WWF for a living planet

MARINE HEALTH CHECK 2005

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

About the authors

Keith Hiscock PhD, BSc (Hons) has been involved in UK marine conservation since the early 1970s when he was instrumental in seeing the establishment of the UK's first voluntary marine nature reserve at Lundy. He has undertaken numerous surveys and monitoring projects around Britain and was Head of the Marine Nature Conservation Review of Great Britain. In 1998, with the Director of the Marine Biological Association, he established the Marine Life Information Network for Britain and Ireland *(MarLIN)* which provides information for marine environmental management, protection and education.

Jack Sewell MSc, BSc (Hons) has been working for the Marine Life Information Network for the past year. He has degrees in marine biology and coastal ecology and coastal and ocean policy. He has been involved in a variety of research and environmental educational projects, including research contributing to the development of the *MarLIN* website.

Judith Oakley MSc, BSc (Hons) has a background in marketing but has switched to marine biology and has most recently been carrying out out species research work for the Marine Life Information Network. In 2003 she completed a research project on short-finned pilot whales in the seas around the Canary Islands, and presented a poster on this to the European Cetacean Society conference in Sweden. She has just completed a research project on the endangered Knysna seahorse *Hippocampus capensis* for her Master's Degree.

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The *Marine Health Check 2005* was prepared by the Marine Life Information Network at the Marine Biological Association of the UK.

The MBA promotes scientific research into all aspects in the sea and disseminates to the public the knowledge gained. The *MarLIN* programme is a part of the MBA supporting marine environmental management protection and education.
www.mba.ac.uk, www.marlin.ac.uk

THE MARINE BIOLOGICAL ASSOCIATION

MarLIN
The Marine Life Information Network for Britain and Ireland

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FOREWORD

Five years on from WWF's first *Marine Health Check*, which gauged the wellbeing of the UK's sea-life, this new report depressingly reveals that the marine environment is still in crisis.

Since the last report in 2000, the potential threats it described have now manifested themselves – for example, sand and gravel extraction is reaching unexploited areas of the seabed, and climate change threatens to alter the distribution of marine life, change sea temperatures and bring about a rise in sea level. The new millennium has also brought with it additional demands on our seas. For example, offshore wind farms, prospecting among marine life for medicinal cures, and even the prospect of burying carbon dioxide in the seabed. On top of that, many other threats remain, such as over-fishing, pollution, coastal development and adverse effects on native marine life through invasions of non-native species.

This new report investigates 16 "flagship" species and habitats that help to provide a snapshot of the health of our seas. The picture remains a depressing one as little seems to have changed in the past five years, and 13 entries recorded here show varying degrees of degradation. Sea-life is still in decline and, most worryingly, the habitats – the very homes of the sea-life – are being damaged and reduced in extent.

In the intervening years, there have been some gains for the marine environment – the basking shark has been listed on Appendix II on the Convention of International Trade in Endangered Species and the Darwin Mounds, a field of cold-water coral off the north-west coast of Scotland, have at last received permanent protection from bottom trawling. But these are counterbalanced by notable losses such as the destruction of horse mussel beds in Strangford Lough – a candidate Special Area of Conservation – and the devastation of common skate stocks.

To most people, the marine environment is out of sight and out of mind, so its demise is hidden. But visible clues are there for all to see: strandings of porpoises are on the increase and failing fish stocks are being recorded. And it's not just marine life that's suffering – coastal towns and villages in many parts of the UK that once thrived on the riches of the seas have become hollow shells of the vibrant communities they once were and ought to be.

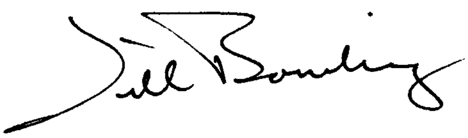
To date, marine legislation and planning, including that which applies to nature conservation, has been largely developed on a sector by sector basis. This has led to numerous regimes which are not "joined up" in their approach to management of the marine environment. In addition, many marine species and habitats important to the UK are unprotected under EU laws – and we still only have three national Marine Nature Reserves.

Encouragingly, in September 2004 the Prime Minister announced his intention to bring forward a new Marine Bill. This is a welcome decision, but it's important that the Bill has the right content to resolve the problems facing us.

WWF believes that a UK Marine Act could help solve the crisis in our seas by establishing a long-term, holistic vision and by taking an ecosystem approach to the management of the marine environment. Embedded in this should be a system of marine spatial planning, sealed not only by duties of good stewardship placed upon regulatory regimes, but also supported by a marine environmental information system essential to ensuring the best use of available scientific data. One component of such a plan should be the designation of a nationally representative network of Nationally Important Marine Sites.

The adoption of such an approach would ensure that the exploitation of marine resources is planned carefully and strategically, taking into account species and habitat conservation. Cumulative impacts would also be addressed and conflicts of interest between different users of the sea would be minimised.

By highlighting threats to our precious species and habitats, *WWF's Marine Health Check 2005* illustrates why a Marine Act is so important for the wildlife of our seas, and the seas themselves.



Dr Jill Bowling, Director of Conservation, WWF-UK

INTRODUCTION

MARINE HEALTH CHECK 2005

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

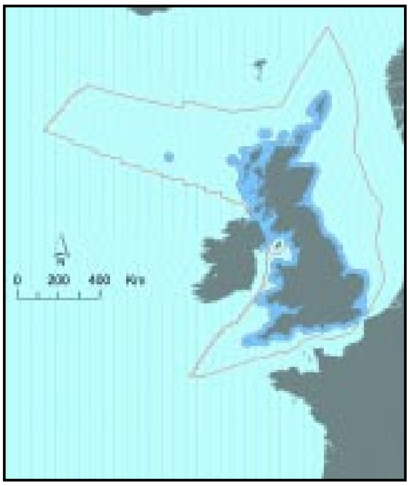


Figure 1. UK seas, including the extent of the 12 nautical mile limit of territorial seas (dark blue)[1]

UK sea-life

The coastline of the UK is about 20,000km long, while the UK Continental Shelf Designated Area extends over an area of approximately 710,100 sq km and to depths of more than 2000m. In contrast, the land area of the UK, including inland waters, is 244,101 sq km and the highest mountain (Ben Nevis) is 1,343m high[2]. The UK lies across a marine bio-geographical transition zone, meaning that many species with a Mediterranean-Atlantic distribution thrive in south-west and western waters while a number of species that are predominantly Arctic in their distribution reach our northern waters. The range of habitats in which those species can live is extremely varied, ranging from sheltered lagoons, deep sea lochs (loughs) and muddy estuaries to wave-lashed rocky coasts and deep waters off the edge of the Continental Shelf.

Some wildlife facts and figures:

- At the higher levels of classifying life – the major groups (phyla) such as sponges, molluscs and vertebrates – there were 34 groups in the sea and only 15 on the land until 1995, when a new phylum represented by one marine species *(Symbion pandora)* was described.
- There are around 10,600 multi-cellular species of plants and animals recorded from the seas around Britain.
- In the sea, algae are the predominant plant group and only five species of flowering plant exist in British seas. The total marine algal flora of Britain and Ireland exceeds 822 species compared with a terrestrial flora of about 2,223 vascular plants and perhaps 40,000 lower plants (including around 15,000 to 20,000 algae and some 15,000 fungi).
- About 7,300 animal species are recorded from the seabed (numbers in predominantly seabed taxonomic groups) and around 30,000 animal species on the land and in freshwater, including some 20,000 insects, 5,000 nematodes and 3,000 arachnids.
- There are 333 fish species recorded from the seas around Britain and 55 recorded from freshwater habitats.
- There are 33 mammals recorded from our seas: only a small part of the total marine fauna, but their ecological importance and intrinsic appeal leads to their achieving a high conservation focus. The otter (which is a sea creature around the Scottish coast) and seals (Atlantic grey and common) are important species in areas adjacent to the shore. Cetaceans are mainly creatures of the open seas but may occasionally venture near to the shore.
- There are 187 species of seabirds, waders and wildfowl that use the sea and seashore for food. Seabirds are marine species in virtually all respects except production of young. Waders and wildfowl play an important role in marine systems as intertidal predators and grazers near the top of the food chain.

Another way to look at biodiversity is through the range of habitats in the sea. The UK has taken a lead in Europe in providing a classification for marine habitats that includes about 270 major types. Having such a classification greatly assists in identifying the best or most representative examples, especially as we work to achieve "the establishment of Marine Protected Areas consistent with international law and based on scientific information, including representative networks by 2012" – an outcome of the World Summit on Sustainable Development in 2002.

Threats to UK sea-life

Since the last WWF-UK *Marine Health Check* in 2000, there have been significant shifts in the potential threats to sea-life in the UK – in information about impacts of human activities on marine life, in perceptions of what action is most needed to prevent or at least minimise damage, and in the positive action now being taken to improve prospects for recovery and maintenance of biodiversity.

This report is intended to give an easily understood account of some issues that the public and politicians can relate to and that may provide indicators for the future assessment of the health of our seas. Several issues have increased in importance since the last *Marine Health Check* in 2000[8]:

- The likely impact of climate change is now becoming apparent with rising sea levels, increasing temperatures, adverse effects on fisheries, changing distributions of sea-life and predictions of increased acidification of the sea.
- What were just prospects for offshore energy generation using wind, tidal and wave power in 2000 are now being realised with structures being built in the sea to provide us with much-needed energy – but at what cost to the natural environment?
- Non-native marine species continue to arrive in our seas via shipping and aquaculture – the next one may be capable of devastating native sea-life.
- Aquaculture, while having the potential to provide cheap fish protein and other products, may be harming sensitive habitats and species if sited irresponsibly.
- Hopes that EU Special Areas of Conservation (SACs) will protect sensitive sea-life have been diminished by the destruction of reef habitats in the Strangford Lough candidate SAC.
- Extraction of sand and gravel from the seabed is expanding to previously unexploited areas, removing areas of seabed and the species that live there.
- At last, the impact of overfishing on fish stocks is being acknowledged, but measures to create sustainable fisheries seem far away. Nevertheless, the concept that No-Take Zones (1) might not only help fisheries to recover but also protect wildlife is gaining favour, including the first statutory No-Take Zone being designated off Lundy in 2003.
- Much more stringent measures are being introduced to assess the health of our rivers, estuaries and coastal waters and to improve their quality as a result of the implementation of the EU Water Framework Directive.
- And much good thinking is going into UK government, including the devolved administrations – for example, proposed measures to improve prospects for marine environmental protection and the management of human activities.

There are bound to be new threats to our sea-life over the next few years, but what will they be? Perhaps bio-prospecting for potential drugs, perhaps inappropriate aquaculture. Unfortunately, commercial interests are always quicker off the mark than regulators and new approaches may be needed, including Biodiversity Stop Orders. (2)

The variety of sea-life and marine habitats surrounding the UK is probably the greatest for any European state. This report acknowledges that fact, but it also highlights where things are going wrong and where action is required to improve the prospects for healthy, diverse and productive seas. It also identifies progress being made to protect and restore our sea-life. This report uses a small number of "flagship" species and habitats that can represent the health of our seas across the spectrum of marine wildlife. Readers will be aware of other species that we might have included, such as some of the seabirds or other commercial species.

(1) An area of the sea that has been temporarily or permanently closed to fishing and other extractive activities to protect fish stocks and/or natural habitats.

(2) A mechanism which WWF would like to see introduced in a Marine Bill. Biodiversity Stop Orders would be a way of controlling damaging human activities which are likely to have adverse effects on any Nationally Important Features. Nationally Important Features are those species, habitats and marine landscapes chosen for priority conservation action because of their threatened, rare or otherwise exceptional nature.

Action to protect UK sea-life

Protecting the diversity of UK marine wildlife has been undertaken in a piecemeal and not always effective way. Sites of Special Scientific Interest (SSSIs) have been established to protect marine biological features for some intertidal locations over the past 50 years. Legislation to identify and protect Marine Nature Reserves (MNRs) was introduced in 1981 in Britain and 1985 in Northern Ireland, but only three MNRs have been designated. Sixty-five Special Areas of Conservation have been identified for marine habitats and species for establishment under the EU Habitats Directive which came into force in 1992. Implementation of the EU Water Framework Directive in the UK over the next few years should significantly improve the condition of inshore waters for the marine life there.

Other international imperatives that will inform or drive conservation measures in the marine environment include the UN Convention on Biological Diversity, the OSPAR Convention for the Protection of the Marine Environment of the North-east Atlantic, and the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS). The requirement of the World Summit on Sustainable Development in 2002 to develop a representative network of Marine Protected Areas by 2012 based on scientific information will be achieved by UK initiatives.

There is currently a great deal of action in the UK to identify the problems faced by marine wildlife as a result of human activities and the measures required to protect that wildlife within the context of sustainable development. The UK government's intentions were outlined in the *Safeguarding our Seas* report[9] followed by recommendations published in the *Review of Marine Nature Conservation*[10] and, with regard to sustainable fisheries, in the report *Net Benefits*[11]. Action will increasingly be based on the "ecosystem approach"[12]. WWF-UK is advocating the preparation of a Marine Bill to further good stewardship of the marine environment.

Author

Keith Hiscock PhD, BSc (Hons)

"This [new sustainable development strategy] will deal with, among other matters, issues of waste, recycling, sustainable agriculture, all aspects of biodiversity and fishing, and will set out policies in each key area. For example, on the marine environment, I believe there are strong arguments for a new approach to managing our seas, including a new Bill."

Tony Blair,
14 September 2004

The ecosystem approach is the comprehensive integrated management of human activities, based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and the maintenance of ecosystem integrity.

EU marine strategy stakeholders' workshop, Denmark, 4-6 December 2002[9]

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Research was carried out in August and September 2004.

full explanation at end

HARBOUR PORPOISE

(Phocoena phocoena)

The harbour porpoise *Phocoena phocoena* is the smallest and most numerous of the cetaceans found around the UK. It is also the most heavily protected species, being listed in 23 directives, statutes and conventions. Incidental captures, or bycatch, in certain fisheries is acknowledged as one of the most significant threats to this species. Measures are being developed to protect the harbour porpoise, but implementation is slow and, in some cases, inadequate.

NATURAL HISTORY

Twenty-eight species of cetaceans have been recorded in British and Irish waters, representing a third of global cetacean biodiversity. Fifteen species, including the harbour porpoise, are either resident or annual visitors to the north-west European continental shelf. The harbour porpoise has a small rotund body with a short, blunt head, no beak and a small, triangular dorsal fin. The back and dorsal fin may be seen briefly at the surface, but the animal rarely leaves the water entirely. Harbour porpoises live for up to 20 years in the wild and usually occur in small groups of up to three, but large aggregations may be seen occasionally. During late summer, porpoises are more social. The main mating season is the summer, with calves born 11 months later[1, 2, 3].

Harbour porpoises do not usually approach boats or bow ride. They can dive underwater for as long as six minutes before coming up for breath. Their diet comprises a wide variety of small shoaling fish such as herring as well as cephalopods and crustaceans[1, 2, 3].

Plate 1. Harbour porpoise.

Harbour porpoises are widely distributed in coastal and offshore waters and, in the main parts of their range, are recorded throughout the year. In the UK, locally high densities occur in south-west Wales and off the west coast of Scotland[1, 4] but they occur infrequently in the English Channel for reasons not yet fully understood. There is some indication of an offshore movement between May and June, possibly associated with calving[4].

EXISTING PROTECTION AND MANAGEMENT

The harbour porpoise is protected by many international agreements and regulations. The most important of these are:

- The EU Habitats Directive. Article 3 requires member states to designate Special Areas of Conservation (SACs) for specified species which include the bottlenose dolphin and harbour porpoise. Of the 65 candidate marine SACs in the UK, three were selected to protect the bottlenose dolphin. None is specifically designated to protect harbour porpoises, but areas where they are concentrated have now been identified[4] and further work is under way by the Joint Nature Conservation Committee (JNCC) to identify future SACs[5].
- Under Article 12.4 of the Habitats Directive, EU member states are obliged "to establish a system to monitor the incidental capture and killing of all animals listed in Annex IV" (which includes cetaceans) and, in light of the information gathered, to take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant impact on the species concerned. Very few fisheries have been adequately monitored in UK waters for associated bycatch of small cetaceans such as the harbour porpoise, although there is an awareness that where gill nets are deployed, bycatch will occur. To date, very few mitigation measures have been deployed to address this.
- The United Nations Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), of which the UK is a contracting party, has set a target to reduce total North Sea bycatch to 1.7 per cent of the latest abundance estimates[5].
- Appendix II of the Convention on International Trade in Endangered Species (CITES).
- Appendix II of the Bern Convention, which gives special protection to vulnerable or endangered species. This is implemented in the UK through the Wildlife and Countryside Act 1981.
- The harbour porpoise has a UK Biodiversity Action Plan: part of the UK response to the Convention on Biological Diversity.

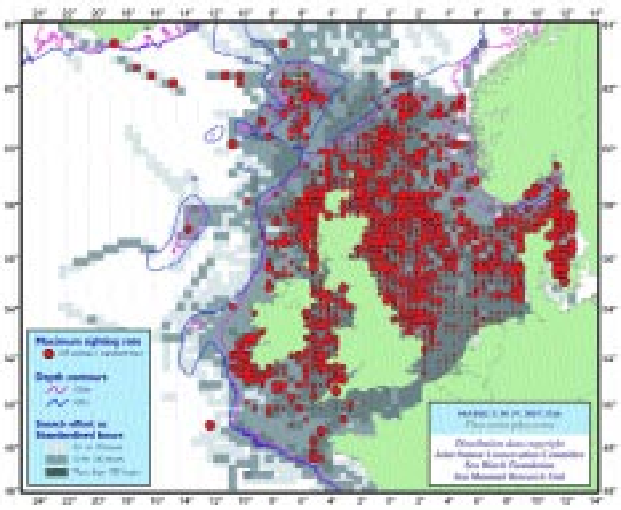

Figure 1. Harbour porpoise distribution in the north-east Atlantic[1]. Reproduced withpermission of the Joint Nature Conservation Committee.

STATUS
(DEGREE OF DECLINE)

The harbour porpoise has been recorded from all British coasts [1, 4]. The Department for Environment, Food and Rural Affairs (Defra) and the JNCC estimates that the total UK continental shelf (including territorial waters) population of harbour porpoise to be around 150,000[5]. Numbers have most likely declined or remain absent in the eastern Channel and southern North Sea at least[6]. However, numbers of porpoises present in UK waters vary seasonally and more animals are likely to pass through than are present at any one time. In the last 30 years, numbers have declined (to the point of absence in some areas) in the southern North Sea, the English Channel and the Bay of Biscay. Even so, the harbour porpoise remains the most frequently observed and stranded cetacean in British and Irish waters[4].

Throughout its range, the harbour porpoise is under threat from the incidental capture in certain fishing gear, in particular bottom set and drift gill nets. The harbour porpoise has almost disappeared from the

Baltic Sea and the winter migration between the Baltic and North Sea has decreased[7]. For the Celtic Sea (the western approaches to Britain and Ireland), it is estimated[8] that, between August 1992 and March 1994, the total annual bycatch of 2,200 porpoises was 6.2 per cent of the estimated population there. When scientific advice states that cetacean populations can only withstand bycatch levels of up to 1.7 per cent (or less in more threatened populations), this high proportion raises serious cause for concern.

Cetacean bycatch in UK waters is a Defra "Biodiversity Indicator". Defra notes that the estimated total bycatch of harbour porpoise in the North Sea had declined from around 1,000 in 1995 to 600 in 2000, probably linked to a reduction in effort of set fisheries[9].

CHANGE IN STATUS SINCE 2000

Change in status of populations of harbour porpoise is difficult to assess as any census requires extensive survey. Figures given in the next section suggest that a decline in abundance in the past few years is likely. The north-east Atlantic seas survey undertaken in 1994 is planned to be repeated in 2005.

ISSUES/THREATS

Fishing

Each year, around 10,000 harbour porpoises are believed to be killed in EU fisheries in the North Sea and Celtic Sea – most in bottom-set gill nets[9]. Given that it is internationally recognised that any bycatch representing more than 1 per cent of the harbour porpoise population is a threat[11], the estimated Celtic Sea annual bycatch of 2,200 porpoises or 6.2 per cent of the population present in the early 1990s[8], raises serious concerns regarding the ability of the population to sustain such levels of by-catch.

Between August 2003 and July 2004, there were 80 sightings and 109 strandings of harbour porpoises in Cornwall. Between January and June 2004, 124 dead cetaceans were recorded on the Cornish coast alone – most apparently the victims of bycatch[12].

Pollution

Pollution is a well documented and increasing threat to cetaceans in UK waters. Cetacean physiology and food chain position dictate risk in terms of pollutant accumulation and significantly high pollutant body burdens.

Chemicals such as polychlorinated biphenyls (PCBs)[13] and mercury have known immuno-suppressant effects in cetaceans, as highlighted by WWF-funded research at the Institute of Zoology, London. Effects on reproductive and developmental systems have also been mooted. A plethora of chemicals are known to be accumulating in cetacean tissues, many of which have unknown effects on mammalian systems.

Cetacean prey are also under threat, raising the possibility of reduced availability.

A study of perfluorochemicals in harbour porpoises concluded that animals from northern Europe are heavily contaminated. There is also a high presence of perfluoro-caboxylates. In the German Baltic Sea, the concentration of these chemicals is significantly higher, due to increased pollution levels in this area[14].

Ship strikes

Fast ferries may be a threat to small cetaceans.

Noise pollution

Noise pollution from ships, seismic surveys and seal scrammers are also thought to affect the porpoise by causing local distribution changes. There is also growing evidence that physical injury can be inflicted on the mammal by high frequency sonar waves.

Natural threats

Individual harbour porpoises are sometimes attacked by bottlenose dolphins *Tursiops truncatus*. Instances have been recorded in Cardigan Bay and the Moray Firth. The reason for such attacks, which can be fatal, is unknown[15].

Plate 2. Harbour porpoise showing gill net entanglement marks around mouth, head and fins.

SPECIES UNDER SIMILAR THREAT

Common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus* and the basking shark *Cetorhinus maximus*.

