at sea, and are believed to congregate in sub-arctic areas around Norway, Greenland and the Faeroes during the marine phase of their life cycle. The fish can grow to a considerable size: the largest so far captured in UK waters, netted in the River Tay, weighed nearly 32kg.

STATUS

The Atlantic salmon is in serious decline. UK river catch figures show that catches have declined by 82 per cent in the last 25 years, falling from 12,700 tonnes in 1973 to 2,300 tonnes in 1997[36]. Regional declines have been recorded as follows:

- a fall in catches in Scotland, from a peak of more than 2,000 tonnes in 1967, to around 300 tonnes in 1997 – a decline of 85 per cent;
- a fall in catches in England and Wales from a peak of approximately 550 tonnes in 1970 to around 150 tonnes in 1997 – a decline of 72 per cent;
- a fall in catches in Northern Ireland from a peak of more than 450 tonnes in 1967 to approximately 100 tonnes in 1997 – a decline of 78 per cent[37].

During summer 2000 there have been reports of increases in the number of young salmon returning to UK rivers. Scientists, however, caution that there remains evidence of long-term decline and these recent reports do not represent a change in the long-term pattern.

While the complex life history of the salmon means that it is vulnerable to threats at various stages of its life, there is great concern that threats facing the salmon at sea are playing a major role in the decline in salmon stocks. ICES estimates there has been a 65 per cent reduction in the abundance of salmon stocks that spend only one winter at sea[38].

THREATS

Climate change

Scientists believe that climate change may be a significant cause behind the decline of salmon stocks[39]. Salmon prefer water at a temperature of between 4° and 10°C and changes in water temperature as a result of climate change may be reducing the salmon population[40]. Scientists believe it is also possible that climate change is affecting the wider ecology of the North

Atlantic, such as the levels of plankton, which may also be lowering salmon populations[41]. Significantly, it is believed that the rate of climate change responsible for these changes is accelerating[42].

Fishing activity

Investigations are being carried out into the by-catch of young salmon in mackerel and herring fisheries in the Norwegian Sea. The levels of catches for these fisheries are so large that even if a small proportion of the total fish captured consisted of a by-catch of salmon, it could have a significant impact upon salmon stocks[43]. There are also some cases of over-exploitation of salmon as they return to rivers to breed.

Salmon farming

Large numbers of Atlantic salmon are intensively farmed in UK waters, particularly in the sea lochs of Scotland. The scale and intensity of commercial salmon farming in the UK has resulted in a number of impacts, including:

Disease: The intensive, high concentration conditions associated with salmon farming result in a higher incidence of disease and parasites among farmed fish. This increases the risk of transmission of diseases to wild salmon. Migrating salmon are extremely vulnerable to attack by salmon lice, which are often found in high concentrations among farmed fish, and transmission of these parasites has been linked to the virtual collapse of wild stocks in some rivers[44]. The international nature of salmon farming has also meant that diseases previously unknown in the UK have been introduced into its waters. For example, the highly destructive virus that causes Infectious Salmon Anaemia (ISA) was recently introduced to farmed salmon in the UK from Norway. Recent research has revealed that the virus has now been found in wild stocks in Scotland[45].

Interbreeding: There is scientific evidence that escaped farmed fish have interbred with native stocks in the UK. Given that stocks in individual rivers are genetically distinct, and therefore adapted for a particular river environment, such interbreeding may harm their chances of survival.

GM salmon: Genetically modified fish produced in the US have grown almost three times as fast as non-GM fish[46]. Trials involving the growing of GM salmon have already been undertaken in Scotland, although the fish were reared in tanks on land. However, concerns have been raised regarding the impact GM salmon would have upon wild stocks, were they to be farmed and subsequently escape. While GM fish are supposed to be sterile, doubts remain over the effectiveness of this process. There are also concerns that they are genetically manipulated to grow faster and larger than wild fish, making any escaped GM salmon more attractive as potential mates to wild fish. If non-sterile GM salmon were to escape to the wild and reproduce, this could have significant impacts upon the genetic make-up of wild stocks. And if sterile GM fish make their way into the wild in sufficient numbers, this, too, could damage wild stocks. As the GM fish are sterile, breeding would not be successful, and the decline in wild stocks would be compounded.

Pollution: A number of chemicals are used to treat a range of diseases affecting farmed salmon. Considerable concern has been expressed over the impact of a number of these, including ivermectin, upon the wider marine environment[47]. Originally used for treating worms in cattle, ivermectin is now used to treat sea lice, which are a considerable pest to farmed salmon. The chemical is incorporated into the food fed to fish, so it can enter the marine environment either through fish faeces or uneaten food pellets. Ivermectin is not only extremely toxic to marine life, but is also relatively persistent. Tests on the common mussel show that concentrations of ivermectin in the shellfish were 750 times higher than those found in water[48]. An agricultural herbicide, Atrazine, has also been shown to impair salmon migrational breeding capability.