HOW A MARINE ACT CAN HELP

The harbour porpoise should be considered a Nationally Important Feature (1) under a Marine Act, even though full protection is already afforded to the species. A Marine Act would help protect porpoises by placing a duty of care on all responsible bodies to meet biodiversity obligations. In the case of porpoises this would require action to reduce unsustainable levels of bycatch in fisheries. It is also likely that the harbour porpoise would benefit from the creation of Nationally Important Marine Sites (2), some of which may have restrictions on the use of certain types of gear at certain times of the year. Biodiversity Stop Orders could also be applied if new practices were thought to threaten the species.

Implementation of marine spatial planning would enable the management of areas important for the harbour porpoise to be considered alongside human activities.

Plate 3. Cetacean watching has become very popular in Britain. Such environmental tourism benefits local economies and protects cetacean populations.

STATUS

Decline. The population has suffered a "minor" but "noticeable" reduction in numbers or distribution, or evidence suggests that there is a high probability of significant decline due to reduced recruitment and/or reproductive individuals, or continued unsustainable extraction.

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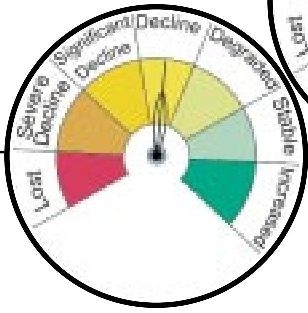
Author Judith Oakley

(1) Species, habitats and marine landscape chosen for priority conservation action because of their threatened, rare or otherwise exceptional nature

(2) These are sites where human activities may continue, subject to compatibility with the sites' conservation objectives and the need to avoid adverse effects on site integrity. In some cases it may be necessary to introduce higher levels of protection/management which may exclude human activities.

North Atlantic

full explanation at end



Worldwide

full explanation at end

All turtle species are threatened by human activities throughout the world. The leatherback is the only species to include UK waters as a part of its natural foraging area. In some parts of the world, numbers of leatherbacks have fallen by 95 per cent over 20 years, and extinction of Pacific leatherbacks may occur within the next 10 years. While some action has been taken to reduce mortalities, further measures are required – for example preventing litter, especially plastic and balloons, and modifying some fishing practices, in particular long-lining and pelagic driftnets.

LEATHERBACK TURTLE

(Dermochelys coriacea)

NATURAL HISTORY

Over the last 100 years, there have been some 500 records of marine turtles from UK waters, particularly along the western coast[1]. Five species have been identified, most being adult leatherback turtles *Dermochelys coriacea*[1]. Leatherbacks habitually occur in UK waters and are the only species of marine turtle to have adapted to life in cold water. Today, the leatherback is a regular member of our marine fauna, occurring to 71 degrees north in the Atlantic[2]. But even though sightings continue to increase, the leatherback is believed to be in overall decline in the Atlantic[3].

In the UK, the leatherback is usually sighted between August and October with strandings in September and October. Its occurrence in UK waters is probably due to migration to and from the nesting beaches of the eastern US mainland coast and Caribbean islands[1]. The first live sighting of 2004 was in February, off the south coast of Cornwall: an unusually early visit. Leatherbacks follow swarms of jellyfish, which are their main prey. Analysis of the gut contents of dead stranded leatherbacks on UK shores shows the main prey species to be barrel, blue, compass, lion's mane, mauve stinger and moon jellyfish[2].

The leatherback turtle is the largest marine turtle species, with a greatest recorded length of 2.91m and weight of 916kg. Characteristic features are a blackish leathery shell (tapering to a blunt spike), with seven longitudinal ridges along the back. Three of these are clearly visible when the animal is swimming at the surface. The shell and flippers are often patterned with white spots. The species can dive to more than 1,200m. Females can lay hundreds of eggs in a year, but relatively few young turtles survive their first year of life. The age of sexual maturity is unknown, as is the lifespan, but it is believed that it takes decades for juveniles to reach maturity and breed[3].

© PGH Evans/Sea Watch Foundation

Plate 1. Leatherback turtle in the Irish Sea.

EXISTING PROTECTION AND MANAGEMENT

- All turtle species are regarded as threatened at a global level.
- The five species recorded in the UK are listed on:
  - Appendix I of the Convention on International Trade in Endangered Species (CITES) 1975,
  - Appendix II of the Bern Convention 1979,
  - Appendices I and II of the Bonn Convention 1979,
  - Annex IV of the EU Habitats Directive, and
  - Schedule 5 of the Wildlife and Countryside Act 1981.
- The leatherback turtle is listed as Critically Endangered on the IUCN Red List of Threatened Species, 2000
- The leatherback turtle is also included in the UK Biodiversity Action Plan within the marine turtles Species Action Plan.

STATUS
(DEGREE OF DECLINE)

Turtles are a difficult group to study, so changes in the abundance of the leatherback in UK waters are unknown. Marine researchers at the 2003 meeting of the American Association for the Advancement of Science concluded that the leatherback was expected to become extinct "in 10-30 years" in the Pacific[4]. However, in the Atlantic, increases in numbers of nesting turtles have occurred in the Caribbean and South Africa. Scientists estimated the global leatherback population of nesting females to be 30,000 to 40,000 in 1996[3].

CHANGE IN STATUS SINCE 2000

Although 2003 was a record year for sightings around Britain and Ireland[5], numbers vary greatly from year to year and long-term trend data is needed to see if overall increases or decreases are occurring. Worldwide, leatherback turtle numbers continue to decline and reports from nesting areas are alarming.

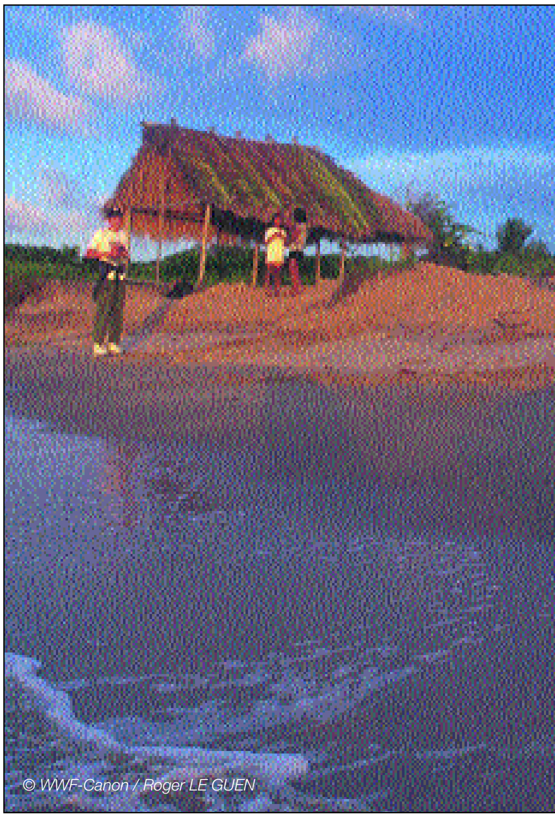


Plate 2. A leatherback turtle leaves its nesting site in French Guiana. © WWF-Canon/R. LeGuen

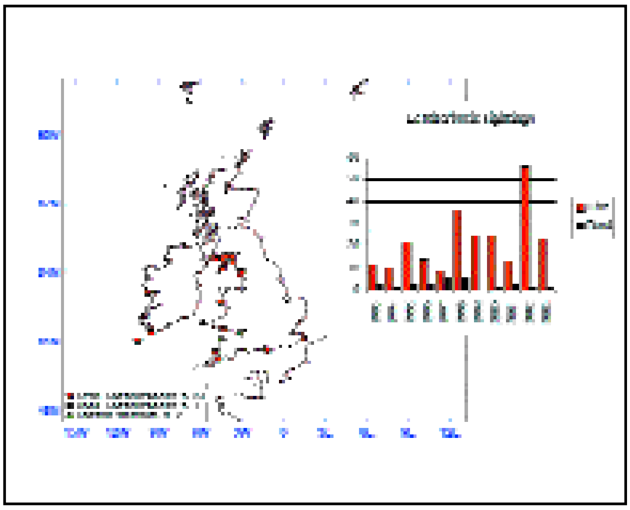


Figure 1. Leatherback sightings for 2003 with inset graph showing sightings between 1993 and 2003[5]

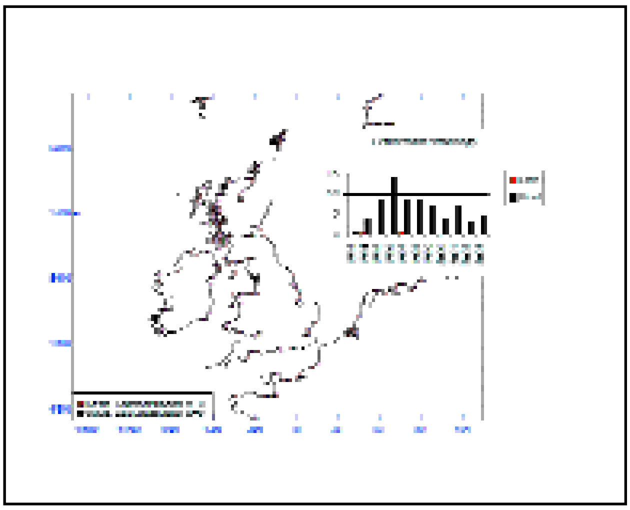
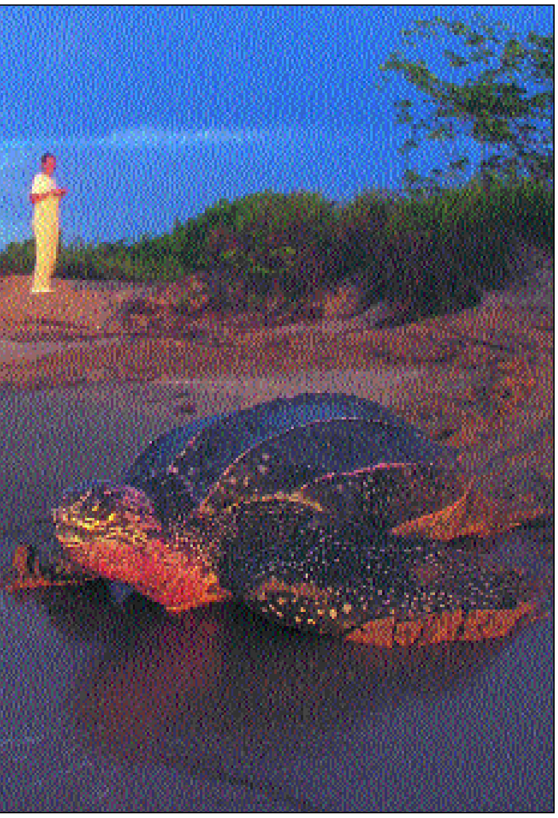


Figure 2. Leatherback strandings for 2003 with inset graph showing strandings between 1993 and 2003[5]



> "This organism has been around for 100 million years. It outlived the dinosaurs; at the moment, it is having trouble outliving us"
> *Professor Larry Crowder, marine scientist* [4]

ISSUES/THREATS

Marine turtles face a range of threats, both at nesting colonies and in the wider marine environment[2]. In the eastern Pacific, numbers have decreased from more than 90,000 adults in 1980 to fewer than 2,000 adult females in 2000[6].

Fishing

Fishing for tuna and swordfish is the biggest threat to leatherbacks. Longlines up to 60km in length are used, each with thousands of hooks which cause large-scale bycatch of turtles and other marine wildlife. Some 60,000 leatherback turtles were estimated to have been caught globally in 2000 by commercial longlines[7]. Incidental capture from other fishing gear such as set nets, demersal and pelagic trawls and driftnets also poses a widespread threat to marine turtles.

For many years Turtle Excluder Devices (TEDs) have been hailed as the solution to sea turtle mortality from trawl fisheries. TEDs are grids or gratings sewn into trawl nets that selectively remove large organisms such as turtles, while allowing the smaller target species to be caught. In 2000, the use of TEDs was made mandatory in the Northern Prawn Fishery, Australia[8].

In 2003, a large stranding of 13 leatherback turtles occurred in Carmarthen Bay, Wales. This was thought to have been associated with rapid expansion of a pot fishery for whelks. The animals displayed signs of injuries consistent with rope entanglement[2].

Direct hunting and egg collection

Destruction of nests, egg theft, and killing the turtle for meat or souvenirs has caused numbers to decline.

Coastal development

Turtle numbers are threatened by the development of coastal areas in the countries where they nest. Light pollution and disturbance can reduce the chance of successful nesting. Development can also lead to beach loss and reduce the area available to nesting turtles. Increased use of beaches can lead to nests being damaged by trampling or traffic.

Boat traffic

Collisions with boats and wounds from propellers can cause severe physical trauma. Turtles characteristically spend time at or near the surface of the sea, making them particularly vulnerable to collisions with vessels. In 1998 a dead leatherback with boat collision injuries was washed up on the banks of the Thames at Rainham, Essex.

Marine litter

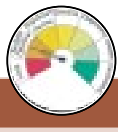
The largest marine turtle yet recorded in the UK was a male leatherback three metres long and weighing 916kg, which was washed up at Harlech, Wales, in 1988. It had drowned after becoming entangled in fishing gear, but an autopsy revealed a more insidious threat: the turtle's gut was full of plastic. Leatherbacks mistake floating plastic litter such as balloons and carrier bags for their main prey, jellyfish. Once ingested, plastic can block the turtles' intestine, leading to a slow death by starvation[9]. Each time a mass balloon release event takes place, thousands may end up in the sea and may be mistaken by turtles for food.

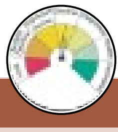
SPECIES UNDER SIMILAR THREATS

Loggerhead turtle *Caretta caretta*, Kemp's Ridley turtle *Lepidochelys kempii*, green turtle *Chelonia mydas* and Hawksbill turtle *Eretmochelys imbricata*.

HOW A MARINE ACT CAN HELP

Leatherback turtles should be considered a Nationally Important Feature under a Marine Act, although full protection is already afforded under the Wildlife and Countryside Act 1981 and various directives and conventions listed previously. However, adding data on turtle movements to a marine spatial plan would help identify where better protection from the impact of human activities is required. A Marine Act would also address activities associated with inshore fisheries, such as certain types of fishing gear, and it would establish an obligation for action to address any such problems.





STATUS

Worldwide – **Severe decline.** The population demonstrates a high and rapid decline in numbers (refers to the Pacific population).

North Atlantic – **Decline.** The population has suffered a "minor" but "noticeable" reduction in numbers or distribution, or evidence suggests that there is a high probability of significant decline due to reduced recruitment and/or reproductive individuals, or continued unsustainable extraction.

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Author

Judith Oakley

full explanation at end

The Atlantic salmon is a migratory fish that spends its reproductive and nursery phases in freshwater and the majority of its adult life at sea. It migrates over extremely long distances, and is often found in the ocean beyond the Arctic Circle. The Atlantic salmon's life history makes it vulnerable to a wide range of pressures during its various life stages in both freshwater and the sea.
In Britain and Ireland, threats to the species include the effects of climate change, pollution, fishing and salmon farming. For its effective protection, action is required in both the freshwater and marine environments.

ATLANTIC SALMON

(Salmo salar)

NATURAL HISTORY

The Atlantic salmon *Salmo salar* is found throughout Britain and Ireland. It is distributed as far south as northern Portugal and north to the Barents Sea, Iceland and Norway, but also to North America and Canada[1]. It can live for up to 13 years[2] but four or five years is the normal age in Britain and Ireland. At the same age, females are smaller than males and grow to a maximum size of around 120cm, while males may reach a maximum size of 150cm[2].

The Atlantic salmon spends most of its adult life at sea[3]. In Britain and Ireland, it spends the first 1-6 years of its life in freshwater[2] before smolting (undergoing morphological and physiological adaptations to life in salt-water) and moving down river to the ocean. On leaving their freshwater environment, young salmon are subject to a number of new, natural and anthropogenic pressures and as a result suffer high levels of mortality in the early stages of their lives at sea.

The marine phase of the Atlantic salmon's life is spent feeding primarily on marine fish, squid and crustaceans. During this maturation period the fish grow rapidly. This life phase never takes less than a year[4] and can take up to four[2]. Several North Atlantic feeding areas attract fish from a number of different stocks. Following a tagging session in a known feeding area in the North Atlantic just north of the Faeroe Islands[5], individuals were recaptured from rivers in nine countries. Four of these recaptures were from North America, indicating a rapid transatlantic migration. Individuals from Scotland were recaptured over a very wide area, suggesting that fish from a number of discrete populations came together to feed. Fishing vessels have historically targeted feeding areas like this, and fishing in these mixed-stock fisheries can have serious impacts on a number of breeding populations worldwide.

Following maturation, the Atlantic salmon will almost always return to the river where it hatched; females are more faithful to natal sites than males. Spawning takes place during autumn and early winter in gravel beds, often in the upper reaches of suitable rivers.

Following spawning, and depending on conditions, most Atlantic salmon die. A very few survivors, mainly female, may return to the ocean to recover for a period of five to 18 months[4]. On very short coastal rivers, salmon that successfully recover might return again for a second spawning[4]. However, in the vast majority of cases, fish suffer debilitation and disease as a result of the energy lost and physical damage incurred during the reproductive process, and die.

Each river can have many populations of salmon within it[6]. These distinct populations often adapt to local environmental conditions. For example, in some rivers fish may have large fins to move against particularly fast-flowing water and in acidic rivers, fertilised eggs may have a high tolerance to low pH levels[6]. Unfortunately, this means that prolonged genetic contamination of these populations by accidental or deliberate introduction of non-native fish can reduce survivability, by weakening these adaptations.

The flesh of the salmon has extremely high food value, so the species is targeted by commercial fisheries throughout the world. The value of live fish to the recreational fishing industry is also extremely high. The Atlantic salmon is also captive-reared in pens worldwide, often causing severe impacts on the surrounding environment. In the UK, this aquaculture is largely restricted to Scottish sea lochs and river mouths, where conditions are favourable for fish farming.

EXISTING PROTECTION AND MANAGEMENT

- As part of the EU Habitats Directive, a number of salmon rivers across the UK have been proposed as Special Areas of Conservation, affording the Atlantic salmon and its freshwater habitat protection. This includes the River Foyle, which crosses the border between the Republic of Ireland and Northern Ireland, the River Tweed and the River Spey in Scotland. However, the Directive does not enable protection at the marine stage of this species' life cycle.
- Several measures are currently in place in Britain and Ireland to regulate the impact of freshwater angling and are enforced by the relevant environmental authorities. These include restrictive licensing schemes, catch and release schemes and strategically timed closed seasons.
- The Environment Agency in England and Wales has been phasing out mixed-stock fisheries salmon drift nets since 1992. This has included the partial buy-out of the north-east England drift net fishery. In 2003, as a result of this scheme, 16 licensed drift nets were fished, compared with 69 in 2002[7]. Buy-out schemes for salmon net fisheries are also well under way in Scotland and Northern Ireland.
- In Scotland, the Salmon Act (1986) and the Salmon Conservation Act (Scotland) (2001) aid the conservation of salmon in Scottish waters. In October 2002 regulations came in to force, prohibiting the sale of rod-caught salmon.
- The North Atlantic Salmon Conservation Organization (NASCO) was established under the Convention for the Conservation of Salmon in the North Atlantic Ocean in 1983. It is an international organisation responsible for the conservation of salmon stocks worldwide and is primarily involved in the acquisition, interpretation and dissemination of scientific information pertaining to North Atlantic salmon stocks.
- The North Atlantic Salmon Fund (NASF) is a private funding base that has so far been used to buy out salmon fisheries in Iceland and Greenland. In 2002, a voluntary agreement was reached between Greenland fishermen and NASF which suspended all commercial salmon fishing and allows only an annual subsistence take that will be strictly limited.

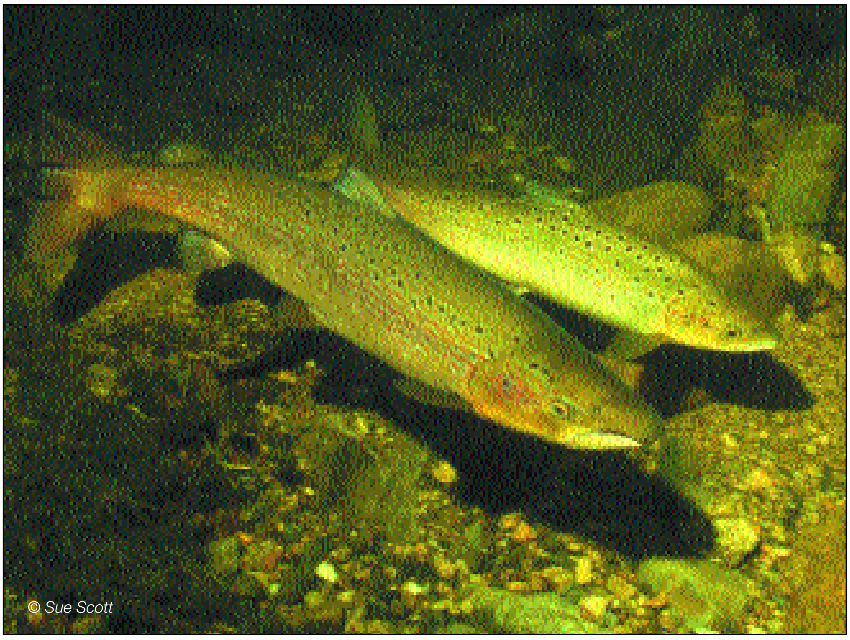


Plate1. A male (front) and female (behind) Atlantic salmon Salmo salar *from the river Avon in Scotland.*

STATUS
(DEGREE OF DECLINE)

Throughout its range, around 90 per cent of the known healthy Atlantic salmon populations exist in only four countries – Iceland, Ireland, Norway and Scotland[8]. In the remainder of the range, 85 per cent of the wild Atlantic salmon populations are considered to be vulnerable, endangered or critical[8]. Catches of salmon in the North Atlantic dropped by more than 80 per cent between 1970 and the end of the 20th century[8].

Throughout Britain and Ireland, the condition of salmon stocks and salmon-bearing rivers is varied. In the past few years there has been a steady decline in salmon numbers in British waters[3]. In Britain, the largest number of "historically salmon-bearing rivers" is found in Scotland (See figure 1) and of these, 63 per cent are considered healthy. However, there is evidence of a decline in salmon numbers, even here[8]. Catch data indicates a decline in salmon catches, particularly by net and coble (netting from boats) fisheries in Scotland between 1950 and 2001[9]. However, some of this may be attributable to fisheries' buy-out schemes which have resulted in far lower fishing effort. Similar patterns of decline are also apparent in fisheries in England and Wales[7], where a phase-out scheme has been in place since 1992 for drift net fisheries. However, calculated stock levels have also apparently declined during this time[7].

COUNTRY	Total number of historically salmon-bearing rivers
England and Wales	76
Scotland	350
Northern Ireland	44
Republic of Ireland	339

Figure 1. Number of historically salmon-bearing rivers in Britain and Ireland[8]

CHANGE IN STATUS SINCE 2000

Recent water quality improvements and reintroduction efforts in the UK have allowed rivers such as the Clyde, Lagan, Taff and Tyne, among others, to become naturally repopulated by salmon.

ISSUES/THREATS

Salmon farming

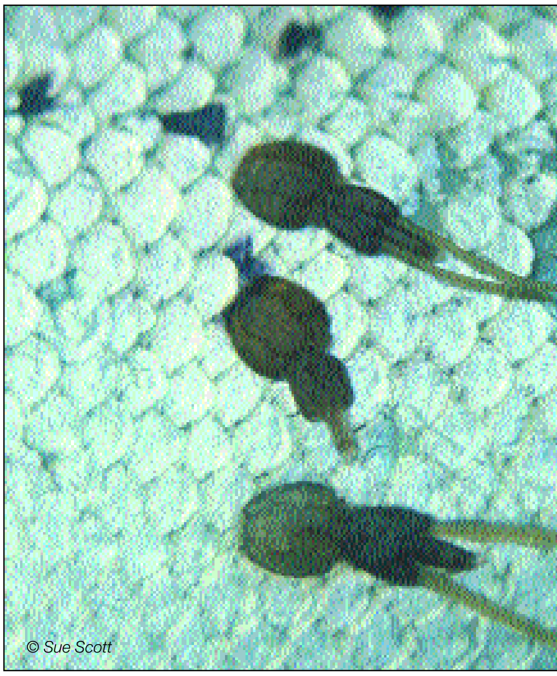
Plate 2. Farmed Atlantic salmon held in a Scottish loch.

Farming of the Atlantic salmon is a contentious issue and has received worldwide attention. On a global scale, production and sale of salmon from aquaculture is a huge industry and now dwarfs salmon fisheries. The production of farmed salmon in the North Atlantic is 600,000 tonnes annually – which is 300 times greater than the annual catch of wild salmon[8]. At first, farming salmon to relieve the pressure of harvesting wild stocks may seem like an environmentally friendly option – but it can have severe impacts on the wider environment, in particular on wild salmon populations.

In the UK, salmon farming is limited to Scottish sea lochs and estuaries, where the deep, clean, sheltered water provides ideal conditions for this aquaculture. There are a number of ways that salmon farms can impact upon local wild salmon populations.

In salmon pens, fish are kept in high concentrations, creating ideal conditions for the spread and development of parasites such as the salmon lice *Lepeophtheirus salmonis*. In high numbers, these parasites can be fatal to young and old wild and farmed fish and can also help spread infections between fish[8]. Other diseases such as bacterial infections can also be spread from captive to wild stocks. Where fish are transported from other localities prior to rearing, they can carry infections/parasites, not endemic to their new home – for example the deadly parasite *Gyrodactylus salaris* from the Baltic. It is likely that where salmon pens occur on wild salmon migratory routes, particularly estuaries, parasites and diseases may pass from captive to wild fish. A relative of the Atlantic salmon, the sea trout *Salmo trutta,* is particularly vulnerable to sea lice infestations in the early marine stages of its life cycle. Escapees carrying infections and parasites can also potentially infect wild stocks. Where local wild populations have low natural immunity to an artificially introduced disease, this can be particularly dangerous.

The escape of farmed salmon, including genetically modified salmon, into wild populations can have further damaging effects. If farmed salmon interbreed with wild populations, this can result in the transfer of non-adaptive traits, reducing survivability and recruitment levels[6]. Although cultured salmon generally have less reproductive success than wild individuals[10], in large numbers escaped specimens can compete with wild ones for breeding space and partners[8]. Studies have shown that in the wild, the offspring of cultured salmon also have lower survival rates[10].

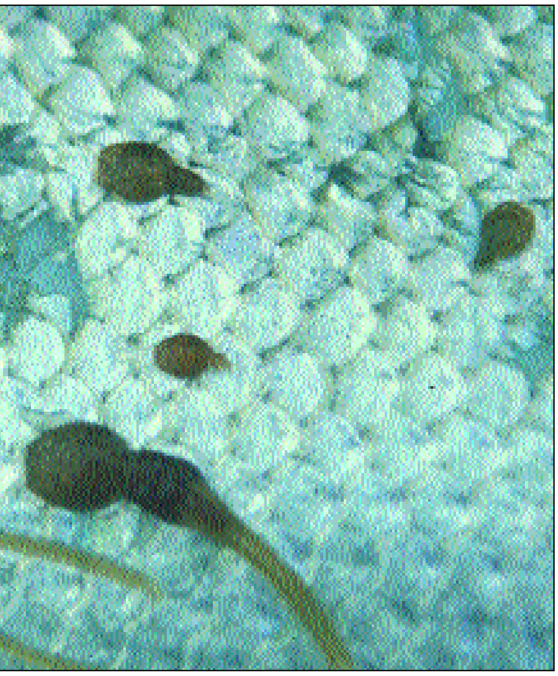


Fishing in estuaries, coastal waters and at sea

In 2001, Irish commercial salmon fisheries caught 720 tonnes of salmon, which included tagged salmon from UK waters[11]. Since 2001 catch limits have been introduced, along with a carcass tagging scheme to reduce sales of illegally caught salmon.

Various methods are deployed to catch fish in estuaries and the sea, including static and drift nets, large-scale salmon traps and long-lines. Migrating fish can be caught in large numbers in estuaries as they pass through on their way upstream, with severe impacts on local populations. Over the past decade, buy-out schemes have reduced the impact of coastal salmon fisheries around the UK.

The issue of salmon caught as bycatch in coastal and marine fisheries throughout their range requires thorough investigation.



Marine pollution

In the open ocean, salmon are predatory and as a result can potentially accumulate large amounts of persistent chemicals over time from their prey. The accumulation of these contaminants can have negative effects on the health and reproductive capabilities of the fish.

Climate change

The effects of climate change may have significant effects on wild salmon populations. Studies have shown that sea surface temperatures in the North Sea can be directly correlated with post-smolt survival and growth of Atlantic salmon. This may be due to direct physiological effects or indirect changes to ecosystem productivity and food availability[12]. Particularly warm summers may also inhibit spawning migrations of adult salmon into freshwater by causing unfavourable river conditions for the survival of adult and juvenile fish[13]. Mixed stock groupings in North Atlantic feeding areas such as those off the Faeroe Isles and Greenland, are particularly vulnerable to changes in salinity, water temperature, biological production and ocean currents arising from climate change.

Plate 3. Sea lice on a farmed salmon. Salmon pens can act as a source of lice that then infect wild salmon.

Threats in freshwater

The Atlantic salmon in freshwater is vulnerable to a number of threats.

In 2003, anglers in England and Wales caught 46.7 tonnes of salmon, but 27 tonnes of these were released alive[7]. In Scottish salmon fisheries, the proportion of salmon released following capture has increased steadily since the early 1990s and in 2003 almost 60 per cent of rod-caught salmon were returned alive[9]. There is evidence that salmon have a high chance of survival following catch and release[14, 15] and can go on to spawn successfully[14]. However, studies have shown that if further stress is inflicted on the fish after it is released – for example by high water temperatures – it has an increased chance of delayed post-angling mortality[15]. This indicates that not all returned fish will survive and the rate of survival is dependent on environmental conditions.

The Atlantic salmon requires high water quality and very specific sediment characteristics to reproduce successfully. Any human activity which pollutes or obstructs salmon migration routes can have deleterious effects on the reproductive success of salmon, and in extreme cases has led to its extinction from some UK rivers[3]. Chemicals used as herbicides and pesticides can be particularly harmful[8]. Synthetic pyrethroids-based sheep dips are extremely toxic, and inadequate disposal can lead to the contamination of upland streams, wiping out invertebrates over

© Keith Hiscock

Plate 4. Small-scale netting for salmon in the River Dart in the south-west of England.

several kilometres[16]. This results in there being little or no food available for young salmon during their development[16]. Contamination of rivers and estuaries by organic pollutants, manure, slurry and sewage can lead to eutrophication, anoxic water conditions and ultimately high levels of fish mortality. Poor soil management by farmers can lead to redds (nests) being blocked and the encouragement of water plants which slow the river flows and alter the river environment adversely.

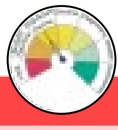
The development of lock gates, hydroelectric dams, weirs and other watercourse obstructions can create significant obstacles to salmon migration up and downstream. The construction of effective fish passes can help alleviate such problems. River obstructions can also alter river flow and encourage increased sedimentation above the obstruction, causing a loss of spawning habitat for wild salmon. The reduction of water levels through arterial drainage and the loss of suitable habitat caused by canalisation and the extraction of gravel from riverbeds represent further threats. The EU Water Framework Directive should enable much restoration and conservation work to be targeted at issues occurring in the freshwater and coastal environment.

SPECIES UNDER SIMILAR THREAT

Sea trout *Salmo trutta*, Common eel *Anguilla anguilla*, Allis shad *Alosa alosa* and Twaite shad *Alosa fallax*.

HOW A MARINE ACT CAN HELP

An integrated approach to developing marine spatial plans can aid the siting of fish farms in a way that minimises adverse impacts on wild fish. Biodiversity Stop Orders may help prevent the operation of fish farms where there is an unacceptable adverse effect on salmon populations. Links between marine spatial plans and implementation of the Water Framework Directive in catchments will address problems of pollutants from land-based sources.



STATUS

Significant decline.

The population has undergone a considerable decline in numbers, range and distribution beyond that expected from natural variability.

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Author

Jack Sewell

North Sea

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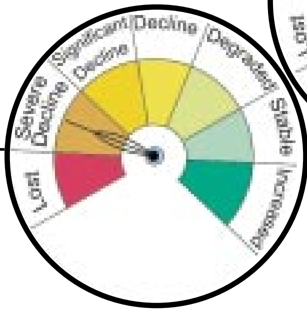

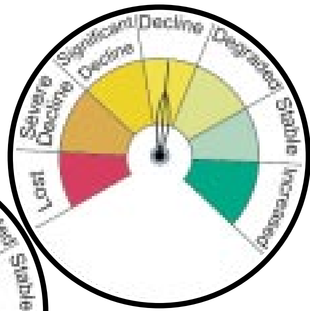

Other UK seas

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ATLANTIC COD

(Gadus morhua)

The cod is an iconic species for the British. It traditionally provides the fish in "fish and chips" and has been a mainstay for the fishing industry. In the 19th century, biologist Thomas Huxley wrote, "I believe that the cod fishery...and probably all the great sea fisheries are inexhaustible". But now that commercial fisheries have devastated many of the world's most important fish stocks, there is no question that Huxley, like many others, was wrong.

NATURAL HISTORY

The Atlantic cod *Gadus morhua* favours cool, temperate waters and is found throughout the North Atlantic, all around the UK coast as far south as the Bay of Biscay and north to the Barents Sea. Cod are found from the shoreline to depths of 600m or more[1].

Cod mature between 1 and 15 years of age[2], although in heavily fished areas the age may be reduced, perhaps as an adaptation to fishing[3]. In the North Sea, all cod are mature by six years[4]. Spawning takes place in locations across the European continental shelf between February and April. Between 2.5 and 9 million tiny (1.25-1.45mm diameter), buoyant, spherical eggs are laid[2] and often transported many miles in ocean currents in the 12 days before hatching. The larvae are also planktonic and are transported by currents for around two months. Then they move to the seabed, where they spend most of their life[5]. The cod feeds on invertebrates but becomes increasingly dependant on fish as it becomes larger, feeding on a variety of species including other cod[5]. The Atlantic cod can grow up to190cm in length, but is most common from 50 to 80cm[1].

Highly valued as a food resource, the Atlantic cod has been fished extensively throughout UK waters. The species is often present in large, compact shoals during daylight hours and during migrations[5], making it easy for fishermen to catch large numbers when shoals are located. Fishing is thought to be the most significant threat to the species and has caused a severe decline in numbers over the past century.

Plate 1. The Atlantic cod Gadus morhua.

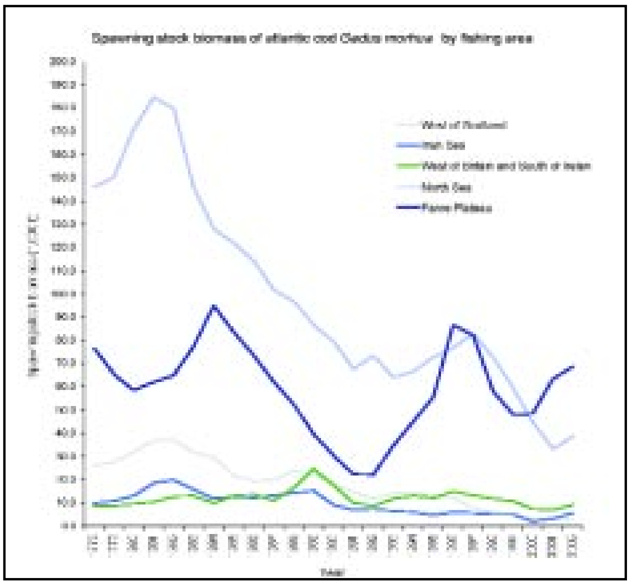


Figure 1. Spawning stock biomass of the Atlantic cod, by region, between 1978 and 2002. Based on available UK fisheries data [7].

EXISTING PROTECTION AND MANAGEMENT

- Due to the depleted nature of cod stocks in European waters, they are now subject to a recovery plan under EU law. This involves a number of technical measures including minimum mesh size and compulsory square mesh panels in trawls. A closed season in the North Sea, two small closed areas to the west of Scotland and greatly reduced Total Allowable Catches in all major cod fisheries round Britain and Ireland have also been implemented and are enforced by governments.
- The minimum mesh size for trawls primarily targeting cod, haddock and whiting in the North Sea and west Scotland was increased to 120mm in 2003.
- Listed as Vulnerable in the IUCN Red List of Threatened Species [6].
- The cod is included in the grouped species Biodiversity Action Plan for commercial marine fish.

STATUS (DEGREE OF DECLINE)

Cod stocks around the British Isles have declined drastically over the past century. North Sea populations, and stocks to the west of Britain and south of Ireland, are also outside safe biological limits[4] and Irish Sea stocks are "seriously depleted", while west Scotland stocks are "seriously overfished"[7]. Since the 1980s, spawning stock biomass has rapidly decreased in the North Sea (see Figure 1) and decreased in the west of Scotland. Stocks in the Irish Sea, and west of Britain and south of Ireland, have remained relatively stable but low in comparison.

CHANGE IN STATUS SINCE 2000

Spawning stock biomass in all fishery areas around Britain and Ireland, with the exception of the West Scotland fishery, has risen slightly since 2000-01. This may be related to a drop in fishing mortality during this period[7]. However, the 2002 year class in the North Sea is estimated to be one of the poorest on record[4].

The amount of cod landed by UK vessels into the UK decreased from 32,000 tonnes in 2000 to 13,000 tonnes in 2003[7], while the amount of cod imported from overseas increased from 122,000 tonnes in 2000 to 132,000 tonnes in 2003[7].

In 2002, the International Council for the Exploration of the Sea (ICES) recommended that a zero catch should be enforced in the North Sea in 2003, 2004 and 2005. This advice was based on the high catch rate, low recruitment rate and the fact that numbers of North Sea cod are still outside safe biological limits. However, this advice was not followed in 2002 nor in 2003, when an international Total Allowable Catch for cod in the North Sea was set at 27,300 tonnes[4].

© Laurence Dutton

Plate 2. A more usual view of cod.

ISSUES/THREATS

Fishing

Fishing has been identified as the greatest cause of population decline of the Atlantic cod[8]. There is an extremely high consumer demand for cod in Britain due to its high-quality flesh. Historically, this demand has led to intensive targeted fisheries, particularly in the North Sea and Arctic areas where the species was once abundant. In recent times, the technology used to find and catch cod has become more effective, despite populations plummeting.

Larger individuals produce the most offspring, but are the most vulnerable to capture by trawls. The current minimum landing size for cod in the UK is 35cm – but they are usually longer than 50cm before they spawn[4].

In the early 1990s, cod fisheries in Canada collapsed primarily as a result of overfishing, and a moratorium was declared to aid the recovery of stocks[9], [10]. They have still not recovered in all the areas that were closed. Lack of recovery was exacerbated by the reopening of the fisheries in the late 1990s, which led to further decline[10]. Despite new moratoriums being declared in 2003, stock increases in the depleted fisheries over the next five years are unlikely[10]. Those fisheries which did recover were less depleted to begin with, and numbers recovered more quickly[10]. Lessons should be learned from these experiences: in European waters, action should be based on a precautionary approach and fishery managers should not wait until serious stock depletion before closing a fishery, because late closures are likely to be ineffective[10].

Young and adult cod are often caught as part of mixed fisheries and as bycatch when targeting haddock, whiting and Norwegian lobsters. This is a problem likely to reduce stock recovery unless efforts are made to restrict these activities.

Pollution

There is evidence to suggest that the eggs of the Atlantic cod are adversely affected by heavy metal pollution. For example, development of embryos is delayed when eggs are exposed to sub-lethal doses of copper[11]. These metals may be present in discharges from industry or household waste.

Chlorinated hydrocarbons can build up and become concentrated in the bodies of female cod. These contaminants can then be passed into developing eggs, greatly reducing their ability to hatch or develop[11]. Egg development is also likely to be impaired by petroleum hydrocarbons. These types of pollutants originate from agriculture and industry and can be deposited in the sea from the air or via freshwater input.

Loss of nursery grounds

Eelgrass *Zostera marina* beds can be important nursery grounds for young cod[12]. Any damage caused to these habitats by coastal development or pollution could be detrimental to cod populations. It is also likely that young cod utilise other structurally complex habitats such as horse mussel beds and maerl beds for feeding and refuge. Any human impacts which destroy these habitats may also indirectly affect cod populations.

Climate change

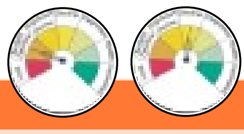
The Atlantic cod is sensitive to temperature variation, and studies suggest that the ability of stocks to adapt to temperature change is limited[13]. Further warming of the seas may force southern cod stocks northwards, squeezing the range of northern populations resulting in an overall reduced population size[13]. Changes in planktonic activity as a result of climate change may also impact cod populations, because the availability of food for larval cod at the time of hatching is affected.

SPECIES UNDER SIMILAR THREAT

Haddock *Melanogrammus aeglefinus*, hake *Merluccius merluccius*, ling *Molva molva*, plaice *Pleuronectes platessa* and saithe *Pollachius virens*.

HOW A MARINE ACT CAN HELP

Effective delivery of marine spatial planning could be used to identify and protect nursery and spawning areas from fishing and other human activities, where stocks occur within UK jurisdiction. For example, the fishing industry should be considered as an equal stakeholder with other marine industries, engage in the development of marine spatial plans, and be equally responsible for sustainable use of marine resources. The process of developing marine spatial plans would include the designation of areas protected for the recovery of fish and shellfish.



STATUS

North Sea – **Severe decline.** The population demonstrates a high and rapid decline in numbers.

Other UK Seas – **Decline.** The population has suffered a “minor” but “noticeable” reduction in numbers or distribution, or evidence suggests a high probability of significant decline (above) due to reduced recruitment and/or reproductive individuals, or continued unsustainable extraction.

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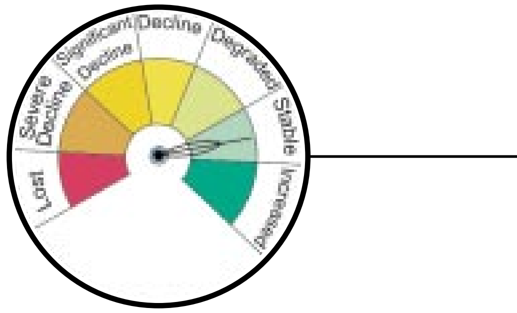

full explanation at end

Seahorses are under threat worldwide through collection for use in medicines and for the aquarium trade. In the UK they are rarely seen and, when found, are greatly valued as curiosities. Seahorses are known to breed in the UK and may become more common as seawater temperature rises. They need to be protected through legislation.

LONG SNOUTED (MANED) SEAHORSE

(Hippocampus guttulatus)

NATURAL HISTORY

Two species of seahorse have been recorded around the coasts of the UK – the short-snouted seahorse *Hippocampus hippocampus* and the long-snouted (maned) seahorse *Hippocampus guttulatus*. The long-snouted seahorse can be up to 18cm in height. It appears quite bony with obvious ridges and a distinctive head and neck "mane" of thick filaments[1]. Like all seahorses, it is the male which becomes pregnant and broods the young in a pouch. Males and females form a monogamous pair bond which is reinforced by a daily greeting ritual during the breeding season.

Plate 1. Pregnant male Hippocampus guttulatus discovered in August 2004 in Dorset.

The long-snouted seahorse is usually shades of brown to olive-green in colour but it can also change colour to aid camouflage. It has prominent white spots on the body, often with a dark ring around them[2]. Captive records show it to be quite long-lived, with some animals surviving between five and seven years[1].

Hippocampus guttulatus is primarily a species of European seas and occurs in shallow, muddy water among seagrass beds, in estuaries and rocky areas[3]. In the UK, it has been recorded from the easternmost point of Kent, along the south coast to Land's End, up the west coast of England, Wales and Scotland as far as the Shetland Isles and all around Ireland. This is probably the most northern and western points of its range[1].