Similar species under threat: sea trout.

Plankton

NATURAL HISTORY

The term plankton refers to plants and animals (often microscopic) that live in the sea and possess such limited powers of locomotion they are they are carried along in prevailing currents and water movements. Plankton is divided into two groups:

- Phytoplankton – comprising (usually single-celled) free-floating plants.
- Zooplankton – which are free-floating animals. Zooplankton are further subdivided into two groupings: holoplankton, which are animals spending their entire lives as plankton; and meroplankton, which are animals spending only part of their life cycle in the plankton, such as crabs and many fish species.

Plankton is a particularly important group of organisms, as the entire functioning of the world's oceans is almost exclusively dependent upon it. This is because phytoplankton are the main primary producers in the oceans: by using photosynthesis they produce energy-rich organic compounds such as carbohydrates from inorganic chemicals found in seawater. Many zooplankton derive their energy by feeding upon phytoplankton and are themselves consumed by other animals. Between them, phytoplankton and zooplankton form the basis for complicated food webs, stretching all the way up to top carnivores such as the Orca (killer whale).

Phytoplankton act as one of the world's most important carbon sinks, absorbing approximately two billion tonnes of CO_2 each year. It is estimated that the North Atlantic populations absorb 10 per cent of this total annual oceanic uptake of CO_2[49]. Phytoplankton also convert carbon dioxide into much of the oxygen we breathe via the process of photosynthesis. Plankton therefore plays a pivotal role in maintaining the balance in the global environment and regulating the global climate. Changes in the nature and amount of plankton in the world's oceans could potentially have serious repercussions on their ability to act as carbon sinks, which in turn may produce significant impacts upon the global climate.

STATUS

The nature and quantity of plankton in UK waters and the wider north-east Atlantic is subject to a degree of natural variability. However, a number of unusual changes in the abundance and distribution of plankton have been detected in recent years, with plankton levels declining in some areas and increasing in others. Scientists believe these changes may be linked to human-induced climate change.

THREATS

Climate change

For some 50 years, levels and composition of phytoplankton in the north-east Atlantic have been monitored by the Continuous Plankton Recorder (CPR) survey. This survey provides a considerable time series by which changes in phytoplankton can be assessed. Analysis reveals that there have recently been significant changes in the nature and levels of plankton in the north-east Atlantic, including the waters of the UK. Results indicate that between 1948 and 1995 there has been a growing trend in the average amount of phytoplankton in the North Sea and central north-east Atlantic, and that this increase has been very rapid since the mid-1980s. At the same time a decrease in the average amount of phytoplankton has been witnessed in the northern reaches of the Atlantic between Iceland, Norway and northern Scotland[50]. It is believed that these changes are related to changes in weather and oceanic patterns that are being affected by human induced climate change[51].

As well as these changes in phytoplankton abundance, related and rapid changes in zooplankton, fish and benthos (seabed-dwelling creatures) have been observed in the North Sea since 1988 and these have been interpreted as a major shift in the ecology of the area[52]. It is believed that these related changes may also be brought about by climatic change[53]. Changes associated with the ecological shift in the North Sea include:

- increased levels of phytoplankton colour – an indication of the amount of phytoplankton present – and a greatly extended season of production compared with any period since 1946;
- changes in the relative abundance of certain copepod species – small crustaceans that form a major constituent of the zooplankton;
- changes in other taxonomic components – *ie* the species present – in the zooplankton, including the nature of decapod crustacean (*eg* crab and shrimp), echinoderm (*eg* sea urchin and starfish) and fish larvae;
- a significant increase in the levels and distribution of the stock of western horse mackerel in the North Sea. These changes led to catches of the species in the area general area of the north-east Atlantic increasing from 40,000 tonnes in 1982 to more than 300,000 tonnes from 1990 to 1994[54].

The observed changes in the North Sea ecosystem appear unique in living or recorded memory, and if the changes observed in the plankton between 1988 and 1994 become established as the norm, they will have implications for the future management of living resources in the North Sea[55].