Although the seahorse's preferred habitat is predominantly seagrass beds, it occurs in them only during the spring, summer and early autumn. In the winter it is known to migrate to deeper waters. Seahorses are often brought up in crab and lobster pots, and it is thought that they are attracted by small crustaceans that feed on the bait in the pots[1]. Seahorses are ambush predators, feeding by drawing live prey into the long snout with a rapid intake of water. The long-snouted seahorse has been observed feeding from the sediment, suspending it in the water column by jetting water into the substratum[4].

EXISTING PROTECTION AND MANAGEMENT

- In the UK, there is no specific protection given to seahorses. However, their main habitats, seagrass beds, are protected by legislation underpinning the EU Habitats Directive and they are included in a UK Biodiversity Action Plan[5].
- After much lobbying by the conservation organisation Project Seahorse, seahorses throughout the world are now protected from international trade. At the Convention on International Trade in Endangered Species (CITES) conference in 2002, a US-led proposal to have all 33 species of seahorse listed on Appendix II was successful. This regulates international trade in species threatened with extinction without trade regulation. The ruling came into effect on 15 May 2004, and makes seahorses one of the first commercially valuable marine species to be protected and managed by the world's largest wildlife treaty. The CITES listing means that more than 160 countries must now ensure that commercial trade of seahorses is not detrimental to wild populations[6], [7].

Hippocampus guttulatus and *Hippocampus hippocampus* both have small home ranges. This may have enabled them to adopt camouflage appropriate for their environment, and to maintain a stable social structure[4]

- As a result of lobbying by the British Seahorse Survey, the two native UK species have been submitted for inclusion in the Wildlife and Countryside Act 1981. The short and long-snouted seahorses have been proposed for addition to Schedule 5 of the Act to give them full protection. The principal reasons are to prevent commercial collecting of the species, and their vulnerability to habitat disturbance[8].

STATUS (DEGREE OF DECLINE)

The status of seahorses in the UK is not fully understood but they are thought to be uncommon. They are very secretive and this is aided by their camouflage ability of growing weed-like appendages on their bodies[1]. Sightings are infrequent and usually of solitary specimens.

As a result of surveys run by the Seahorse Trust since 1994, seahorses have been found to be widespread residents, occurring all year round. The lifespan, natural mortality rates, predation and disease factors are virtually unknown for most seahorse species[4].

There was a remarkable "catch" of seahorses in September 1998 when a fisherman netted around 120 short-snouted specimens (*Hippocampus hippocampus*) in five days in the North Sea close to the Belgian coast. They were caught in bottom set gill nets and were associated with colonies of the bryozoan *Alcyonidium condylocinereum*[9].

Some exciting discoveries were made in 2004 in UK waters. In June, a long-snouted seahorse was found in the Thames Estuary by a fisherman trawling in shallow water off Leigh-on-Sea, Essex[10] (seahorses have not been recorded from the Thames since 1976). A short-snouted seahorse was found by divers in Plymouth Sound in July. Then, a month later, a pregnant male long-snouted seahorse was photographed for the first time off the south-west coast of Britain near the Isle of Purbeck in Dorset. This confirms that the species is breeding in our waters[11].

Seahorses may be more abundant in British waters than thought. In August 1999, a seagull regurgitated about 10 small seahorses onto a boat moored near Brixham in south Devon[12]. It is assumed that the seahorses were caught locally.

Fig. 1. Recorded and expected distribution of Hippocampus guttulatus. *Source: MarLIN*

CHANGE IN STATUS SINCE 2000

Seahorses were not included in the 2000 *Marine Health Check*. Effective from May 2004, the entire genus *Hippocampus* was listed in Appendix II of CITES. The long-snouted seahorse is listed as "data deficient" by IUCN[3] but is listed in the Red Data Books of France and Portugal.

There is no published data regarding population trends or total numbers of adults for the long-snouted seahorse. There is also little information regarding its distribution, ecology or biology. Further research on this species' biology, ecology, habitat, abundance and distribution is needed.

ISSUES/THREATS

Seahorses worldwide are threatened by many activities. The long-snouted seahorse may be particularly susceptible to a decline in the extent of seagrass[3]. Other threats include:

Trawling and dredging

These activities destroy the habitats as well as the seahorses themselves as they become bycatch, particularly in the prawn-trawling industry. Scallop dredging and boat moorings are a further threat to the seahorse and its habitat in the UK.

Traditional medicine

A major threat is from the traditional Asian medicine trade which takes more than 30 million seahorses a year from the wild[6,13].

Curio trade

The curio trade is also responsible for killing thousands, which are sold as dried souvenirs.

Marine aquarium trade

Up to a million seahorses a year are taken live from the wild. Most of these die in transit or survive only for a short time because they are difficult to feed in captivity.

Habitat disturbance

Eelgrass beds are under threat from habitat disturbance due to building of marinas, smothering from silt, damage from storms, trampling, nutrient enrichment and marine pollution.

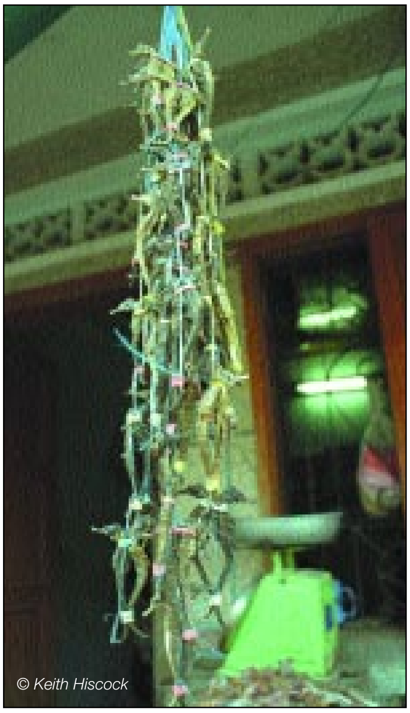

Plate 2. Worldwide, seahorses are threatened by collection for medicinal purposes. These are in a Vietnamese market.

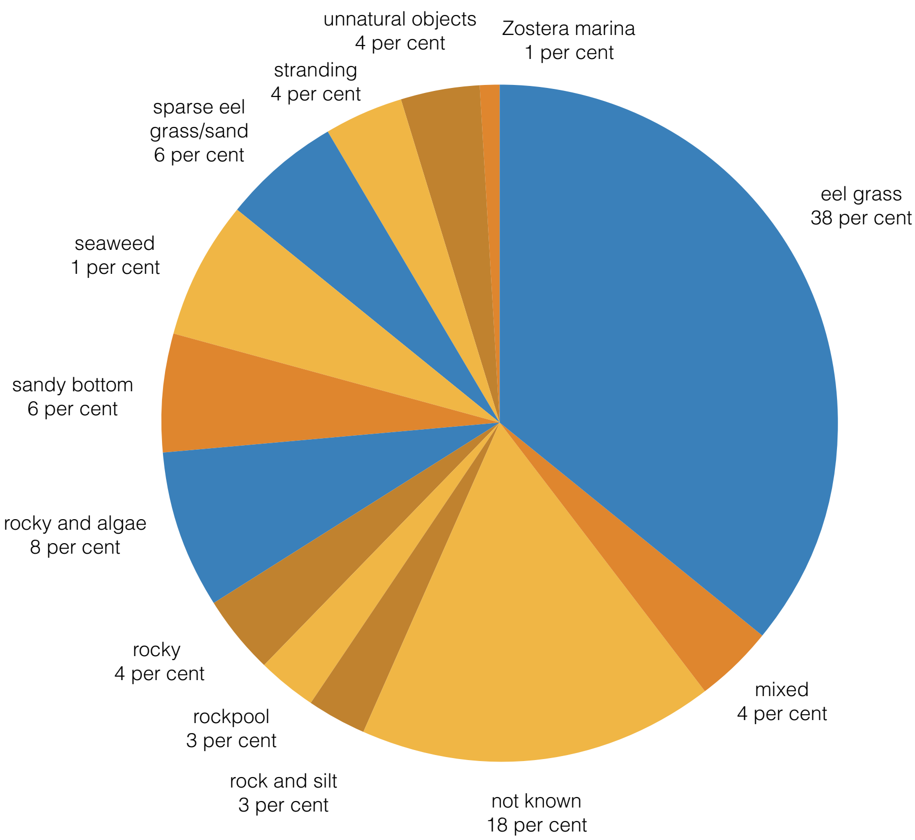

Fig. 2. Habitats where Hippocampus guttulatus *has been recorded in the UK (1821-2004 sightings records). Source: The Seahorse Trust*

SPECIES UNDER SIMILAR THREAT

The short-snouted seahorse *Hippocampus hippocampus*.

HOW A MARINE ACT CAN HELP

Sea horses should be considered a Nationally Important Feature under a Marine Act. Full protection is being sought for the species under the Wildlife and Countryside Act 1981. A Marine Act would reinforce the importance of gathering scientific information to inform protection measures. Habitats important to the survival of the seahorse should be designated Nationally Important Marine Sites.

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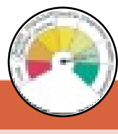
Author

Judith Oakley



STATUS

Stable. No change in status (distribution, range, abundance or numbers) reported or expected in the UK.

full explanation at end

The basking shark *Cetorhinus maximus* is the largest fish in British waters and the second largest in the world. Its late age of maturity, low reproductive rates and potential low population growth makes it particularly vulnerable to fishing, both accidental (bycatch, for example) and deliberate. Protected by the Wildlife and Countryside Act 1981, it is also a priority species under the UK Biodiversity Action Plan.

BASKING SHARK

(Cetorhinus maximus)

NATURAL HISTORY

Sharks and rays belong to the fish subclass Elasmobranchii. The basking shark can grow to more than 10m in length and seven tonnes in weight. It feeds exclusively on zooplankton by swimming with the mouth wide open, filtering water through its gill rakers[1].

It is thought that basking sharks take 12-20 years to reach maturity, have long gestation periods (1-3 years) and produce large pups in small numbers[1]. In UK waters they can be seen feeding on plankton near the surface, especially between April and September. Findings from a shark tagging project in 2001 and 2002[2] revealed that individuals tagged in the summer remain on the European continental shelf through the winter. They do not appear to make trans-oceanic migrations and do not hibernate on the seabed during winter, as once thought. Basking sharks undertake extensive horizontal (up to 3,400km) and vertical (deeper than 750m) movements to utilise productive continental shelf and shelf-edge habitats during summer, autumn and winter. They travel long distances (390 to 460 km) to locate temporarily discrete productivity "hotspots" at shelf-break fronts. Tagged sharks moved extensively within continental shelf waters and there do not appear to be separate sub-populations off Scotland and south-west England[2].Courtship behaviour has been observed between May and July along oceanographic fronts, probably as a consequence of individuals aggregating to forage in prey-rich patches before initiating courtship. Mating has not been observed and may occur at depth[3].

"Hotspots" for basking shark sightings in the English Channel include the waters around Land's End, the Lizard peninsula and off Plymouth. Sharks are also seen off north Cornwall and at Lundy. In the Irish Sea, basking sharks are seen sporadically off the west coast of the Isle of Man and at Strangford Lough in Northern Ireland. In Scotland, Arran in the Firth of Clyde and an area north of the Hebrides are also important[4].

EXISTING PROTECTION AND MANAGEMENT

- Basking sharks have been protected in British waters since April 1998, under Schedule 5 of the Wildlife and Countryside Act 1981 (in England, Wales and Scotland)[5].
- Since 2003, basking sharks have been listed on Appendix II of the Convention on International Trade in Endangered Species (CITES)[6]. This listing permits closely regulated global trade, to help ensure that depleted stocks can recover. Countries trading in shark fins and livers have to keep up to date records to determine whether the trade is sustainable.
- There is a zero Total Allowable Catch under the Common Fisheries Policy in EU waters.
- The Countryside and Rights of Way Act 2000 makes it an offence recklessly or intentionally to disturb or harass a basking shark. (in England and Wales)[7].

Plate 1. Basking shark feeding off the UK coast.

Plate 2. Basking shark "basking" at the surface.

Figure 1. Basking shark recorded distribution in inshore areas around the British Isles. Source: MarLIN

- The basking shark was listed as Vulnerable in the 2000 IUCN Red List of Threatened Species[8]. This listing reflected a lack of scientific knowledge and concern over depleted populations, as a result of over-exploitation by fisheries.
- Under the UK Biodiversity Action Plan[9], a published Priority Species Action Plan for the basking shark recognises the need for improved long-term monitoring of the UK population. This will enable population trends to be identified.
- Interest in basking shark conservation goes back many years; indeed, the Marine Conservation Society launched its basking shark project in 1987[10]. In addition, the Conserving Endangered Basking Sharks project (CEBS) is coordinated by the Marine Biological Association of the UK. Its aim is to bring together organisations with complementary datasets to help enable basking shark populations to be more accurately estimated and their critical habitat defined.

STATUS
(DEGREE OF DECLINE)

Although some monitoring of basking shark populations is being carried out, information to date does not enable reliable population trends to be determined. There are still gaps in scientific knowledge regarding basking shark biology. Current conservation measures rely heavily on the precautionary principle[11]. Further research is required to investigate population structure, reproductive biology, annual migration, regional population declines and global trends.

However, surveys have helped establish population size and structure around the UK and increased awareness of these mammals in our waters.

In June 2004, 58 sightings of more than 136 sharks were reported to the Marine Conservation Society. Most were seen swimming off headlands. Dead, stranded animals comprised 8 per cent of the sightings[12]. The latest survey results from the Wildlife Trusts' Basking Shark Project (see box on page 34) emphasise the differences from year to year in sightings. This variability is linked to the abundance and distribution of the zooplankton species that form the diet of basking sharks[13].

CHANGE IN STATUS SINCE 2000

Numbers of basking sharks sighted at the surface in one location vary greatly from year to year and it is not possible to identify any overall trends of increase or decrease at present.

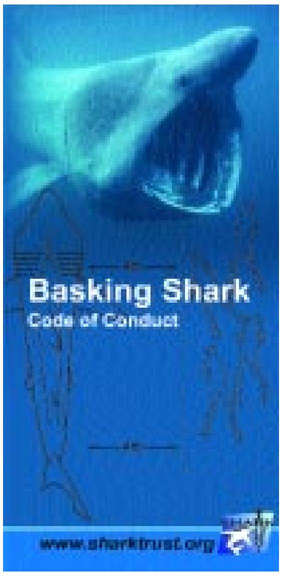


Plate 4. Leaflets such as this help create public awareness of protected species.

ISSUES/THREATS

Overfishing/over-exploitation

Basking sharks are vulnerable to the negative impacts of extraction, due to their slow growth rate, lengthy maturation time and long gestation period[1, 15].

Worldwide shark finning and shark liver oil industry

The gigantic dorsal fin is a highly valued delicacy in the Far East, and is used in shark-fin soup. The meat is consumed fresh or dried and salted[8]. The large liver is extracted for its high squalene oil content[8]. Squalene is an intermediate in the biosynthesis of cholesterol and is used in biochemical research.

Boat traffic

Boats, yachts and jet skis present a risk to basking sharks when they swim at or close to the sea surface. Each summer, there are reports of basking sharks with open wounds or badly scarred fins from collisions with marine craft.

Marine eco-tourism

Poor boat handling skills of some tour operators and harassment by chasing the animals or being too close to them may lead to injury or stress to the shark.

Bycatch

Basking sharks have been found entangled in bottom set gill nets and in pot lines.

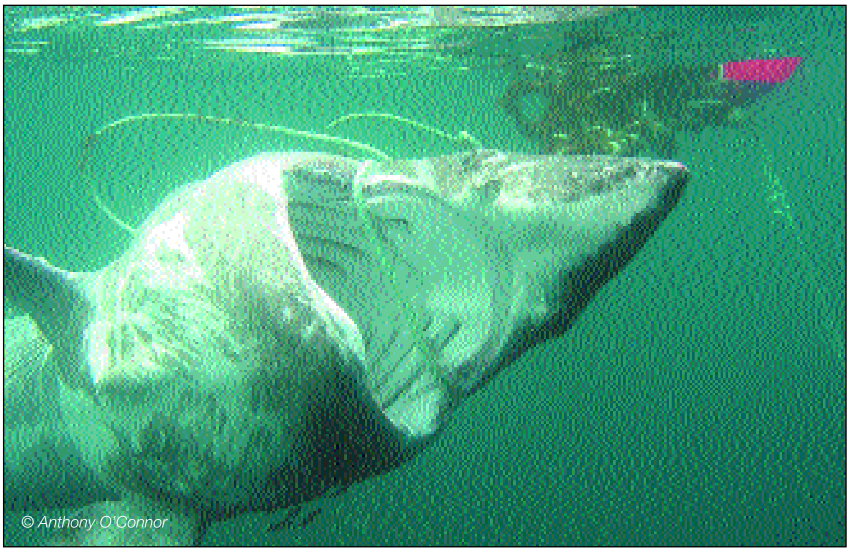


Plate 3. Basking shark entangled in ropes.

SPECIES UNDER SIMILAR THREAT

Harbour porpoise *Phocoena phocoena* and bottlenose dolphin *Tursiops truncatus*.

HOW A MARINE ACT CAN HELP

Basking sharks should be considered a Nationally Important Feature under a Marine Act. Protection is afforded under the Wildlife and Countryside Act 1981 and the various directives and conventions listed in this section, but enforcement is difficult if not impossible. However, adding data on basking shark movements, together with man's activities, to a marine spatial plan would help identify where better protection is required.

Plate 5. The Wildlife Trusts Basking Shark Survey Project began in July 2003 to evaluate existing threats, identify individuals and help establish population size and structure around the UK[14]. Survey vessel Forever Changes.

The Basking Shark Survey Project

"Our surveys are effort-corrected line transect surveys, undertaken from Devon and Cornwall through the Irish Sea to the Firth of Clyde and the Hebrides.

"In 2002 we only saw 29 sharks in total, of which 23 were in the south-west, five in Northern Ireland and one in Scotland. In 2003 we sighted 108 sharks, with 56 in Scotland, and 52 in the south-west. Unfortunately, 2004 has been very poor in the south-west, despite good weather early on, with only 14 sharks sighted, with the balance of 106 sharks in Scotland. Such year-to-year differences are not unknown, and there may be 'cycles' of 5-15 years.

"We feel that we can confidently identify a 'favoured site' status for several small areas such as the Lizard and Land's End peninsulas in the south-west and locations in western Scotland."

Colin Speedie,
Basking shark researcher,
MER Consultants Ltd

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Author
Judith Oakley

STATUS

Stable. No change in status (distribution, range, abundance or numbers) reported or expected.

full explanation at end

COMMON SKATE

(Dipturus batis)

The now ironically-named common skate *Dipturus batis* has suffered a great decline in abundance over past decades. This is largely due to targeted and non-targeted commercial fishing and angling. Poor recovery is a result of the species' slow growth rate and long reproductive development. Anglers are now helping to sustain populations of common skate by returning captured individuals to the sea and participating in recording programmes. The designation of refuge areas may help protect remaining populations. The common skate is still prone to capture as bycatch by trawlers and there is still a risk that without fast action and adequate protection, the species may face further decline.

NATURAL HISTORY

The common skate is the largest member of the skate and ray family found in European waters, and can reach 285cm in length[1].

The common skate is distributed between the Mediterranean and the North-east Atlantic as far north as Norway and Iceland[2]. It generally lives on soft and mixed sediment seabed and hunts for bottom-living invertebrates including worms, crabs and molluscs. It will also feed on a variety of fish species from the bottom and occasionally higher in the water column. Adults are usually found in depths between 100 and 600m, while juveniles are more commonly found in shallower waters.

Common skate live for up to 100 years. Males reach maturity at around 11 years, but little is known about how long females take to reach maturity. Females lay up to 40 large egg cases a year[1], giving them a very slow rate of potential recovery. The large size (up to 24cm long) at hatching and morphology (wings and thorns) of this species mean that all age classes are liable to be caught by trawls[3].

Conventional tagging studies based on capture and recapture data suggest that individuals may remain in a restricted geographical area for most of their lives[4], often in small numbers[5]. However, this data is limited and should be interpreted with caution. Until recently, records of the thornback ray *Raja clavata* in the Thames indicated that this, too, was an isolated population. However, more up to date surveys in the estuary using data recording tags showed that, although the animals aggregated in the Thames during spring and summer, they travelled considerable distances at other times[6]. Based on these findings, it is likely that although the common skate aggregates in some areas at specific times of the year, it is possible that individuals travel to other areas during their lifetime.

The species is very resilient to being returned alive when caught. Elasmobranchs have no swim bladder and are therefore not affected by changes in pressure associated with a rapid ascent to the surface from depth. They also have very tough skin without scales or slime, so are fairly protected from physical abrasion. During tag and release studies, individuals have been re-caught by anglers up to six times in one area [4].

EXISTING PROTECTION AND MANAGEMENT

There is little statutory protection for the common skate and most "measures" are recommendations and information-gathering.

- It is included in an emergency Total Allowable Catch for skates and rays (combined) in the North Sea, set in 1997 in response to a severe decline in this area.
- In 2002, the common skate was one of four species of skate officially recommended for statutory protection in an amendment to the Wildlife and Countryside Act 1981, due to its endangered status [9]. However, the review of this Act has not yet been concluded (2004) so the species still awaits protection.
- Currently listed as Endangered in the IUCN Red List of Threatened Species [7] (it has been identified as facing a very high risk of extinction in the wild in the near future).
- The UK Biodiversity Action Plan makes a number of recommendations for the species' future management [8].
- Glasgow Museum's tagging programme in association with local anglers has targeted a population in the Sound of Mull area since 1974 [4]. Not only has this generated a large amount of data and information about this population, but it has also promoted best practice and encouraged anglers to return tagged individuals unharmed to the sea.
- The Shark Trust has been funded by the Countryside Council for Wales (CCW) Species Challenge Fund to assess the possibility of reintroducing the species into Welsh coastal waters through a captive breeding programme [10]. However, fundamental gaps in knowledge of behavioural patterns, combined with a lack of protective status, make reintroduction inappropriate at present [11].
- The Welsh Skate and Ray Initiative has been facilitated by the Shark Trust, with funding from CCW, to gather information to inform the development of management and conservation programmes for skates and rays in Wales [10].
- The Shark Trust has also developed a code of conduct for common skate anglers [12].
- English Nature is setting up a project to locate populations of common skate around England, with a view to their future protection and management [11].

Plate 1. A 150lb (68kg) female common skate, caught by an angler. The fish was tagged and released after being measured and checked for signs of injury.

STATUS

(DEGREE OF DECLINE)

Long-term data sets[2, 13, 14] have shown that common skate have virtually disappeared from the North Sea. However, a few sporadic catches indicate that they may still be present in small numbers and confined to the northern extremes of the North Sea and the Shetland Isles[2]. Evidence also indicates a similar situation in the Irish Sea[13], where larger individuals (more than 80cm long) have become extremely scarce[2], implying that breeding stock is very limited.

It is thought that localised populations may be present in areas of the North Sea, which are or have been inaccessible to fishing vessels[2]. It is important that these populations are identified and protected in the future. A small population is also being studied off the west coast of Scotland in the Isle of Mull area[4].

CHANGE IN STATUS SINCE 2000

Due to the lack of data during this period, it is difficult to quantify any change in status since 2000. However, this lack of data, and no occurrences of the common skate in survey trawls, indicates that numbers are still extremely low in areas where they were once common.

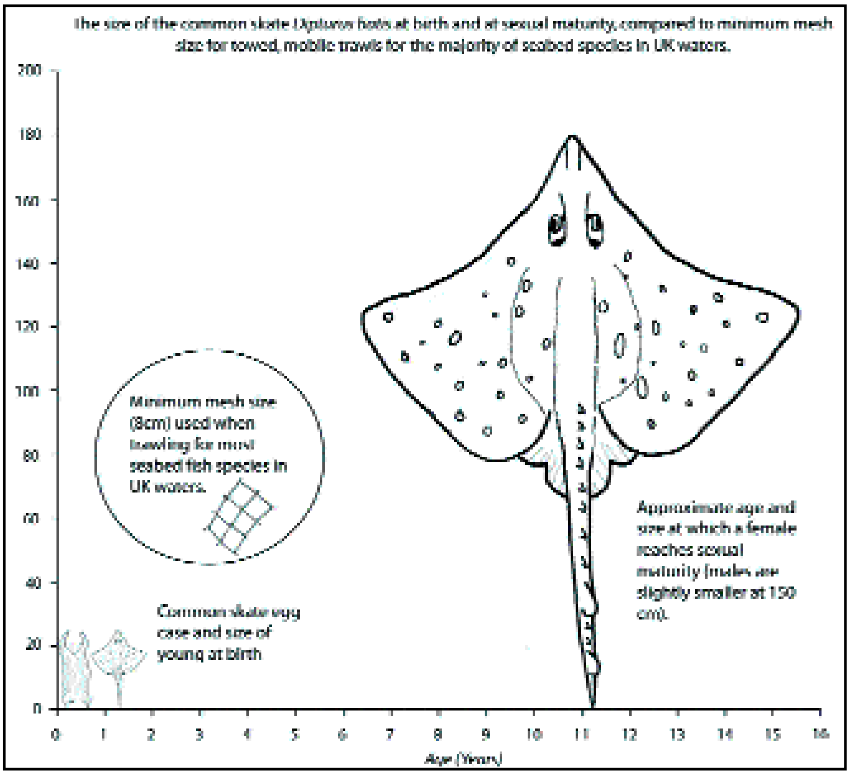

Figure 1: The minimum mesh size used for most benthic species around the UK is very small compared to the size of the common skate at all its life stages. The species is therefore vulnerable to being caught as bycatch throughout its life and if it is not returned when caught, the skate stands little chance of reaching sexual maturity in heavily-fished areas. Fully grown, the common skate may reach lengths of up to 285cm.

ISSUES/THREATS

Commercial fishing and angling

In the past, commercial fisheries specifically targeted skate, due to the high commercial value of their wings. Nowadays, this type of fishery is no longer profitable and has all but ceased in UK waters due to reduced stock size. The common skate is a large animal which spends its time on or very near the seabed. As a result, it is extremely vulnerable to being caught as bycatch in large, commercial, benthic trawls (see figure 1). The effect of any extraction is exacerbated by the slow reproductive rate and life history of the species.

Currently, skates and rays are recorded together in fisheries data. This species-unspecific information has hidden the decline of some larger species for some time, because while they have been lost, smaller species such as the starry ray and cuckoo ray have increased in abundance[14, 15].

In the past, angling has been a serious cause of mortality as the large common skate was targeted and killed. However, it is likely that this is becoming less of a problem due to changing attitudes among anglers and skippers, and the promotion of catch and release and tagging schemes by a number of angling and conservation organisations.

Offshore wind turbines

The well-managed development of offshore wind farms has the potential to provide a significant and sustainable source of energy. It may also be possible to establish fisheries No-Take Zones where wind turbines could provide refuge to the common skate. However, electromagnetic fields produced by the current within cables may be detrimental to the feeding behaviour and migration of many species of sharks and rays, including the common skate. Despite these potential risks, very little work has been done to assess the actual impact of offshore wind farms and more research is required[16].

Coastal development and sea defences

Although further research is required, it is quite possible that the development of sea defences and coastal structures will reduce the breeding grounds of the common skate, by removing suitable substratum.

SPECIES UNDER SIMILAR THREAT

All UK skate and ray species, particularly the long-nosed skate *Dipturus oxyrinchus*, white skate *Bathyraja spinosissima*, thornback ray *Raja clavata* and blonde ray *Raja brachyura*.

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites so that locations where common skate habitually aggregate can be protected. This would allow the common skate to reproduce, feed and have a chance of recovering population numbers, A Marine Act should also result in a reviewed list of marine features, including the common skate, that require protection under UK law to ensure the integrity of UK seas.

Plate 2. A range of publicity material, including this poster, raises awareness of common skate conservation, particularly among anglers.

STATUS

Severe Decline. The population demonstrates a high and rapid decline in numbers; the species has already disappeared from the major part of its former range; and population numbers are at a severe low level due to a long continous decline in the past.

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Author

Jack Sewell

full explanation at end

FAN MUSSEL

(Atrina fragilis)

Fan mussels are fragile bivalve molluscs that live embedded in sediment from where they pump water to feed on plankton. Their large translucent shells can make popular souvenirs. Numbers have declined since the advent of intensive bottom fishing and there may now be only a few locations left where they can remain undisturbed. Designation of refuge areas, and a European ban on collection and trade in their shells, is needed to maintain remaining populations and to encourage recovery.

NATURAL HISTORY

Fan mussels *Atrina fragilis* are usually solitary but may occur in groups. They can reach a length of 40cm and, based on growth rates in similar species, such large specimens may be 12 years old or more [1]. The fan mussel is unable to burrow upwards, nor can it re-burrow following displacement. The fragile shell further adds to its susceptibility to physical disturbance.

Fan mussels have been recorded in south-west England, western Ireland and western and northern Scotland, but are more abundant in the Bay of Biscay and along the Atlantic coasts of Spain and Portugal. It is possible that fan mussels in the UK settle from larvae produced in the Bay of Biscay, which are brought by winter currents sweeping northwards and eastwards [2].

Fan mussels have never been abundant in the UK, but now they are extremely rarely seen and, when found, it is often as a bycatch of scallop dredging. However, an exception occurred in late 2003 when a recreational diver reported several in Plymouth Sound – which is now known to hold a significant population. Fortunately, the use of mobile fishing gear is prohibited in the Sound.

Plate 1. Fan mussel in Plymouth Sound.

Plate 2. Fan mussels make popular souvenirs. This one is Pinna fragilis *from the Mediterranean.*

EXISTING PROTECTION AND MANAGEMENT

- The fan mussel *Atrina fragilis* is protected under Schedule 5 of the Wildlife and Countryside Act 1981 and under the Wildlife (NI) Order 1985.
- There is a UK Biodiversity Action Plan for *Atrina fragilis*[3].
- *Atrina fragilis* is not listed on Annexes II, IV or V of the EU Habitats Directive and is not included on the Berne Convention or CITES.

STATUS

(DEGREE OF DECLINE)

Records of decline in populations of fan mussels are documented in the UK Biodiversity Action Plan, but due to the sparse nature of populations, quantitative comparisons of population numbers do not exist. The extreme difficulty in finding individuals or populations suggests a decline in occurrence and, taking post-1970 records, *Atrina fragilis* would qualify as "nationally rare"[4].

CHANGE IN STATUS SINCE 2000

Atrina fragilis was not included in the 2000 *Marine Health Check*. Since 2003, the Marine Conservation Society has been seeking observations of fan mussels and the *MarLIN* programme has included them in its identification guide aimed at obtaining sightings of rare and other species. It is therefore expected that reported sightings will increase.

ISSUES/THREATS

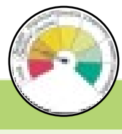
Atrina fragilis shows "high" sensitivity to many physical disturbance factors, in particular substratum loss, smothering and displacement. The documented impact of dredging on fan mussel populations, combined with the long-lived low gamete production, means that this species population cannot be compensated for by an immediate reproductive response and recruitment[5].

ACTION NEEDED

Fan mussels most likely come to UK waters from continental Europe where populations have been substantially reduced by mobile fishing gear[6] and souvenir collecting[7]. The UK needs to advocate addition of *Atrina fragilis* to Annex IV of the Habitats Directive, to the Berne Convention and to CITES.

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites so that locations where *Atrina fragilis* occurs now or has occurred in the past can be protected from potentially damaging activities.



STATUS

Severe Decline: the population demonstrates a high and rapid decline in numbers; the species has already disappeared from the major part of its former range; and population numbers are at a severely low level due to a long continuous decline in the past.

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MORE DETAILED INFORMATION

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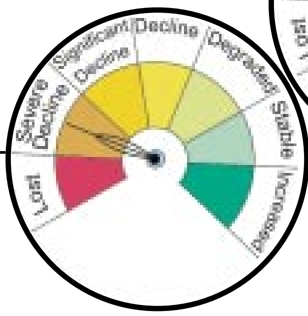
Author

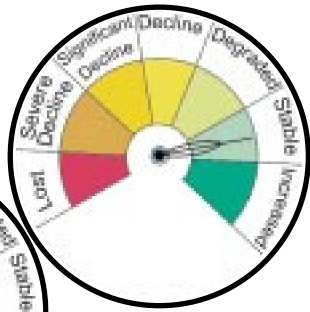
Keith Hiscock

Figure 1. Recorded distribution of the fan mussel Atrina fragilis *in Britain and Ireland. Source: MarLIN*

Past 100 years

full explanation at end





Past five years

full explanation at end

One hundred years ago, native or flat oysters occurred on the open coast as well as in estuaries and provided a staple diet for many people in Britain. Now, oyster beds are restricted to a few estuaries and native oysters are a luxury food. Disease and competition, as well as predation from non-native species and overfishing, may be the cause of decline but some populations are now supporting sustainable fisheries. If fisheries are to be maintained and improved, good management and good water quality are needed.

Fig 1. Recorded and expected distribution of the native or flat oyster Ostrea edulis *in Britain and Ireland. Source: MarLIN*

NATIVE OYSTER

(Ostrea edulis)

NATURAL HISTORY

The native or flat oyster is a fairly large bivalve (two shelled) mollusc, growing up to 110mm. It usually lives for between three and five years, but has been known to live for up to 10 years. Oysters can change sex and alternate between being male and female.

One oyster is capable of producing a million (sometimes more) free-swimming, planktonic larvae, which settle after 11 or more days as spat on suitable surfaces such as empty shells, rocks or debris that may be resting on muddy or sandy substrata.

The native oyster can form extensive beds, covering large areas of mixed sediment, which provide a habitat for numerous other species[1]. However, due to a variety of impacts, beds of oysters are now very rare in UK waters and are found only in a handful of estuaries.

For many years, native oysters have been harvested from the wild and more recently farmed for human consumption.

The native oyster is the only oyster species native to UK waters, but other non-native species can now be found around the UK. These species, (*Crassostrea gigas* from Portugal and *Crassostrea virginica* from the US) were imported for their larger size and fast growth for commercial farming. However, "escapees" have become established in our waters – bringing with them a number of problems, particularly other invasive species and infectious diseases, which have varying impacts on the native oyster.

EXISTING PROTECTION AND MANAGEMENT

The native oyster:

- has its own UK Biodiversity Action Plan, which makes a number of recommendations for the species' future management[2];
- is listed as an OSPAR priority species;
- has a national closed season for fisheries between 14 May and 4 August every year – its spawning season[2], and
- has UK shellfisheries regulations to prevent the spread of infections between populations and to prevent over-fishing.

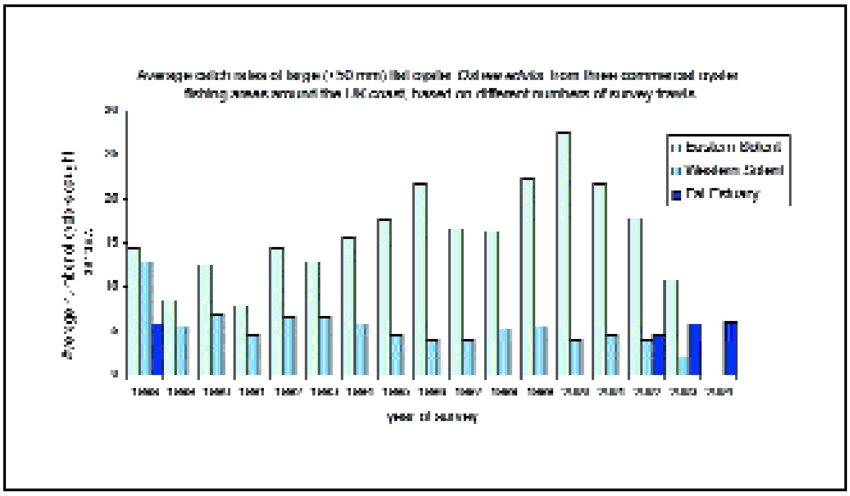


Figure 2. Average catch rates of large native oysters (larger than 50mm) Ostrea edulis *based on survey trawls in the western and eastern Solent and the Fal estuary. There is no data for the Fal between 1989 and 2001 due to cessation of surveys following infection by the parasite* Bonamia ostrea. *Based on data from Palmer and Walker 2003[6] (Solent) and Walker 2004[7] (Fal).*

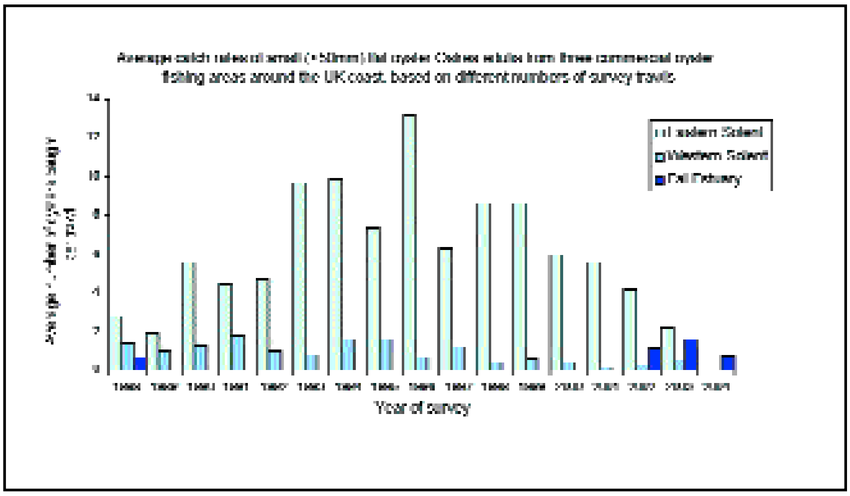


Figure 3. Average catch rates of small native oysters (smaller than 50mm) Ostrea edulis *based on survey trawls in the western and eastern Solent and the Fal estuary. There is no data for the Fal between 1989 and 2001 due to cessation of survey following infection by the parasite* Bonamia ostrea. *Based on data from Palmer and Walker 2003[6] (Solent) and Walker 2004[7] (Fal).*

STATUS

(DEGREE OF DECLINE)

The native oyster is widely distributed around the British Isles. However, due to a variety of human impacts, oyster populations in the UK are much smaller than they used to be and the dense oyster beds that once occurred in the North Sea and other offshore locations can now only be found in a few estuaries and coastal areas around the country. The main UK stocks are now found along the west coast of Scotland, the Thames estuary, the Solent and the River Fal[3]. Populations are also present in the Crouch Estuary[4] and the Stour Estuary[5].

CHANGE IN STATUS SINCE 2000

Although information is limited, it appears that oyster populations around the UK have changed in a number of ways. Although fisheries in the Solent appear to have decreased in the short term, this followed a large increase in numbers in 2000 (see Figures 2 and 3). In the long term, it appears that this fishery is relatively stable. The fishery in the Fal seems to be improving following a decrease between 1989 and 2000 due to disease.

Plate 1. A view of the upper side of a native or flat oyster Ostrea edulis *attached to pebbles.*

© Keith Hiscock

Plate 2. Oyster fishing in the Fal Estuary. Using wind powered vessels to catch oysters is less efficient, but more sustainable than large-scale fisheries.

© Andy Campbell

ISSUES/THREATS

Over-exploitation

The past century has seen a reduction in stock abundance of the native oyster throughout UK waters. This has been largely attributed to improved transport and an increased demand for the species as food[2]. However, small-scale oyster dredging using wind-powered vessels and smaller oyster dredges is likely to be far less damaging to oyster populations.

Reduced freshwater input

There is evidence to suggest that oyster populations in estuaries can be adversely affected by reduced freshwater input and increased salinity. Predators of the oyster, particularly the non-native American oyster drill *Urosalpinx cinerea*, feed more actively on the oyster as levels of salinity increase[8]. Therefore, any human activity or natural event which reduces the flow of rivers supporting oyster populations could pose a risk to the species.

Disease

Bonamiasis is caused by the protozoan parasite *Bonamia ostrea*, which infects the granular blood cells of the native oyster[9]. The disease has caused extensive oyster deaths in the UK, including destruction of the Fal oyster fishery in 1984, which is only now beginning to recover[7]. The disease is thought to have originated in the US and brought to Europe with imported non-native oysters[9].

Marteiliasis, caused by another protozoan parasite *Marteilia refringens*, has not yet been recorded in Britain[10] – but it has been responsible for serious mortalities of the native oyster throughout Europe since 1967[10]. Although strict regulations are in place to prevent it reaching the UK, there is a risk that without very careful management of infected stocks, the disease may reach these shores.

There is strong evidence to suggest that the effects of these and other diseases will be exacerbated by the presence in the water of non-lethal doses of metals such as cadmium, which seriously impair the immune system of the native oyster[11].

Introduced species

Several introduced species present in the UK pose a threat to the native oyster. The slipper limpet *Crepidula fornicata* was first introduced to UK waters as a "hitchhiker" on imported oysters from the US[12]. The spread of slipper limpets through the UK began when they were introduced to Essex between 1887 and 1890[12]. The species is also thought to be transported on the hulls of ships[12]. The slipper limpet is believed to compete for space with the native oyster, as both settle on the same type of hard substratum[13]. However, it is also likely that empty slipper limpet shells will provide additional surfaces for the settlement of oyster spat[2]. The slipper limpet is a filter feeder and while there is evidence that it is not a serious competitor with the native oyster for food[13, 14], studies have shown that the planktonic larvae of the native oyster can easily be carried into the feeding current of the slipper limpet and eaten[13]. Large numbers of slipper limpets deposit high quantities of pseudofaeces and trap sediment, leading to the transformation of oyster beds to "mud and limpet" habitats, in which oysters are smothered and unable to survive[13].

The American oyster drill *Urosalpinx cinerea* is a predatory sea snail which was introduced to the UK and Europe with non-native oysters from the east coast of America[12]. It is believed to have been introduced around 1900[12] and was first recorded in Essex in 1927. As its name suggests, the oyster drill prefers to feed on oysters and can consume up to 40 young individuals a year[12]. It therefore has a potentially high impact on oyster populations.

Habitat loss and siltation

Loss of habitat, which can be caused by coastal development and aggregate dredging, is a significant risk to the native oyster. Siltation can also occur as a result of dredge spoil dumping, land run-off or natural sediment movements. If this smothering is temporary and short-term, oysters may be able to recover[5]. But if it is long-term or continuous, it can devastate oyster populations.

Pollution

Oysters are filter feeders, so are very sensitive to many types of pollution including heavy metals and synthetic compounds[3]. Tributyl tin (TBT) associated with antifouling paints has been blamed for damaging effects on the native oyster, including stunted growth and reduced fecundity[2]. However, the use of TBT-based paints on vessels less than 25m long was banned in 1987 and since then, oyster numbers have increased in some areas such as the Crouch Estuary[4]. Whether this is a direct effect of the reduced impact of TBT on the oyster remains to be seen.

Increased oyster numbers may also be an effect of reduced numbers of predators such as dog whelks and sting winkles, which resulted from the use of TBT. These populations are less likely to recover quickly, due to the fact that they have a short dispersal range, but may increase in the future[4].

The native oyster is also vulnerable to oxygen depletion[3], suggesting that eutrophication of estuaries, resulting from excessive nutrient inputs from agricultural or other sources, may severely impact existing populations in the future.

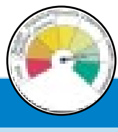
Plate 3. A clump of slipper limpets Crepidula fornicata *on the lower shore.*

SPECIES UNDER SIMILAR THREAT

The horse mussel *Modiolus modiolus*, the common mussel *Mytilus edulis* and the great scallop *Pecten maximus*.

HOW A MARINE ACT CAN HELP

Establishing a system of marine spatial planning will allow for the identification of special features for protection which can include oyster beds. A Marine Act should include provision for the designation and protection of Nationally Important Marine Sites so that locations where the native oyster occur now or have occurred in the past can be protected from potentially damaging activities. An integrated management regime implemented by a Marine Act could aid measures to reduce the arrival and spread of non-native species and diseases.




STATUS

Past five years – **Stable.** No change in status (distribution, range, abundance or numbers) reported or expected. Year-to-year fluctuations excepted.

Past 100 years – **Severe decline.** The species has disappeared from most of its former range.