The ecological shift in the North Sea has coincided, and may be associated, with the highest and most positive index of the North Atlantic Oscillation (NAO) for more than a century. The NAO is the dominant mode of atmospheric behaviour in the north Atlantic and western Europe, and is characterised by differences in atmospheric pressure as measured in north Atlantic northern latitudes (in Iceland) and southern latitudes (in Portugal)[56]. The status of the NAO has a pronounced effect upon wind strength, temperature, circulation, wave height and precipitation in surface and deeper waters of the north Atlantic, and all these factors influence the status of marine ecosystems. As a result of increased CO_2 levels in the atmosphere, it is expected that the NAO will remain in a positive state until at least 2040[57]. This will have pronounced implications on the status of the following in the north Atlantic:

- the nature, abundance and distribution of plankton, which will itself have consequences for all marine species and ecosystems for which plankton form the basis of the food chain, including most commercial fish species such as cod and salmon;
- the formation and path of both surface and deep ocean currents. Significant changes are already being observed in current patterns in the north Atlantic as a result of the NAO status, and these could ultimately result in the diversion of the Gulf Stream away from northern Europe. Paradoxically, this would mean that global warming would actually result in a cooler climate regime for the UK, as the warming effect of the Gulf Stream elevates our average temperature in comparison with other regions at the same latitude[58]. As current systems in the Atlantic are intrinsically interlinked with those in the rest of the world's oceans, such changes could have global consequences;
- changes in ocean currents and the abundance and distribution of plankton could also potentially influence the ability of the north-east Atlantic to act as a sink for CO_2. For example, scientists have already predicted that warmer temperatures and increased rainfall, resulting from climate change, will inhibit mixing in the Southern Ocean which surrounds Antarctica, slowing the circulation that carries large amounts of carbon from surface layers to the ocean floor[59]. The early signals of continuing climate change are likely to become apparent first in plankton[60].

Pollution

The release of large amounts of nitrogen and phosphorus, through sewage discharge and agricultural runoff, have been shown to have a demonstrable impact upon phytoplankton, increasing production and bloom duration and potentially altering ecosystems. Such an effect has been observed in a number of estuaries throughout the UK where such discharges are concentrated, as well as along the coast of south-east England[61].

Recent research has indicated that a number of pollutants may potentially have an impact upon plankton at concentrations much lower than was previously believed. Experimental research into the effect of polyaromatic hydrocarbons (PAHs) – a chemical released from the burning of fossil fuels – has revealed that their toxicity to marine life, especially certain plankton species, may be significantly increased through the exposure of the organism to UV light, for example. Further research is now being undertaken to establish the degree to which these phototoxic reactions are occurring in marine ecosystems and their subsequent long-term effects upon plankton species.

Wire Weed

To illustrate the threat posed to the UK's marine environment by the introduction of non-native species, the status and impacts of one of these species – wire weed – is assessed.

NATURAL HISTORY

Wire weed is the common name given to a species of brown seaweed (*Sargassum muticum*) that is native to the western Pacific and was introduced to the UK in the 1970s. In its native range, which extends from south-east Asia to the southern Pacific seaboard of Russia, wire weed is not problematic. However, in many locations, including the UK, where wire weed has been introduced, it overgrows and displaces native species. In its native range it does not usually grow to more than one metre in length but in the UK it typically grows to four metres and can grow up to 12 metres. Wire weed is found just below the low water mark but can also grow in areas of standing water such as channels, pools and lagoons[62].

STATUS

Wire weed was first introduced to Europe together with Pacific oysters, which were brought from the US to be cultured. The first recorded population of wire weed in the UK was in 1973 off the Isle of Wight[63]. It continued to spread and populations are now found along the entire south coast from Kent to Cornwall. It is also found at Constantine Bay in north Cornwall, around the Channel Islands and the Isles of Scilly, and in Strangford Lough, Northern Ireland[64].

THREATS

Unlike the other species and habitats featured in this report, wire weed presents a threat to native species and habitats. Once it becomes established at a site, it spreads out over the sea surface, creating a dense canopy. This canopy can impact other native plant and animal species by reducing the level of light penetrating through the water and lowering the water temperature below the canopy[65]. It is believed that this can result in a decline in the number of native seaweed species, which can in turn exclude the animal communities that they support[66]. Fears have been expressed that wire weed may displace algal species including *Laminaria sp.*, *Cystoseira sp.*, *Halidrys siliquosa* and *Scytosiphon sp.* as well as eelgrass, an important marine habitat (see Eelgrass Meadows section, page 27).

Research has revealed that wire weed is a "space filler": it will rapidly move into areas where populations of native species have declined, filling the space before the native species have a chance to return[67]. For example, at Bembridge on the Isle of Wight, wire weed colonised space formerly occupied by eelgrass after it died back as a result of frost damage. This prevented the eelgrass from re-establishing itself[68]. Wire weed can also be a recreational nuisance, forming extensive mats on the sea surface.

Further research is needed into the impacts of wire weed, given the fact that water temperature appears to be one of the main factors that limits its distribution, and that climate change may result in sea temperatures becoming favourable for its establishment further north along British coasts.

Case Study – Wire weed invades Strangford Lough

The most northerly location at which wire weed is recorded in the British Isles is at Strangford Lough, Northern Ireland. This is one of only three National Marine Reserves in UK waters and is also a candidate Special Area of Conservation (cSAC) under the EC Habitats Directive. The potential impacts of the seaweed in the lough are therefore serious.

Of particular concern was the discovery of the plant in the Dorn National Nature Reserve, within Strangford Lough, a nature conservation area of prime importance. In common with every other incident of wire weed introduction in the UK, all attempts to remove it from the lough have failed. Plants have also been discovered at the mouth of the lough, raising concerns that wire weed could now spread to other coastal areas of Northern Ireland[69].

Other alien marine species found in UK waters

A report produced by the Joint Nature Conservation Committee, the government adviser on conservation, has catalogued 53 alien marine species introduced into the UK. These range from planktonic algae through to worms, crustaceans, molluscs, seaweed and a sea squirt. There are concerns that a number of these species pose a threat to native marine animals and plants and that other non-native species will continue to be introduced.

Eelgrass Meadows

NATURAL HISTORY

Eelgrass is the term given to a number of marine flowering plants that occupy intertidal and sub-tidal areas of estuaries and coastlines. There are three types of native eelgrass in the UK: dwarf eelgrass, narrow-leaved eelgrass and common eelgrass.

Growing on sand or mud, eelgrass forms dense meadows. More than 78 species (excluding birds) are associated with eelgrass beds in the UK, but the total number utilising the habitats are significantly greater than this[70]. They include cockles, starfish, sea urchins and seahorses, fish such as the bass, two-spot gobie and 15-spined stickleback. Bird species include the whooper swan, widgeon and brent goose.

Eelgrass favours areas sheltered from wave action, so it is typically found in estuaries, inlets, bays, lagoons and sheltered channels. All three species of eelgrass are found throughout the UK, although their distribution is now patchy[71].

STATUS

It has been suggested that until the outbreak of a wasting disease in the 1920s, the vast majority of mudflats in Britain were “clothed” in eelgrass[72]. Since then it has declined significantly[73]. Only 20 of Britain’s 155 estuaries now possess eelgrass beds of more than 1 hectare in size – a possible decline in 85 per cent of estuaries[74]. Eelgrass is in serious danger and recovery continues to be impeded by a number of threats including pollution, disturbance and climate change.

THREATS

Disease

A wasting disease has had the most significant impact upon eelgrass populations in the UK during the last 100 years. The disease was most virulent during the 1920s and ’30s, causing eelgrass to decline severely or to disappear completely in many locations. The cause was positively identified as a fungus only during the 1980s, and it is believed that this may be continually present in Zostera beds. It is believed that only when other factors, such as pollution, stress the eelgrass that the fungus causes disease[75].

Nutrient pollution

Nutrient pollution, caused by sewage and fertiliser runoff, can damage eelgrass meadows by altering the metabolic balance of the plant and encouraging the growth of algae that blankets the beds.

Other pollution

Eelgrass is impacted by other pollutants including heavy metals and organic compounds – a number of which have been demonstrated to reduce the nitrogen-fixing ability and therefore the growth and viability of eelgrass. Certain herbicides used in anti-fouling paints and agricultural treatments have also been found to be harmful[76].

Disturbance

Various human activities including trampling, dredging, coastal defence work, land reclaim, anchoring of boats and certain fisheries methods also threaten eelgrass meadows.

Climate change

Factors associated with climate change, such as increasing sea temperatures, sea level rise and greater frequency of storm events, threaten to have a significant impact upon the survival of eelgrass in the future.

Maerl Beds

NATURAL HISTORY

The term maerl refers to several species of red algae that produce a branched skeleton of calcium carbonate. Although relatively slow-growing, over considerable time periods these algae form extensive fields or beds composed of their skeletal structures on the seabed. The underlying structure comprises the skeletal remains of the dead algae, with a pink crust of living algae occupying the uppermost layer. The species are so slow-growing that some maerl beds are estimated to be more than 8,000 years old[77]. Live maerl can be found in water as deep as 40m, but is more commonly encountered from 20m depth to the low tide mark.