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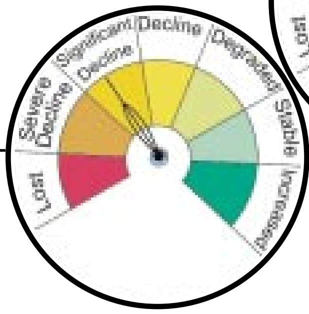
Author Jack Sewell

Lundy and Lyme Bay
full explanation at end



Rest of Britain and Ireland
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PINK SEA FAN

(Eunicella verrucosa)

The pink sea fan *Eunicella verrucosa* is one of the most exotic of our seabed species. It thrives only in the south-west of Britain where, at a few locations, it can occur in virtual "forests". In 2001, the sea fans at Lundy, England's only Marine Nature Reserve, suffered a mystery disease that devastated the population there. Furthermore, a species of warm-water barnacle, until recently unknown in Britain, now infests a portion of the population of pink sea fans. Its protected status (the pink sea fan is listed under the Wildlife and Countryside Act 1981) cannot help prevent natural changes, but a better understanding of the reasons for such fluctuations and whether human activities are part of the cause is needed.

NATURAL HISTORY

Sea fans are a type of horny coral that grow as branching flat fans oriented at right angles to the prevailing current, so that the anemone-like polyps arranged along the branches can catch as much suspended food as possible. Sea fans live deeper than the algal-dominated shallow rocks, usually in depths greater than about 15m. *Eunicella verrucosa* occurs from the eastern Mediterranean to south-west Britain as far north as Pembrokeshire and as far east as Portland. Nineteenth century records suggest that the species occurred in the English Channel as far as Margate in the Thames Estuary [1], [2].

Studies of growth rates in the pink sea fan [3] suggest that the branches grow at about 1cm in length a year, although rates vary. Some sea fans are 50cm high, suggesting great longevity. Sea fans may be swept off the rock by storms or caught in fishing gear including set nets. In 2003 and 2004, observations have been made of reproduction in pink sea fans for the first time [3]. Eggs are produced and, if fertilised, become swimming planulae larvae that can live for several days, suggesting an ability to colonise locations distant from the parent colony.

The nationally rare sea fan anemone *Amphianthus dohrnii* lives almost exclusively on sea fans. The sea slug *Tritonia nilsohdneri* and the "poached egg shell" *Simnia patula* feed on sea fans and both are camouflaged to look like the sea fan. Other species, especially barnacles, bryozoans and ascidians, colonise damaged or partially dead sea fans where the outer tissue has been abraded and lost. In 1994 *Solidobalanus fallax*, a species of barnacle previously unrecorded in Britain (but a native species in the north-east Atlantic) was found growing on *Eunicella verrucosa*. *Solidobalanus fallax* is now widely distributed on sea fans in south-west England and in a few cases may dominate [4].There have been several recent unpublished studies of sea fans, including significant surveys by amateur divers undertaken as a part of the Seasearch programme [5].

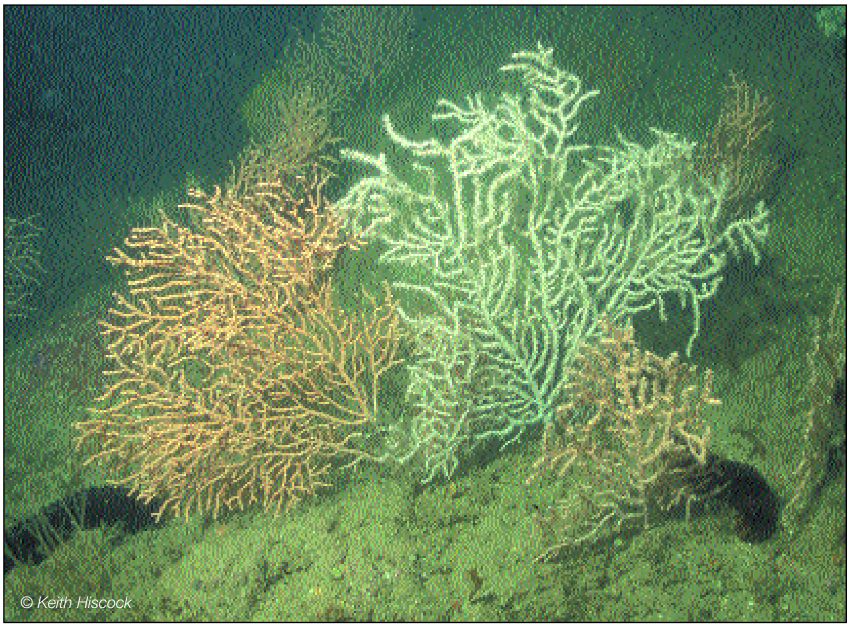

Plate 1. The sea fan Eunicella verrucosa *occurs in the UK almost entirely as pink individuals although white ones, more characteristic of areas to the south, also occur. Plymouth Sound entrance.*

Plate 2. Polyps of the sea fan catch passing plankton and other suspended organic matter.

EXISTING PROTECTION AND MANAGEMENT

- Listed on Schedule 5 of the Wildlife and Countryside Act 1981.
- The pink sea fan is included in the UK Biodiversity Action Plan.

STATUS

(DEGREE OF DECLINE)

The highest density of sea fans in the UK occurs off Plymouth and parts of the Lizard. Here, there can be up to 20 fans on a square metre of seabed. In the Plymouth region, such high densities suggest a population in excess of two million[3].

Since divers started to observe sea fans more than 30 years ago, numbers have probably been stable. Sea fans were collected as souvenirs in the 1960s and early 1970s, but this practice stopped in the mid-1970s when more was known about their biology and the likely poor rate of replacement – or perhaps it was the unpleasant smell of the dried fans.

Although most sea fan populations are probably stable, a mystery disease affected those at Lundy in 2001, so that their density there is now much lower. Reasons for the disease are unclear but it may be that such events occur every so often. There is a tantalising mention in the Plymouth Marine Fauna that in the "latter half of Aug. and first half Sept.1924; Capt. Lord reported that a great amount of *Eunicella* brought up was dead: many colonies brought in were partially dead, none in such good condition as the previous July". Captain Lord's observations in 1924 were well worth noting, just as many of today's observations need recording.

CHANGE IN STATUS SINCE 2000

The loss of and damage to sea fans around Lundy occurred in 2001 and was believed to be a localised decline.

ISSUES/THREATS

Fishing

Dredging for scallops may be undertaken deliberately in reef areas where the dredge can "hop" the reefs and catch scallops in the sandy patches between. However, sea fans will be removed by such fishing and damage has occurred in Lyme Bay, where voluntary management measures are now in place to limit adverse effects. Sea fans become caught and detached in nets that are set on the seabed to catch crawfish, or in lost nets that continue to "ghost fish". Anglers' lines may also snag and detach sea fans.

Nutrient enrichment

High seawater temperatures in the summer, and possibly nutrient enrichment, were the most likely reasons for a mortality event that included sea fans in the eastern part of the western Mediterranean in 1999[7]. High nutrient levels will also encourage algal growth that may smother sea fans.

It is possible that high nutrient levels in the Bristol Channel may have been implicated in the adverse effects on Lundy sea fans in 2001[6].

Disease

The Lundy event in 2001 illustrates the adverse effects of disease. However, the cause of the event is unknown and may be entirely natural.

Climate change

The warm-water barnacle *Solidobalanus fallax* is now colonising sea fans in south-west England and will most likely spread to populations in Pembrokeshire. Although the barnacle is unlikely to colonise healthy parts of the colony, bare skeleton brought about by abrasion (by, for instance, entanglement in fishing lines or tissue removal by predatory molluscs) or disease will allow settlement which may then extend beyond the original point of attachment.

Figure 1. Recorded distribution of the pink sea fan Eunicella verrucosa *in Britain and Ireland. Source: MarLIN*

Plate 3. Species that live only or especially on the pink sea fan include, from left to right, the nationally rare sea fan anemone Amphianthus dohrni, *the sea slug* Tritonia nilsohdneri *(adult laying eggs), the "poached egg shell"* Simnia patula *and, in recent years, the warm-water barnacle* Solidobalanus fallax.

SPECIES UNDER SIMILAR THREAT

The northern sea fan *Swiftia pallida*, various long-lived and slow-growing branching sponges and other species attached to the rocky seabed.

HOW A MARINE ACT CAN HELP

Pink sea fans should be considered a Nationally Important Feature under a Marine Act. Some protection is already afforded to the sea fan but it has been generally ineffective. A Marine Act would also reinforce the importance of gathering scientific information to inform protection measures.

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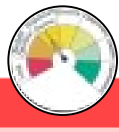
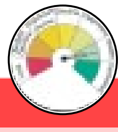
Keith Hiscock

STATUS

Lundy and Lyme Bay – **Significant decline.** The population has undergone a "considerable" decline in numbers, range and distribution beyond that expected by natural variability.

The rest of Britain and Ireland – **Stable.** The population is believed to occur in similar numbers and/or extent, range and distribution to those in historical times before human activities or natural catastrophes adversely affected populations (the assessment relates to the past 30-40 years).

full explanation at end

Saltmarshes are important for many species of plant and animal, several of which exist exclusively in this type of habitat. Saltmarshes also play important roles in the wider environment by acting as important sinks and sources of nutrients and sediment. Historically, large areas of saltmarsh have been lost to development and other human activities. Recently, the value of saltmarsh habitat as a coastal defence resource and as an important environmental asset has been recognised – but due to a combination of natural and man-made impacts, particularly in the south of England, large areas of marsh are still being lost.

SALTMARSH

NATURAL HISTORY

Saltmarshes are intertidal habitats in areas with intermediate to high sediment accretion and low levels of wave exposure. They include estuaries, saline lagoons, heads of sea lochs and areas sheltered from wave action by barrier islands, reefs or sand bars. Saltmarsh occurs down to mean high-water neap level and up just beyond mean high-water spring tide levels [1], particularly at the upper fringe of intertidal mud flats [2]. The rate of saltmarsh development depends on the rate of sediment supply and sedimentation, but it typically takes 40-80 years for mature saltmarsh to develop [3].

Vegetation in saltmarshes consists of halophytic (salt tolerant) higher plant species and several species of algae. Species capable of binding and stabilising sediment are almost always present and play the important role of creating a stable substrate that can be colonised by other plant species. It is thought that species of micro algae, bacteria and fungi also play an important role in binding and stabilising sediment.

The distribution of plant species depends largely on their tolerance to salinity, submersion, temperature change and exposure. Forty species of higher plant in the UK are exclusively found in saltmarshes, with about 10-20 species commonly found in each saltmarsh [3]. Species of glasswort *Salicornia sp*, cord grass *Spartina sp* and sea aster *Aster tripolium* are characteristic of the pioneer saltmarsh often found at the lower levels of the marsh. Other typical saltmarsh plants include sea lavender *Limonium vulgare* and thrift *Armeria maritima* with their beautiful pink and purple flowers. Sea purslane *Atriplex portulacoides* is another common species, often forming dense forests up to 1 metre tall. Many saltmarshes also contain dense hummocks of the saltmarsh grass *Puccinellia maritima*.

Saltmarshes support diverse, detritus-dependant communities. When submerged, gullies provide a nursery area for a number of fish species including mullet *Chelon labrosus* and bass *Dicentrarchus labrax*. The rich, fertile mud provides a habitat for numerous marine invertebrates including the ragworm *Hediste diversicolor*, the common shore crab *Carcinus maenas*, the Baltic tellin *Macoma balthica* and especially the amphipod *Corophium volutator* and the mud snail *Hydrobia ulvae*. It has also been estimated that in the UK there are 148 species of terrestrial invertebrate that can be found exclusively in saltmarsh habitats[3]. Saltmarshes also provide fertile feeding grounds and safe roosting areas for a number of wading birds and wildfowl. These include the shell duck *Tadorna tadorna*, the curlew *Numenius arquata*, the avocet *Recurvirostra avosetta* and several species of migratory geese such as the Brent goose *Branta bernicla*.

Saltmarshes are occasionally used for livestock grazing. This can completely alter the species present and lead to the development of a "grazed saltmarsh" habitat. Grazing also occurs naturally by wildfowl and wild terrestrial mammals such as rabbits and hares.

Plate 1. Saltmarsh at Blakeney.

Saltmarshes can provide valuable nutrients to neighbouring mudflats and marine systems[4] and can trap sediment and reduce turbidity, making conditions more favourable for eelgrass beds. In the past, vast areas of saltmarsh have been drained and used for building and farmland. Saltmarshes require very particular levels of sediment nourishment and are particularly sensitive to changes in water flow or river regimes, which may be caused by human development.

EXISTING PROTECTION AND MANAGEMENT

- More than 80 per cent of the total area of UK saltmarsh is covered by one or more international conservation designation[5].
- Saltmarshes are significantly included in Sites of Special Scientific Interest (Areas of Special Scientific Interest in Northern Ireland).
- A large amount of the UK's saltmarsh habitat occurs in Special Areas of Conservation designated under the EU Habitats Directive and are afforded some protection by this status.
- Coastal saltmarsh is a Biodiversity Action Plan Habitat. The action plan makes several recommendations for the habitats' future management, and a number of local plans address protection issues[2].
- Several managed realignment schemes are currently being initiated, particularly in the south-east of England. These will attempt to allow saltmarsh to re-establish itself in previously "reclaimed" farmland areas.

Plate 2. Grazed thrift Armeria maritima *dominated saltmarsh in Cnoc Cuidhein, Benbecula, Hebrides.*

STATUS

(DEGREE OF DECLINE)

Saltmarsh habitats are found all around the UK but their type, status and condition is extremely variable between regions.

Saltmarshes in Scotland and the north of England are far less affected by erosion and are not thought to be in serious decline. Saltmarshes in sea lochs are generally closed systems, requiring no sediment input from external sources. They are also very sheltered from wave action and therefore less vulnerable to natural seaward erosion[3].

In the south and south-east of the UK, a combination of human-caused and natural processes are thought to be responsible for the rapid decline of saltmarsh habitat. For example, the Lymington saltmarshes in the Solent are believed to be eroding at a rate of three metres a year, although the reason for this is unknown. Saltmarsh in the south-east of England overall has been eroding rapidly over the past 50 years and the current rate of erosion is 40ha a year[5]. Efforts are being made to identify the cause of the erosion and restore lost saltmarsh.

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Plate 3. Natural gullies that form in saltmarshes provide a valuable habitat for a number of marine species. They also provide a passage for sediment and nutrients to the upper reaches of the saltmarsh.

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Plate 4. Saltmarshes can support rich invertebrate communities, which in turn support a variety of bird (such as this curlew) and fish species.

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Plate 5. Before (top) and after (bottom) the breaching of sea walls as part of the Abbot's Hall Farm managed realignment project. The project involved flooding previously "reclaimed" farmland to encourage the development of new saltmarsh habitat.

CHANGE IN STATUS SINCE 2000

Several managed realignment projects have commenced in the last few years. These generally involve breaching existing sea walls, with the intention of flooding previously "reclaimed" land leading to the natural re-establishment of saltmarsh communities. Such projects include Tollesbury and Abbots Hall Farm in Essex, and there are signs that some saltmarsh species are beginning to colonise these areas. However, due to a number of factors including the physical and chemical changes that have taken place to the structure of the previously reclaimed soil, it is not known how long it will take for mature saltmarsh communities to become re-established in these areas. The establishment of new saltmarsh also depends on the availability of seeds, sufficient sedimentation and resistance to erosion. Studies at Tollesbury show that after six years, sediment is being successfully deposited with sufficient erosion resistance to allow the saltmarsh to develop [6].

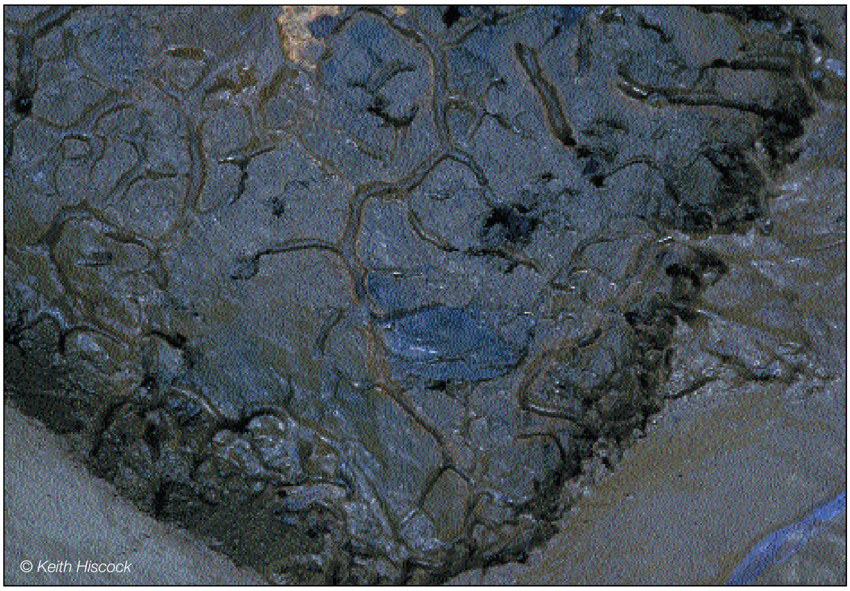


Plate 6. Ragworm Hediste diversicolor *burrows in a muddy creek.*

ISSUES/THREATS

Coastal development/land claim and coastal squeeze

Historically, saltmarsh has been 'reclaimed' for agriculture using sea walls. In the past, small stonewalls or grass-covered banks were used at the top of marshes to reclaim relatively small areas at a time. An adequate time was then left for the natural redevelopment of the marsh at the seaward side before further reclamation. With improving technology, the ability to build larger walls of concrete has led to increasingly large areas of saltmarsh being 'reclaimed', ultimately leading to significant loss of saltmarsh habitat [3]. The development of ports and marinas has also involved the destruction of saltmarsh habitat.

Saltmarshes undergo natural cycles of erosion and accretion [1]. Isostatic adjustment means that the south of England is effectively sinking while sea levels are rising due to climate change – a situation that has led to an overall push of saltmarsh inland. This phenomenon is partly a natural process, although erosion is also caused by man-made impacts. In areas where sea walls or other obstructions prevent the movement of saltmarsh inland, it can be "squeezed" resulting in its eventual disappearance. Increased wave action resulting from climate change and human activities can also raise the rate of saltmarsh erosion.

Changes to sediment supply

Saltmarshes require a constant supply of sediment to regenerate and function. While some of this is provided during the erosion process [1], fresh sediment is required from external sources [3]. Changes to river and tidal flow caused by human development can lead to reduced sedimentation.

Other factors such as channel dredging and the natural or human-induced loss of sea grass beds can also lead to increased water flow, which can impair sedimentation and increase the rate of erosion.

Recreation

Recreational over-use of saltmarshes for hunting, fishing and as pathways to the water for other activities can cause detrimental effects. Excessive direct trampling of plant species can lead to erosion. Disturbance to nesting and/or feeding birds can also have a negative impact on bird numbers. Direct removal of saltmarsh species by hunters or bait collectors is another potential problem [3]. Wake caused by pleasure craft on waterways can lead to increased seaward side erosion.

Pollution

Due to their nature, saltmarshes can act as sinks for contaminants, particularly heavy metals, which can become stored in sediment or within the individual plants. The ability of saltmarsh sediment and plants to trap contaminants over time means that high concentrations of metals can be acquired and potentially recirculated into food chains. Contaminants can also become re-suspended with erosion or during the shedding of leaves. Pesticides, herbicides and fungicides from agriculture can have impacts on species, including microorganisms important to maintaining the function and structure of the saltmarsh.

Many saltmarsh species are vulnerable to oil pollution. Large oil spills can be devastating and there is evidence that small-scale chronic oil pollution can be even more damaging [3]. However, large-scale clean-up operations can often be more damaging than the oil spills themselves [3].

While saltmarshes require relatively high levels of nutrients, excess nitrates and phosphates such as those present in non-point source agricultural pollution can be damaging. Possible effects include eutrophication [7] and excess algal growth leading to smothering of other plant species [3].

It is thought that sewage pollution may be responsible for increased numbers of the ragworm *Hediste diversicolor* [5]. This species is thought to restrict saltmarsh development by inhibiting the establishment of pioneer saltmarsh species [8].

Introduced species

In the late 1800s, smooth cord-grass *Spartina alterniflora* was introduced to UK waters from North America via ships' ballast water [9]. The species subsequently crossed with the native small cord-grass *Spartina maritima* forming a fertile hybrid, the common cord-grass *Spartina anglica*. This species has since become widespread along the east and west coasts of Britain. It has been planted in some areas to stabilise sediment, but has also spread naturally elsewhere. The species is able to colonise bare mud rapidly, reducing feeding space for birds and eliminating native pioneer saltmarsh species [9]. It can also produce monoculture saltmarshes [7], with less habitat value than a mixture of native species [9].

Plate 7. Spartina anglica *dominated saltmarsh in an estuary in the south-west of England.*

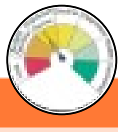
HABITATS UNDER SIMILAR THREAT

Intertidal mudflats and seagrass beds.

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites, although saltmarsh habitats can already be protected as Sites of Special Scientific Interest and included within Special Areas of Conservation under the Habitats Directive. It will also be important to achieve legislation for Biodiversity Stop Orders under a Marine Act as entrepreneurial land claim, causeway construction, use of saltmarsh for construction or as roadways and other damaging activities could rapidly harm saltmarsh habitats.

Integrated management through marine spatial planning will help identify where saltmarsh can be better protected from man's activities – for example, by considering shipping movements and proposals for new port developments or coastal defences together with other data such as fish nursery areas on the coast.



STATUS

Significant decline. Extent: the spatial extent (or density of key structural or key functional species) of the habitat has declined by over 25 to 75 per cent of prior distribution, or the spatial extent (or density) has declined "considerably". The habitat has either shrunk in spatial extent or been fragmented. Degradation: The population(s) of species important for the structure and/or function of the habitat may be reduced or degraded by the factor under consideration, the habitat may be partially destroyed, or the viability of a species population, species richness and biodiversity, and function of the associated community may be reduced. Further degradation may result in severe decline.