Maerl favours sites that produce rapid water flow such as tidal narrows, straits or sounds, or where there is sufficient wave action to prevent it from being smothered with sediment. Maerl beds are patchily distributed throughout the UK, being found almost entirely on the exposed west coasts. In Scotland they are found in the Orkney and Shetland islands and along the west coast of the mainland. In England, maerl is found in the Fal Estuary and there are reports of smaller deposits around the coasts of Dorset, the Isles of Scilly and Lundy Island. In Northern Ireland the most extensive maerl beds are found on the north-east coast.

Maerl beds are a rare but important home to a wide range of other marine species including the corrugated crab and the imperial anemone. Recent studies on the west coast of Scotland have discovered a number of species new to science found living in maerl beds. They are also valuable nursery areas for a number of commercially exploited marine species[78].

STATUS

Maerl is considered to be of significant conservation importance due its rarity and valuable role as a habitat for many other species. In the UK maerl is still being damaged and exploited. It is known to be present in less than 1 per cent of the UK's inshore waters[79].

THREATS

Extraction

Despite its rarity and conservation value, maerl is still used commercially as a soil conditioner, an additive in animal feed, in water filtration, and in pharmaceutical and cosmetic products[80]. Licences have been granted by the Crown Estate Commissioners for the removal of dead maerl in a number of UK locations. The Commissioners are among the authorities that administer the use of the land that forms the UK's seabed. Major historic, actual and potential extractions include:

- a licence, granted in 1978, to remove 30,000 tonnes a year of maerl from the Fal Estuary, Cornwall;
- an exploratory licence to remove 20 tonnes of maerl from the island of Barra, Scotland (this has yet to be taken up); and

- the experimental removal of 4,000 cubic metres of maerl a year from Wyre Sound, Orkney (this extraction is monitored by Scottish Natural Heritage)[81].

Given the sensitivity of the species to extraction, there is now a predisposition by regulatory authorities not to issue further or renew existing extraction licences, and any further applications will be subject to environmental assessment[82]. Even so, evidence suggests that illegal maerl extraction has recently taken place in some parts of the UK.

Removal of live maerl is extremely damaging, as this makes it harder for the bed to regenerate. Dredging of dead maerl can also be harmful as sediment plumes generated by extraction can smother and damage adjacent live maerl beds.

Case Study – Fal Estuary

Dead maerl has been extracted from the Fal Estuary since 1975. It is believed that plumes of sediment generated by dredging could cause smothering of live maerl at the nearby St Mawes Bank. In an attempt to counter this problem, dredging is done on the ebb tide, so that the plume is taken out to sea. However, survey work shows that between 1982 and 1992 the proportion of dead maerl on St Mawes Bank increased significantly from 12 per cent to 23 per cent, although it is not known if this reduction is related specifically to dredging[83].

Dredge fisheries

Dredging for mollusc species such as scallops or razor shells can remove live maerl from the surface of beds, together with other algal species that help to stabilise these beds.

Case Study – Firth of Clyde

Scallop dredging takes place in the upper Firth of Clyde where maerl beds are comparatively rare. Research has revealed that the passage of dredges has not only destroyed large animals and algae associated with the beds, but has also released sediment into the water, which later resettled, causing stress to filter-feeding animals and reducing the ability of algae to photosynthesise. Furthermore, dredge teeth were seen to have penetrated up to 10cm into the maerl bed, crushing and burying the maerl fragments which resulted in the death of living maerl algae. Some months after dredging took place, it was observed that there was less than half as much live maerl as was present in an un-dredged control area. The study concluded that the impact of scallop dredging on maerl beds was extremely serious, compromising the integrity and future recovery of the habitat[84].

Fish farming

The positioning of fish farms above maerl beds can result in the deposition of waste materials onto the beds, producing anoxic conditions and significantly reducing the amount of light reaching living maerl algae. Monitoring of a salmon farm anchored over a maerl bed in Shetland revealed that anoxic conditions developed during the course of a 10-year period[85].

Construction, agricultural and sewage discharges

Coastal construction activity, including sea defences, results in increased amounts of sediment in the water, which can smother living maerl. Sewage discharge and certain agricultural practices result in increased levels of sediment in rivers and coastal waters, which also smother maerl and reduce the level of light available to it. Nutrient pollution, resulting from the discharge of agricultural and sewage waste, can have a similar impact by promoting the growth of other algal species on the living maerl.

Mudflats

NATURAL HISTORY

Mudflats are intertidal areas comprising fine silts and clays and are located in sheltered coastal areas such as estuaries. They are among the most productive ecosystems on Earth.

Species that live on mudflats include cockles, mussels, snails, worms, crabs, shrimps and sand hoppers. These animals provide food for a large number of wildfowl such the brent goose, shelduck, pintail, oystercatcher, ringed plover, godwit, curlew, redshank, knot, dunlin and sanderling[86]. They also provide an important food source for a range of fish species, including plaice, sole, flounder and dab. Mudflats are also vital nursery areas for a number of these fish species. UK mudflats are internationally important due to the habitat they provide for wildfowl and wading birds.

STATUS

Mudflats are widespread in UK estuaries, with important sites located in areas such as the Wash, the Solway Firth and Strangford Lough. It has been estimated that intertidal mudflats cover 270,000 hectares[87], but they are under threat and in decline. At least 25 per cent of the UK's mudflats have already been lost to land claim, many are subject to damaging levels of pollution and a further decline is expected as a result of climate change.

THREATS

Climate change and sea level rise

One of the greatest threats to mudflats is sea level rise as a result of climate change. This threat is magnified by sea defences around many of the UK's estuaries, which stop important coastal habitats such as mudflats from moving back as sea levels rise. Mudflats are therefore being squeezed out. At least 8,000 hectares of mudflats are expected to be lost as a result of sea level rise during the next 10 years[88]. Impacts are likely to be greatest in south-east England, although other areas such as Scotland's firths will also be affected[89].

Land claim

Many areas where mudflats are located, such as estuaries, have also been developed as centres of economic and industrial activity. This has led to mudflats being reclaimed for development. Although the rate of land claim has now reduced, 25 per cent of the UK's estuarine mudflats have already been destroyed as a result. In some estuaries, land claim has had a severe impact. For example, there are no longer any intertidal mudflats in the Tyne Estuary, and the Tees has lost 80 per cent of its intertidal area[90]. Such losses reduce the productivity of the estuary[91]: research shows, for example, that land claim in the Forth Estuary has removed 24 per cent of fish habitat and 40 per cent of their food supply[92]. The removal of mudflats in the late 1980s for the development of the port of Felixstowe also resulted in the loss of important feeding grounds for fish and waterfowl[93].

Fisheries

Certain types of fishing activity can significantly damage mudflat animal communities. Most prominent among these is suction dredging, used to obtain various shellfish species such as cockles. This activity kills a significant number of non-target species and also destabilises the structure of the mudflats. Tractor dredging for cockles is considered so damaging that it has been banned in Scotland – but it still continues in England and Wales.

Dredging

In a number of coastal and estuarine areas, dredging is done to maintain navigational routes for shipping. This can cause damage to both mudflats and their animal communities.

Pollution

Mudflats in estuaries are often contaminated by a range of pollutants, including persistent organic compounds, heavy metals, sewage and agricultural runoff. Of particular concern recently are the impacts on mudflat-dwelling species of pollutants that can disrupt hormone systems.

Case Study – Sex-change flounder

A recent study of the common flounder, a common species of flatfish in UK estuaries, found that many are suffering from “intersex” – that is, male fish have developed female sexual characteristics[94]. The research found that in 11 major estuaries, including the Tyne, Tees, Mersey and Wear, male founder were producing high levels of a protein called vitellogenin (VTG) which is a precursor to egg production. In many cases they were producing more of this protein than female flounder. Male fish in the Mersey and Tyne had even begun to develop eggs in their testes. In the most contaminated estuaries, these changes in the sexual characteristics of the male flounder are thought to seriously impair their reproductive ability. Further research is required to identify which chemicals are causing these impacts, but it is thought that there is a relationship between the occurrence of “intersex” in flounder and the levels of industrial effluent in the estuaries[95].

Reefs

NATURAL HISTORY

In the UK, the term "reef" refers to areas of hard substrate, usually rising from an area of surrounding soft sediment, that is either continually covered by seawater, or may be partly exposed at low tide. Reefs are composed either of rock, varying in composition and therefore hardness depending upon the local geological conditions, or they may be biogenic in origin – that is, produced by living organisms. As soft sediments dominate the UK seabed, reefs provide an important habitat for a range of marine organisms.

Where rocky reefs receive sufficient exposure to light, the dominant habitat is the kelp forest. Kelp is large brown algae which grows on hard substrate, and when occurring in stands – termed forests – it is highly important, as these represent possibly the most ecologically dynamic and diverse habitats on the planet[96]. Kelp forests are highly productive, providing a source of food not only for the animals that live among them, but also for most animals in the surrounding areas[97]. More than 860 species are associated with the five different kelp groupings identified in UK waters by the Joint Nature Conservation Committee[98].

In addition to those formed geologically from rock, several examples of biogenic reefs are found in UK waters. These solid, large areas of hard substrate produced by animals include:

- colonies of tube-forming worms, including *Sabellaria alveolata* and *Serpula vermicularis*;
- dense beds of the common mussel (*Mytilus edulis*) or the horse mussel (*Modiolus modiolus*); and
- the deep-water, colonial, bank-forming coral *Lophelia pertusa*.