In the case of saltmarsh, significant decline is in the past 50 years

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Author

Jack Sewell

full explanation at end

Seagrass beds are rich habitats for marine life and important sources of food for wading birds. Beds are much less extensive than in the early 1930s after devastation due to a wasting disease. Seagrass beds are very restricted in occurrence, and eelgrass *Zostera marina* beds are being "invaded" by non-native japweed *Sargassum muticum*. Other threats, especially to the associated fauna and flora, are dredging, land drain and contaminants.

SEAGRASS BEDS

NATURAL HISTORY

Seagrass beds develop in intertidal and shallow subtidal areas on sand and mud. They can be found in marine inlets, bays, lagoons and channels sheltered from strong wave action, and they thrive where there is some dilution of full seawater. Seagrasses are the only flowering plants (angiosperms) that are truly marine: approximately 60 species are found worldwide[1]. There are three species of seagrass in the UK, all of which are considered scarce. Dwarf eelgrass *Zostera noltii* is found highest on the shore, narrow-leaved eelgrass *Zostera angustifolia* on the mid to lower shore and eelgrass *Zostera marina* mainly in the sublittoral[2]. Narrow-leaved eelgrass may be a variety of *Zostera marina*. Much less is known about these species than their counterparts on dry land. Seagrass meadows are seasonal in very enclosed waters subject to dilution by freshwater. Most species start growth during spring and reach their maximum standing crop during summer months. Autumnal die-back is followed by the development of brown, red and green seaweed scrub through winter and early spring[3].

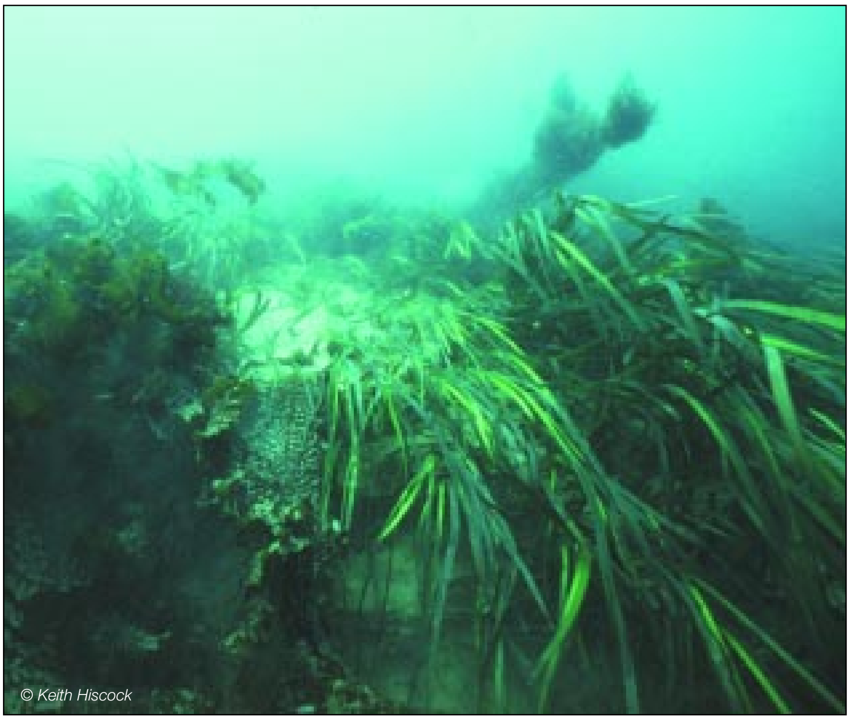


Plate 1. Eelgrass Zostera marina *in Salcombe Harbour.*

Common eelgrass *Zostera marina* is a flowering plant with dark green, long and narrow leaves. The leaves shoot from a creeping rhizome that binds the sediment [4] and the species may form dense swards down to depths of 4m. Studies in the German Wadden Sea indicate that both *Zostera marina* and *Zostera noltii* can spread readily by rafting of reproductive shoots and ingestion of seeds by grazing waterfowl [5,6]. Eelgrass beds are important habitats because they provide shelter and hiding places to a large variety of other species, both on or among the plants. Five community types and 16 microhabitats have been identified for seagrass beds from the southern North Sea and the Channel [2]. Fish such as pipefish and seahorses are sometimes found in this habitat, together with cuttlefish which lay their eggs among eelgrass. Other fish species use the eelgrass beds as a refuge or nursery area. Snails graze the leaves and stalked jellyfish and hydroids may also be present. Some species of algae have only been recorded attached to eelgrass leaves [7].

Seagrass beds are considered to be highly productive and support a wide range of flora and fauna as well as being a refuge and nursery area for a range of fish species. They provide a diversity of microhabitats, especially compared with macroalgal species. Seagrasses are an important food resource for overwintering herbivorous wildfowl. This is especially the case in the intertidal zone where *Zostera noltii* forms an important component in the diet of species such as mute swans *Cygnus olor*, whooper swans *Cygnus cygnus*, light-bellied Brent geese *Branta bernicla* and wigeon *Anas penelope* [8].

Seagrass beds are important and valuable habitats as they stabilise sediment, inhibit erosion and encourage deposition of suspended material. In some areas, the build-up of sediment gives greater protection to adjacent beaches and may decrease erosion of saltmarsh higher up the shore [9].

The general ecology, sensitivity, conservation and management requirements of *Zostera spp*. have been documented as part of the UK Marine SACs Project [11] and as part of the Biodiversity Action Plan process at a UK level [12].

Plate 2. Dwarf eelgrass Zostera noltii *on a mudflat with laver spire shells* Hydrobia ulvae.

Plate 3. A stalked jellyfish Lucernariopsis campanulata *growing on eelgrass leaves in the Isles of Scilly.*

EXISTING PROTECTION AND MANAGEMENT

- Statutory site designation plays an important part in the conservation of seagrass habitats and many of the best examples have been designated Sites of Special Scientific Interest (SSSIs), Areas of Special Scientific Interest (ASSIs), Ramsar sites, Special Protection Areas (SPAs), National Nature Reserves (NNRs) and voluntary marine protected areas[8].
- The UK Biodiversity Group has produced a Habitat Action Plan for seagrass beds. This plan covers all three *Zostera* species and identifies a programme of legislation, management, research and monitoring for all seagrass beds. Its objectives are to maintain the extent and distribution of seagrass beds in UK waters and to assess the feasibility of restoring those that are damaged or degraded[2].
- Although seagrass beds are not listed as an Annex I habitat under the EU Habitats Directive, they are recognised as a component of "Lagoons (a priority habitat) and shallow sandbanks which are slightly covered by seawater all of the time". They are also a characteristic feature of the Annex I habitats "Large shallow inlets and bays, Estuaries, and Mudflats" and "sandflats not covered by seawater at low tide"[10].

STATUS (DEGREE OF DECLINE)

Zostera marina is nationally scarce and has declined in numbers and range by between 25 and 49 per cent in the last 25 years. It is considered to be a globally threatened plant[13].

Of Britain's 155 estuaries, only 20 possess eelgrass beds of more than one hectare: a decline in 85 per cent since the 1920s[14]. The presence and abundance of seagrasses can be considered as indicators of the overall environmental quality of the coastal zone[15].

The widespread loss of seagrasses in Europe is largely due to rapid growth in human activities and transformation of the coastal zone[16].

CHANGE IN STATUS SINCE 2000

In 2003 the *World Atlas of Seagrasses,* produced by the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), provided the first global estimate for seagrasses. The total is 177,000 sq km – an area just two-thirds the size of the UK. The global survey revealed that 15 per cent of seagrass beds had been lost in the 10 years prior to 2003. No figures are available for the UK, but in the Wadden Sea, there has been an increase in extent of both *Zostera marina* and *Zostera noltii* since about 1996[18].

Figure 1. Zostera marina *current recorded UK distribution. Map from MarLIN*

A recent European report[17] suggests that the most important actions to prevent seagrass loss are:

- control and treatment of urban and industrial sewage to reduce the loading with nutrients, organic matter and chemicals;
- regulation of land use in catchment areas to reduce nutrient run-off and siltation due to soil erosion;
- regulation of land reclamation, coastal constructions and downscaling of water exchange between open sea and lagoons;
- regulation of aquaculture, fisheries and clam digging in or adjacent to seagrass beds; and
- creating awareness of the importance of seagrasses and implementing codes of conduct to reduce small-scale disturbances.

ISSUES/THREATS

Disease

Zostera marina is susceptible to a wasting disease caused by a slime mould. In the 1930s, populations were devastated by this disease and have still not fully recovered.

Weather

Severe storms, exposure to air, decreased salinity, warm sea temperatures and low sunlight levels may cause significant stress and large-scale losses, leading to erosion.

Alien species

Competition from species such as the cord-grass *Spartina anglica*, which colonises the upper part of mudflats, may threaten the upper limit of *Zostera noltii*. The large brown seaweed wireweed or japweed *Sargassum muticum* is a sub-tidal species and may compete for space with *Zostera marina*.

Direct physical disturbance

Trampling, dredging, bottom trawling and coastal development all directly cause physical disturbance. Construction of solid causeways between islands in the Hebrides over or adjacent to seagrass beds is of great concern as water flow is blocked. Moorings, dredging and propellers can leave scars in the beds. When disturbance is repeated due to constant dragging of a mooring chain or driving a boat over a particular area of seagrass bed, damage can be permanent and recovery is likely to be slow.

Indirect physical disturbance

Zostera species rely on relatively stable sediments. They are vulnerable to land reclamation and construction of seawalls and causeways.

Nutrient enrichment

High nitrate levels have been implicated in the decline of mature *Zostera marina* plants. Such high levels are most likely to be the result of sewage discharge and agricultural runoff. Phytoplankton blooms can reduce biomass and depth penetration of eelgrass. *Zostera angustifolia* and *Zostera marina* are both affected by nutrient enrichment from nitrates, severe oil pollution and anti-fouling paints used on boats[11]. In high nutrient environments, *Zostera spp*. cannot compete, due to the high respiratory demands of its rhizome system.

Marine pollution

Common eelgrass is known to accumulate tributyl tin and other metals and organic pollutants which may reduce nitrogen fixation in the plant. It may also cause a build-up of the pollutants in the food chain[9]. Intertidal beds are vulnerable to oil pollution and to clean-up operations.

Grazing

Intertidal *Zostera spp*. are utilised by herbivorous wildfowl during winter months. This grazing pressure can severely reduce the biomass, but plants re-grow from rhizomes.

"Globally seagrass beds are regressing and it is highly probable that UK beds are following this trend. We do not have decent monitoring or data on current distribution for subtidal beds around the UK, so significant losses may be occurring without our knowledge. In the UK, the main current threats to seagrasses are increases in turbidity from eutrophication, coastal development, dredging and poor land management which ultimately causes depth squeeze: the depth range of seagrasses is reduced to shallower waters where perhaps they are most at risk. Other major threats include physical disturbance, removal, land claim, nutrient enrichment and smothering by other plants."

Dr Emma Jackson, Seagrass researcher, University of Plymouth

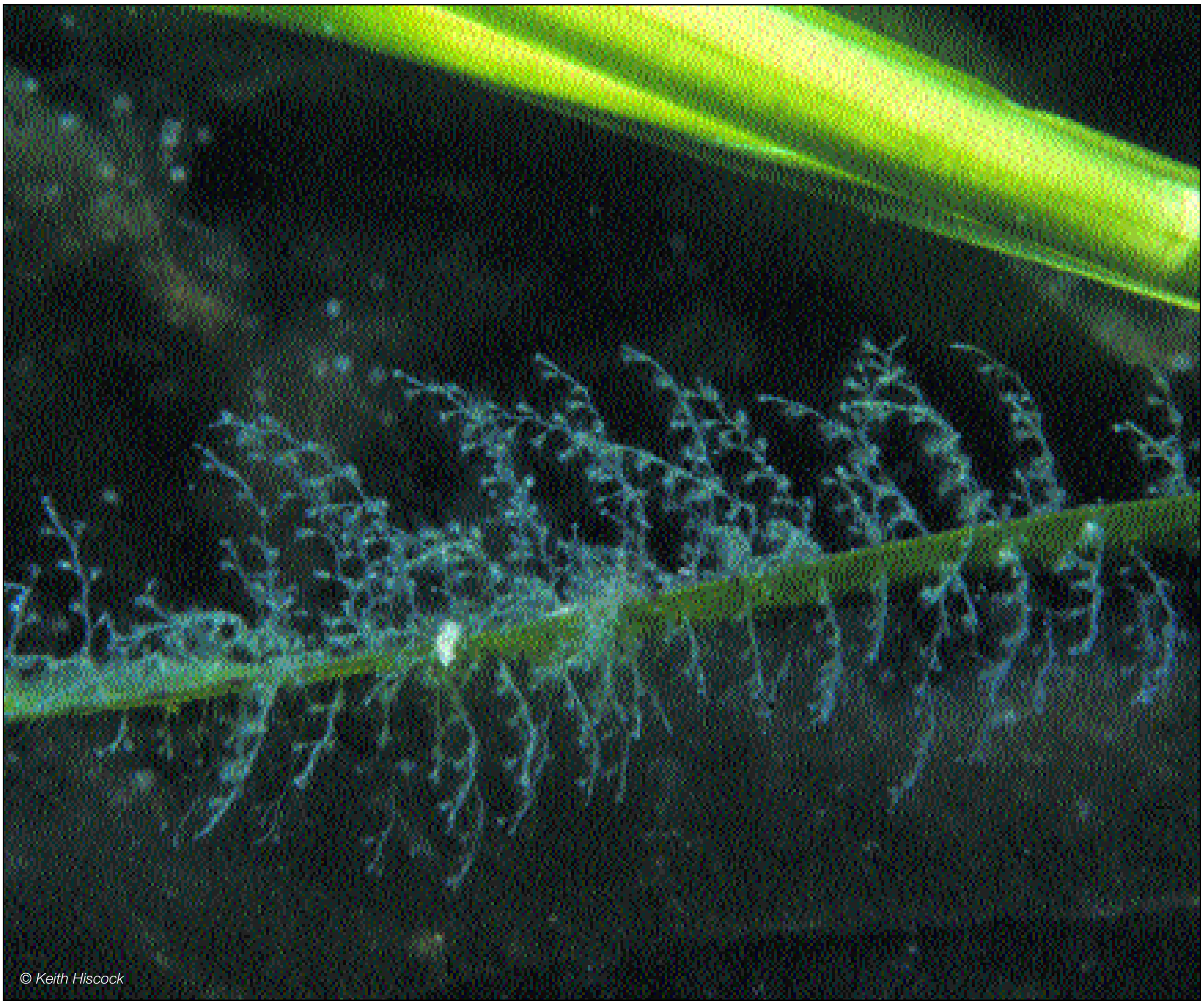
HABITATS UNDER SIMILAR THREAT

Saltmarsh, mudflats and saline lagoons.

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites so that locations where seagrass beds occur now or have occurred in the past can be protected from potentially damaging activities and allowed to recover or be restored. Biodiversity Stop Orders would also be important as land claim, causeway construction and other damaging activities could rapidly damage important sites.

Plate 4. The hydroid Laomedea angulata is only recorded from the leaves of Zostera marina.



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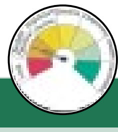
Judith Oakley



STATUS

Severe Decline. Extent: more than 75 per cent of the spatial extent (or density of key structural or key functional species) of the habitat is lost or the majority of the habitat has been lost. Where its overall extent remains, the habitat is reduced to small, widely dispersed fragments. Degradation: the habitat has experienced a severe reduction (more than 75 per cent) in the abundance of associated key structural or key functional species, and the species richness or biodiversity is minimal. Further degradation is likely to result in loss of the habitat.

In the case of seagrass beds, severe decline has occurred since the 1920s.

full explanation at end

MAERL BEDS

Maerl beds occur in south-west England, western and northern Scotland and Northern Ireland. Maerl is a free-living calcified seaweed forming nodules up to about 40mm across that grow at about 1mm a year. The open matrix of branching nodules provides a habitat for a rich variety of species and a nursery ground for several species. Maerl is extracted for soil conditioner and filter media and is subject to dredging for scallops. Fish farms and tidal energy generators may be sited over maerl beds. Recovery from severe damage is unlikely and measures to protect maerl beds from specific activities are urgently required.

NATURAL HISTORY

Maerl (mainly *Phymatolithon calcareum* and *Lithothamnion corallioides*) beds occur widely in Europe in tidal stream-exposed environments to depths of 30m in the Atlantic. However, the extent of a particular maerl bed is likely to be restricted to a few hectares or square kilometres. Although maerl beds have been known to be rich habitats for biodiversity for at least 40 years[1], many aspects of the biology of the component maerl species have only come to light in the past few years[2]. The location of maerl beds around the UK has been mapped as a result of surveys by the nature conservation agencies. Those surveys, now mainly aimed at mapping extent and quality using remote operated vehicles, continue. Maerl beds are extremely long-lived – the lifespan of the habitat can be 6,000 years or more[3] and may take hundreds of years to develop[2]. The growth rate of individual nodules of *Phymatolithon calcareum* is between 0.5 and 1.5mm a year[4]. Pristine maerl beds provide nursery areas for queen scallops and other invertebrates such as the soft clam *Mya arenaria* as well as juvenile gadoid fish more effectively than impacted maerl beds or other sedimentary substrata[5, 6].

Plate 1. Phymatolithon calcareum *maerl bed.*

EXISTING PROTECTION AND MANAGEMENT

- *Lithothamnion corallioides* and *Phymatolithon calcareum* are listed in Annex V (species whose exploitation is subject to management) of the EU Habitats Directive.
- The EU Habitats Directive Annex I Habitat "Sandbanks which are slightly covered by seawater all of the time" is defined as including maerl. Maerl beds occur in "Shallow inlets and Bays", another Annex I Habitat. Several Special Areas of Conservation have been identified because of their maerl beds.
- Maerl beds are included in some of the 29 Scottish Marine Consultation Areas. Although this is a non-statutory designation used by Scottish National Heritage to denote areas of special marine interest, it is used in planning consultations, particularly over the siting of fish farms.
- Maerl beds are a UK Biodiversity Action Plan habitat with the objectives of:
  - maintaining the geographical range of maerl beds and associated plant and animal communities in the UK subject to best available information; and
  - maintaining the variety and quality of maerl beds and associated plant and animal communities in the UK subject to best available information.

STATUS
(DEGREE OF DECLINE)

Recent studies[7] have shown that apart from direct removal, the main anthropogenic hazard for live maerl and the rich communities that depend on it is smothering by fine sediment such as that produced by trawling or maerl extraction, from sewage discharges or from fish farm waste as well as disruption of tidal flow. Maerl beds can survive light dredging for scallops, but heavy toothed gear will at least displace the maerl and break the nodules so that the structure of the maerl bed becomes less open.

St Mawes Bank near Falmouth in south-west England has the most extensive bed of maerl in England and Wales but is subject to increasing threats from extraction of dead maerl nearby and from scallop dredging. In the winter of 2002/03, six local scallop dredgers "worked" the area adjacent to the maerl bed – a practice that was stopped for a year until September 2004 by Ministerial Order to allow time for consultation.

CHANGE IN STATUS SINCE 2000

Several instances of damage to maerl beds have been cited since 2000[5] and a much better understanding of the environmental tolerances of maerl has been researched[7]. Dredging for scallops is becoming more widespread and scallop dredgers are using satellite navigation to target small areas that might previously have been too difficult to access safely, potentially threatening pristine maerl beds.

Plate 2. Maerl dredger operating in the Fal just south of the living maerl bed on St Mawes Bank in 1999.

ISSUES/THREATS

The time taken for maerl to establish and grow, and the longevity of the beds, make them a non-renewable resource[2]. The beds may be nursery grounds for commercial species of fish and shellfish[8]. Maerl will be removed by commercial extraction and areas adjacent to extraction sites show significant reductions in diversity and abundance[2]. Maerl communities are easily damaged by dragged fishing gear, which may cause reduction in complexity, biodiversity and long-term viability of the habitat[9,10]. Mussel aquaculture producing high organic input has also been shown to damage maerl beds[11], as has nutrient enrichment as a result of agricultural runoff[2].

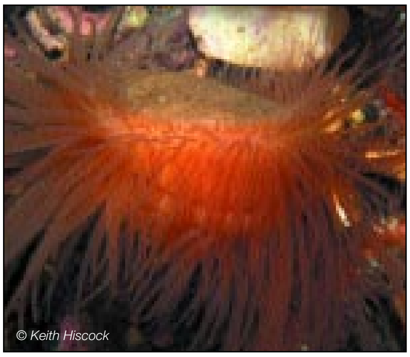
HABITATS UNDER SIMILAR THREAT

Reefs of the file shell *Limaria hians* occur in similar situations to maerl and are often a component of maerl beds. The file shells build "nests" using their byssus threads, consolidating the seabed and providing a stable substratum for attached species. Reefs of file shells are likely to be destroyed by the passage of a scallop dredge[10] and, as the bivalves cannot close their shells completely, they are exposed to predation. Studies in Lough Fyne[12] showed that damaged file shells were consumed by scavengers such as juvenile cod whelks, hermit crabs and other crabs within 24 hours.

HOW A MARINE ACT CAN HELP

Maerl beds and file shell reefs should be notified as Nationally Important Features under provisions in a Marine Act and should be protected within Nationally Important Marine Sites. A Marine Act should also make provision for Biodiversity Stop Orders so that planned activities that may damage maerl beds or file shell reefs – or any such activities already started – can be stopped. Extraction of live maerl, or extraction near live maerl, should not be permitted. Fisheries regulations should be used to prevent damaging gear being used to catch queen scallops from maerl beds and file shell reefs.

Plate 4. Collecting scallops by hand is an alternative to dredging in shallow areas.