Many of these biogenic reefs support a huge range of species. For example, a study of the deep-water coral *Lophelia pertusa*, around the Faeroe Islands, revealed a diversity of associated species similar to that found in some shallow water tropical coral species[99].

STATUS

A number of serious threats are facing reefs around the UK, especially biogenic reefs. Many continue to be degraded and destroyed, and are particularly at risk from fishing activity and oil and gas exploration.

THREATS

Fishing activity

There is evidence that heavy towed fishing gear and shellfish dredges have caused serious damage to reef communities. Biogenic reefs are particularly at risk. For example, the *Sabellaria* tube worm reefs in Morecambe Bay are believed to have been destroyed by a pink shrimp fishery and there is no sign of recovery[100]. There is also evidence that deepwater *Lophelia* coral reefs have been and continue to be damaged by fishing activity[101].

Dredge fisheries for scallops and queen scallops have also been identified as causing widespread and long-term damage to horse mussel reefs in Strangford Lough and to the south-east of the Isle of Man. It is highly likely that similar damage is occurring to horse mussel reefs elsewhere in UK waters.

There is great concern over the potential damage that fishing for queen scallops in Loch Creren, Scotland, may have upon the extremely rare and highly fragile Serpulid reefs located there. These reefs, produced by tube-forming worms, are a major world site for biogenic structures produced by this species[102]. Trawling for queen scallops is known to have taken place in the loch,[103] and an area of reef has already suffered damage as a result of discharge from an adjacent alginate factory.

Oil and gas exploitation

Oil and gas exploitation can cause significant damage to reef communities through the release of toxic chemicals and the discharge of drill cuttings. As oil and gas operations move into deeper water, particular concern has been expressed over the threat to Lophelia coral reefs.

Aquaculture

The UK has an extensive aquaculture industry, predominantly based upon the west coast of Scotland. Concerns have been raised about reef communities being damaged by the release of waste products and chemicals from cages located above reefs.

Aggregate extraction

Certain biogenic reefs, such as those created by the tubeworm *Sabellaria*, occur in the vicinity of marine aggregate deposits. Aggregate dredging threatens to damage these reefs.[104]

Saltmarsh

NATURAL HISTORY

Saltmarsh refers to the habitat formed by vegetation covering intertidal sand and mudflats. Important plant species comprising saltmarsh include sea grass, cord grass, common reed and sea-club rush.[105] Saltmarsh favours areas that are relatively sheltered from wave action and strong water movement, so it is typically found in estuaries, saline lagoons and at the heads of sea lochs.

Saltmarsh provides an extremely important habitat for a range of animal species, especially wading birds and wildfowl including the brent goose, shelduck, redshank and snipe. They are also important feeding sites for many migrating bird species and nursery areas for a range of fish species such as mullet, bass and plaice.

STATUS

More than 200,000 hectares of saltmarsh used to exist along the coasts of England and Wales but there are now only 45,000 hectares left in the whole of the UK – a decline of more than 75 per cent.[106] Saltmarsh faces a number of serious threats including land claim, climate change and pollution.

THREATS

Land claim

Land claim – where a marine area is reclaimed for agricultural or industrial use – has led to the loss of a large area of saltmarsh. Large-scale land claim stopped only relatively recently after nearly 1,000 hectares of saltmarsh were destroyed in the Wash in the 1970s[107]. Small-scale reclaim for projects such as port development, transport, waste disposal and marina construction is still a threat to saltmarsh and continues to contribute towards its decline.

Climate change and sea defences

Sea levels in the UK have risen and will continue to rise as a result of climate change, posing a serious threat to the survival of saltmarsh habitat. The presence of sea defences around significant areas of the UK coast compounds the problem by preventing saltmarsh from moving inland as sea levels rise. The habitat is therefore squeezed out. Climate change is also expected to increase the intensity and frequency of erosive storm events, further threatening saltmarsh and the many species that depend on it. Loss of saltmarsh is accelerating, particularly in the south-east of England, and it is estimated that at least another 6 per cent of saltmarsh habitat will be lost over the next 20 years, due to climate change and coastal squeeze alone[108].

Pollution

Various forms of pollution are damaging saltmarsh habitats. For example, nutrient pollution resulting from sewage effluent and agricultural runoff has resulted in problematic algal growth at some sites.[109] A study of pollutants threatening saltmarsh along the Essex coast provides an example of the chemicals to which such a habitat may be exposed. They include PCBs, DDT, Lindane, Dieldrin, Atrazine, Simazine, mercury, cadmium, lead, zinc and arsenic. All these pollutants are known to be highly toxic, with some also having bio-accumulating tendencies. Their presence could therefore potentially have a harmful impact upon the fauna and flora of the saltmarsh and they may eventually be released into the wider marine environment through erosion.[110]

Subtidal Sand and Gravel

NATURAL HISTORY

Subtidal sand and gravel, found below the low tide mark, form the most common habitats encountered in UK marine waters. Present all around the UK, the geological nature of the habitats assumes a rough east-west divide, with sand and gravel to the south and west of the UK being mostly derived from shells, and those from the east formed from rock material.

There are at least 13 types of sand and gravel biotopes found in the UK. These support a wide range of marine species including worms, crabs, sea anemones, molluscs, razor shells, whelks, sea urchins, sea cucumbers and starfish. They are also crucial nursery areas for a number of commercial fish species such as flatfish and bass.[111] Due to the high number of species they support, they are considered to be of international conservation importance.

STATUS

Sand and gravel habitats and their communities are known to be seriously damaged by a number of activities, including fishing and aggregate (sand and gravel) extraction. Damage from aggregate extraction is predicted to increase.

THREATS

Aggregate extraction

The demand for aggregate in the UK is high, as it is used in most construction projects. Some 20 per cent of the UK's total demand for aggregate is met through material extracted from the marine environment, and the UK government is looking to increase this total to 32 per cent by 2006[112] – an increase in aggregate extracted from the sea of 60 per cent. Around 1,652km^2 of the UK seabed is presently licensed for aggregate extraction.

It is predicted that the overall requirement for marine aggregate will rise, with a projected average annual demand between 1996 and 2015 forecast as being 38.3 million tonnes per year. This represents a 63 per cent increase on the average annual amount extracted between 1989 and 1996[113]. In addition to supplying aggregate for construction, substantial quantities of sand are also removed to replenish beaches that have been eroded, and demand is likely to increase as rates of erosion increase due to climate change-related matters.

Marine sand and gravel is not just an aggregate; it is also an important wildlife habitat. Removing the sand and gravel also removes this habitat and can cause substantial damage to the animal communities it supports.[114] An experimental study into the impacts of sand and gravel extraction off the Norfolk coast shows that some 50,000 tonnes were removed to a depth of 30cm from an area of seabed covering some 150,000m^2. Surveys immediately after dredging revealed that animal populations were substantially reduced in numbers, variety and total weight. Even some three years after dredging, further survey work revealed that the abundance of animals was still significantly lower than had been recorded at an adjacent, un-dredged, reference site.[115]

Fishing activity

Some fishing methods involve the towing of heavy gear over the seabed – a practice that disturbs sand and gravel habitat and causes serious damage to the number of species it supports. Fragile or large-bodied, slow-growing animals are most at risk of damage, and when this happens, populations may be slow to recover.[116] In certain areas of UK waters, shellfish species associated with sand and gravel habitats, such as the scallop, may be exposed to significant fisheries pressure, which may have potential implications on stock viability on a local or regional level.

Pollution

Species and communities associated with sand and gravel habitats are exposed to a range of pollutants including heavy metals, sewage, agricultural runoff and hormone disrupting chemicals.

Because contamination is frequently caused by land-based sources, it is generally assumed that pollution decreases away from the shore. But several studies show that in the case of certain heavy metal pollutants, this may not be the case. In the Dogger Bank area of the North Sea, concentrations of some pollutants may be comparable with those found in industrialised estuaries and coastal waters.[117] High levels of lead and cadmium have been found in sea urchins, hermit crabs, worms, starfish and shrimps in this area.[118]

Conclusion

The damage and threats to these species and habitats indicate that the health of the UK's marine environment is deteriorating. Rapid action is needed to help our marine life recover. Because the number of threats facing these species and habitats is so vast, it is not possible in this report to discuss all the solutions that are needed to address them. However, as part of **WWF's Oceans Recovery Campaign (ORCA)**, WWF is pointing to a number of solutions that will help to kick-start this recovery.

Hundreds of different laws and policies govern our seas – but they frequently conflict with each other. WWF wants the Westminster government, the Scottish parliament, and the National assemblies of Wales and Northern Ireland, to introduce an 'eco-system' approach to the management of the oceans. This will require co-ordinated legislation – an **Oceans Act** – in order to provide the best legislative support for protecting and managing our precious marine environment, for the benefit of wildlife and coastal communities.

WWF is also calling for:

- a stronger network of Marine Protected Areas around the UK;
- a network of regeneration areas to enhance and restore fish stocks, including pilot Fishing-Free Zones.

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