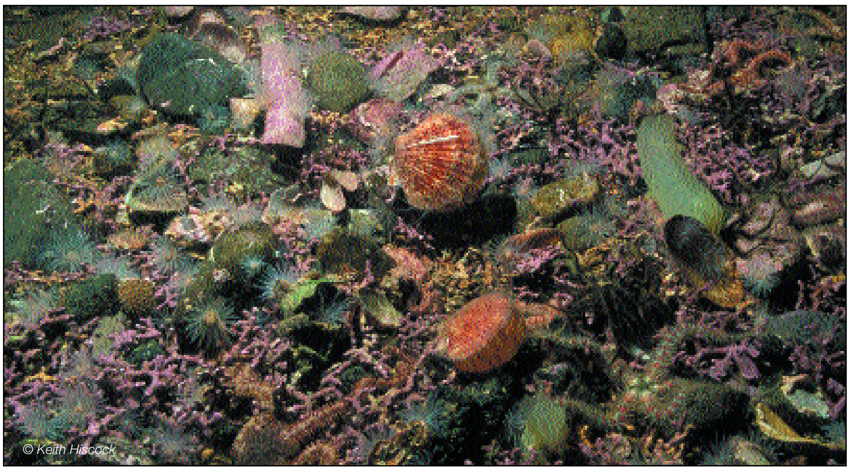


Plate 5. Mixed maerl and file shell bed supporting sea loch anemones, brittle stars and queen scallops. The file shells are buried in their "nests".

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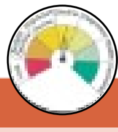
Author

Keith Hiscock



STATUS

Decline. Extent: the spatial extent (or density or key structural or functional species) has reduced by 25 per cent or less, or the habitat has suffered a "minor" but "noticeable" reduction in spatial extent (or density). Most of the habitat remains but has either shrunk in extent, exhibits cleared or disturbed patches or shows signs of erosion or encroachment at its edges. Degradation: species important for the structure and/or function of the habitat are still present but their abundance is reduced. Especially sensitive, rare or scarce species are missing, especially those species sensitive to environmental change and disturbance. The viability of a species population or the biodiversity/functionality in a community is reduced. Further degradation may result in significant decline.

In the case of maerl beds, significant decline is in the past 50 years.

full explanation at end

Horse mussel beds act as biogenic (living) reefs and provide a habitat and refuge for up to 100 other species. Queen scallops often occur here and are a targeted fishery: the dredges used to gather the "queenies" have caused extensive damage. Further threats to the beds and their rich associated communities come from increased dissolved nutrients, climate change and contaminants. Horse mussels are slow to settle and grow so that recovery may take a long time, or not occur at all. The designation of Strangford Lough, Northern Ireland, as a Marine Nature Reserve and its identification as a candidate Special Area of Conservation has failed to protect the once rich horse mussel beds there; stronger regulation of potentially damaging activities will be needed if such communities are to be protected. Strangford Lough is also a Special Protection Area, Ramsar site and contains six Areas of Special Scientific Interest.

HORSE MUSSEL BEDS

(Modiolus modiolus)

NATURAL HISTORY

The horse mussel *Modiolus modiolus* is widely distributed around most of Britain and Ireland, but horse mussel beds are restricted to northern waters. These beds occur in areas with moderate levels of tidal current exposure, particularly tide-swept channels in Scottish and Irish sea lochs (loughs) but also in open sea areas such as the Irish Sea around the Isle of Man and off the Lleyn Peninsula. Beds are most common in depths of between 5m and 70m[1]. Smaller beds or clumps are found on rocky surfaces in some Scottish sea lochs[1], while larger beds are usually found over softer mixed sediment. Where beds occur on softer sediments, the mussels are often partially buried.

Horse mussels are held together and to rocky substrata by strong byssal threads, which are produced by the mussel. When large numbers anchor in close proximity, extensive and complex networks of threads are formed. These networks trap sediment, pseudofaeces, stones and shell, forming reef structures that may be raised several metres above the seabed and can extend over hundreds of hectares.

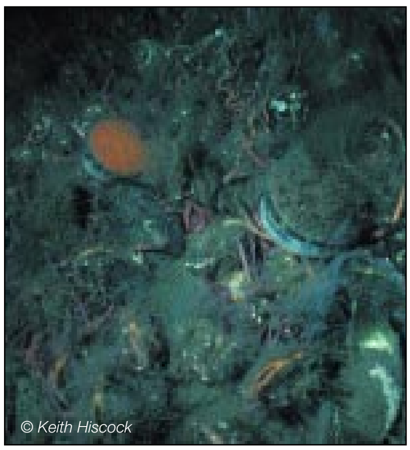


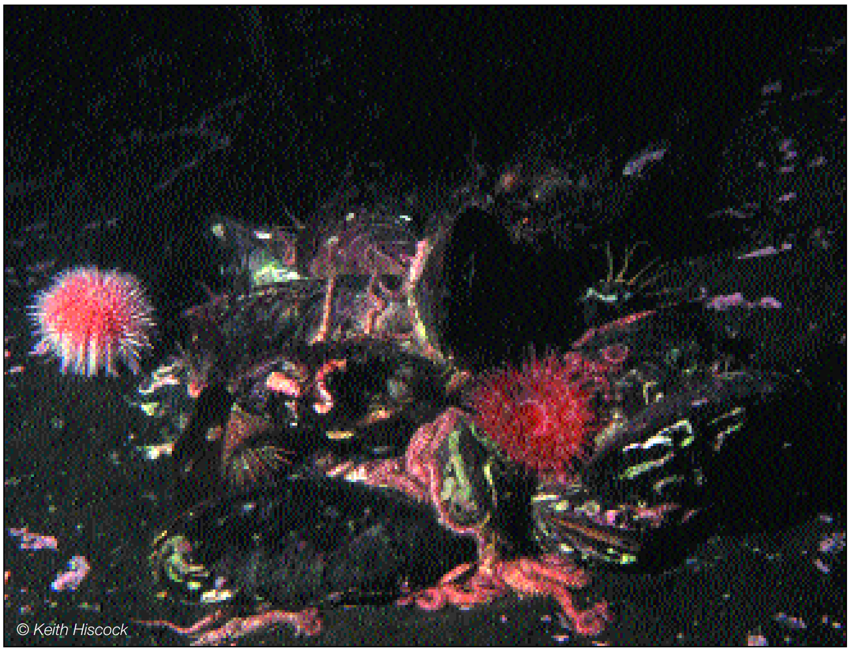
Plate 1. Horse mussel beds can grow several metres above the seabed and cover hundreds of hectares. This image shows a dense reef in the Shetland Isles.

Horse mussel beds support a diverse assemblage of suspension feeders including barnacles, tube worms, hydroids, soft corals, sea mats, sea squirts and brittle stars. Shallow reefs support foliose and crustose seaweeds [2, 3, 4].

Active predators such as the whelk *Buccinum undatum*, crabs including the edible crab *Cancer pagurus* and the common starfish *Asterias rubens* are often present on the mussel beds and may be prolific predators of young horse mussels. At the same time, the spatially complex beds provide valuable refuge for brittle stars and other small invertebrates, including juvenile horse mussels.

Mussels over 25 years old are frequent in British populations, with occasional records of up to 35 years old. However, maximum ages are thought likely to be in excess of 50 years [5]. Horse mussels first reproduce when more than four years of age [6]. Without human interference, the beds are extremely long-lasting, stable structures. However, due to their poor rate of recruitment, they are very slow to recover from any damage. It is possible that beds may in fact never recover from severe damage, particularly that caused by trawling.

Plate 2. Horse mussel Modiolus modiolus *beds provide a valuable refuge for a multitude of species including tube worms, anemones, brittle stars and sea urchins.*



EXISTING PROTECTION AND MANAGEMENT

- Horse mussel beds can be protected as a "reef" under the EU Habitats Directive and can also occur in "shallow inlets or bays", giving them further potential protection.
- Trawling and dredging has now been banned in Strangford Lough, but this may have come too late as much of the damage has already been done and the beds may never be able to recover.
- There is a UK Biodiversity Action Plan for *Modiolus modiolus* beds [1].

STATUS (DEGREE OF DECLINE)

Horse mussel beds occur extensively in wave-sheltered tide-swept areas such as tidal sounds or in deep water offshore. Beds are entirely restricted to northern waters of the UK including the Irish Sea. Their location is poorly known as they are often limited to a few hectares. The extent and diversity of associated communities in the Irish Sea is believed to have been greatly reduced since surveys in the 1950s, almost certainly as a result of use of mobile fishing gear [4, 7].

CHANGE IN STATUS SINCE 2000

Horse mussel beds are most likely to have been adversely affected wherever scallop dredging occurs. Surveys undertaken in the candidate Special Area of Conservation in Strangford Lough have especially drawn attention to damage being done. Here, surveys completed in 2003 revealed that there had been a 3.7 sq km reduction in clumped horse mussel communities since 1993[9]. It was only in 2004 that the impact of dredging in Strangford Lough was acknowledged by regulatory authorities in Northern Ireland.

ISSUES/THREATS

Fishing

The most important threat to horse mussel beds is the use of heavy trawl gear.

Climate change

Horse mussels are also vulnerable to seawater temperature change and future changes may reduce the southern range of the species.

Coastal development and dredging

Horse mussels are likely to be vulnerable to smothering by dumping of sediment or by alterations to water flow, which may be caused by coastal development.

HABITATS UNDER SIMILAR THREAT

Sabellaria spinulosa reefs, maerl beds and file shell *Limaria hians* reefs.

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites so that locations where horse mussel beds occur now or in the past can be protected from potentially damaging activities and recovery can be managed. Fisheries regulations should be used to prevent damaging gear being used to catch queen scallops.

Figure 1. Recorded and expected distribution of horse mussel beds around Britain and Ireland. Source: MarLIN

"Horse mussel communities once covered much of the bottom of Strangford Lough, forming very extensive reefs, providing habitat for hundreds of other species. Most of the area where they once lived has now been destroyed by fishing, the recent surveys [a diving research project by Queens University, Belfast] having found only one remaining living pristine reef. Fishermen use mobile gear to trawl for queen scallops that live in the habitat provided by the horse mussel clumps. With this new evidence it is now unquestionable that the commercial trawling has caused the destruction of the reefs."[8]

Ulster Wildlife Trust

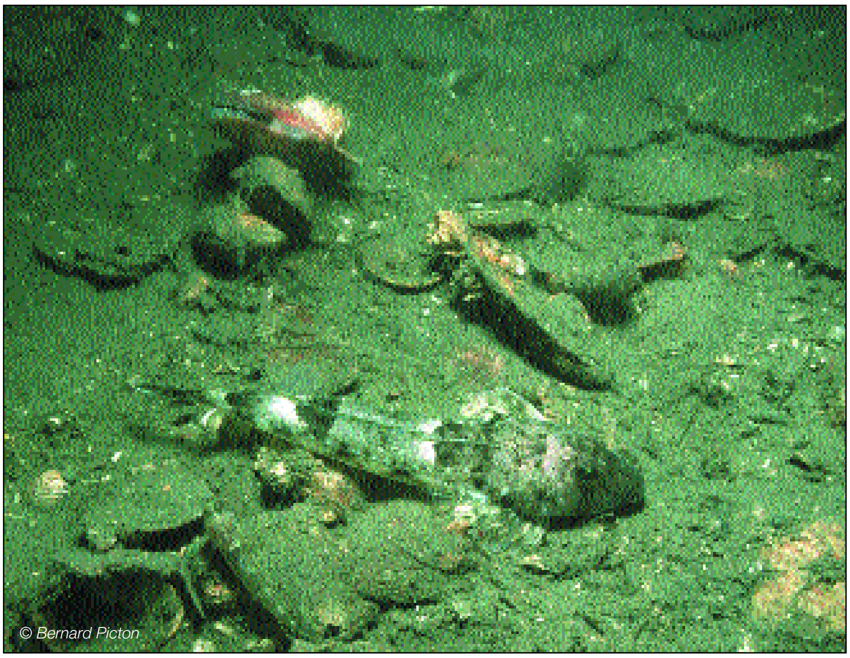


Plate 4. Seabed, previously a rich horse mussel bed, in Strangford Lough.

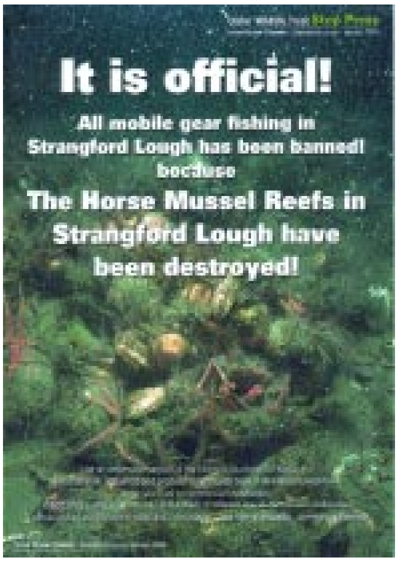
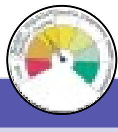


Plate 3. Leaflet issued in January 2004 by the Ulster Wildlife Trust.



STATUS

Significant decline. Extent: the spatial extent (or density of key structural or key functional species) of the habitat has declined by more than 25 to 75 per cent of prior distribution OR the spatial extent (or density) has declined "considerably". The habitat has either shrunk in spatial extent or been fragmented. Degradation: The population(s) of species important for the structure and/or function of the habitat may be reduced or degraded by the factor under consideration, the habitat may be partially destroyed, or the viability of a species population, species richness and biodiversity, and function of the associated community may be reduced. Further degradation may result in severe decline.

In the case of horse mussel beds, significant decline is in the past 50 years.

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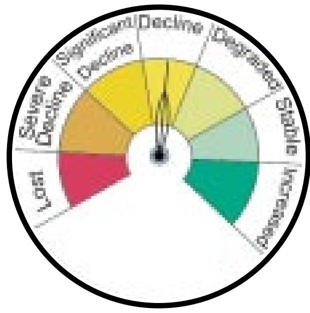
Authors

Jack Sewell and Keith Hiscock



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DEEP-WATER MUD HABITATS

Deep mud habitats are best known from sea lochs where, because of shelter from wave action, they are accessible to *in situ* survey. The deep mud, unfortunately for the wildlife community that lives there, is home to the Norway lobster or scampi. Creeling (potting) for scampi causes minimal damage to associated species and produces a high-quality harvest caught by small local boats. But the sea lochs are now open to trawling and many fragile species such as the tall sea pen are being damaged and removed by mobile fishing gear. Although mud is not a usual attraction for divers, more and more are becoming fascinated by the presence of the spectacular creatures there; perhaps soon, underwater video will bring deep-water mud habitats to a wider public.

NATURAL HISTORY

Fine, silty, nutrient-rich mud sediments accumulate in sheltered coastal areas, especially sea lochs, at depths greater than about 20m. These habitats support a high diversity of large, beautiful creatures.

On the surface of the mud, burrowing anemones such as the spectacular fireworks anemone *Pachycerianthus multiplicatus* occur. Its column and span can reach 30cm and the tube in which it lives can reach lengths of one metre[1]. The tube provides a settlement platform for a number of attaching species[2]. Also present are phosphorescent sea pens *Pennatula phosphorea* that emit waves of light and glow brightly against the darkness of the seabed. Tall sea pens *Funiculina quadrangularis*, which grow to lengths exceeding two metres, occur, sometimes in high densities. Echinoderms – particularly scavenging brittlestars, burrowing sea cucumbers, large starfish and sea urchins – are often abundant in this type of habitat. Other more familiar species such as hermit crabs and turret shells are also common[3,4].

The sea squirt *Styela gelatinosa* is only known from a deep mud habitat in Loch Goil in the UK[3,4].

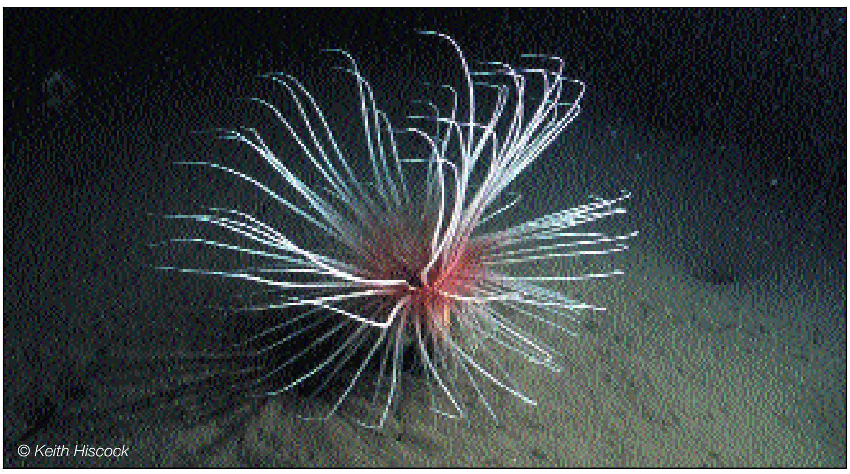


Plate 1. The fireworks anemone Pachycerianthus multiplicatus *is a very large burrowing anemone found in deep mud habitats.*

Most life in deep mud is buried in the soft, fine sediment. Large polychaete worms, bivalve molluscs and echinoderms burrow into the mud. A number of different shrimp species create networks of tunnels, of varying depths, in the sediment. The Norway lobster *Nephrops norvegicus* or scampi is also found, sometimes in great abundance, in burrows. It is the high commercial value of this species in particular that poses the greatest threat to this normally stable habitat. Trawlers targeting Norway lobsters can create trails of devastation in the mud and alter the landscape dramatically.

Plate 2. A diver examining a tall sea pen Funiculina quadrangularis *and (below) tall sea pens on the deck of a trawler.*

EXISTING PROTECTION AND MANAGEMENT

Deep mud communities have little statutory protection.

- A number of deep mud habitats are included in some of the candidate Special Areas of Conservation that were selected for "large shallow inlets and bays" under the EU Habitats Directive. However, the UK interpretation of "shallow" is an average of less than 30m in depth. Deep portions of sea lochs and deep mud habitats on the open coast do not therefore qualify for protection under the Habitats Directive.
- In 2001, a Regulation that banned trawling within a defined area of the Inner Sound of Raasay and Loch Torridon, all year round, for five years was instigated (see Change in status since 2000 for details).

Several initiatives include action to protect deep mud habitats. The Biodiversity Action Plan for "Mud Habitats in Deep Water" makes recommendations for the future management of this type of habitat [5]. Species statements for the tall sea pen *Funiculina quadrangularis* and sea squirt *Styela gelatinosa* accompany the Habitat Action Plan [5]. "Sea pen and burrowing megafauna communities" are an OSPAR "Threatened and/or Declining Habitat".

STATUS (DEGREE OF DECLINE)

Deep-water mud habitats are found in most Scottish sea lochs and the Shetland voes. They are also found in deep offshore areas of the North Sea and the Irish Sea [6].

No structured studies identify the extent of damage to habitats and species in deep mud, but observations and anecdotal evidence as well as plain common sense suggest that damage has occurred, especially to species living at or near the surface of the sediment.

In sheltered areas such as lochs or in deep water, mud species assemblages are relatively stable and slow to recover following disturbance. Studies have shown that areas may require 12 months or more to recover from the effects of trawling [7]. In less sheltered deep water, such as mud habitats in the Irish Sea, carnivorous polychaete worms and opportunistic species now dominate seabed communities in heavily fished areas and species diversity is much lower than in unfished areas [7]. Studies have not been undertaken into the impact of trawling on likely long-lived species such as the fireworks anemone, but it seems unlikely that populations will recover once lost.

Some localised areas of the seabed directly below fish farm pens are currently in poor condition.

Plate 3. The Norway lobster Nephrops norvegicus *is often very common in deep sea mud habitats. Its high market value as food products such as scampi and langoustine means that it is often targeted by fisheries.*

Plate 4. Use of creels instead of trawls can be less damaging to deep-sea mud habitats as well as producing a high quality product.

"Some of the deep mud habitats off the Black Isles in western Scotland are no longer worth taking divers to. The spectacular fireworks anemones that used to be there have all but disappeared – most likely as a result of dredging for scallops."

David Ainsley, dive charter boat skipper.

CHANGE IN STATUS SINCE 2000

Deep mud habitats in Scottish sea lochs continue to be trawled for Norway lobster, with consequent adverse effects on the associated seabed communities. However, the high profile of inshore fishing issues, together with a growing interest in natural heritage, led the Scottish Executive to review controls under the Inshore Fishing (Scotland) Act 1984. In 2001, a Regulation that banned trawling within a defined area of the Inner Sound of Raasay and Loch Torridon, all year round, for five years was instigated. The Regulation created three zones to allow comparative research to be done: one zone for creel fishing only, one for mixed-gear fishing, and one for trawl fishing only. The Regulation will be reviewed in May 2006. While favourable effects on the deep mud communities are to be expected, no work has yet been carried out that might document change in status. However, on 16 January 2003, the Loch Torridon Nephrops creel fishery was awarded the Marine Stewardship Council Environmental Standard for Well-Managed and Sustainable Fisheries.

ISSUES/THREATS

Fishing

The major threat to deep mud communities is the mobile fishing gear used to capture the Norway lobster. Trawled nets can have a devastating effect on these normally stable communities (Figure 2). The sea pen *Virgularia mirabilis* is able to retract into burrows and avoid direct damage from trawls, and deep-burrowing shrimps may be able to avoid direct impact[6]. However, the fragile sea pen *Funiculina quadrangularis* is one of many species vulnerable to damage. The use of static pots and creels can be far less damaging and produce a higher quality product[8].

Pollution

Organic pollution (for instance, pulp mill waste, sewage and fish farm waste) that results in oxygen depletion is a threat to the burrowing megafauna and sea pens which are characteristic of deep-water mud habitats. The greatest source of organic pollution, particularly in Scottish sea lochs, is salmon farming[6]. Areas directly below fish pens can be deprived of oxygen, resulting in total anoxia and the loss of all species with the exception of the filamentous bacterium *Beggiatoa*[9].

There is some evidence that pesticides used in salmon cultivation may be damaging to deep-sea mud communities[6]. Oil-based drilling mud and discharges from oil drilling activities in the North Sea are also locally damaging to some species.

Figure 1. Recorded and expected distribution of sea pen and burrowing megafauna in inshore deep mud habitats around the British Isles. Map from MarLIN website[1]

HABITATS UNDER SIMILAR THREAT

Deep-water *Lophelia* reefs, horse mussel beds, maerl beds and file shell reefs all include fragile species and are under threat from mobile fishing gear.

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites so that locations where deep burrowing mud communities occur can be protected from potentially damaging activities and recover or be restored. Biodiversity Stop Orders would also be important, as entrepreneurial fisheries could rapidly damage important sites.

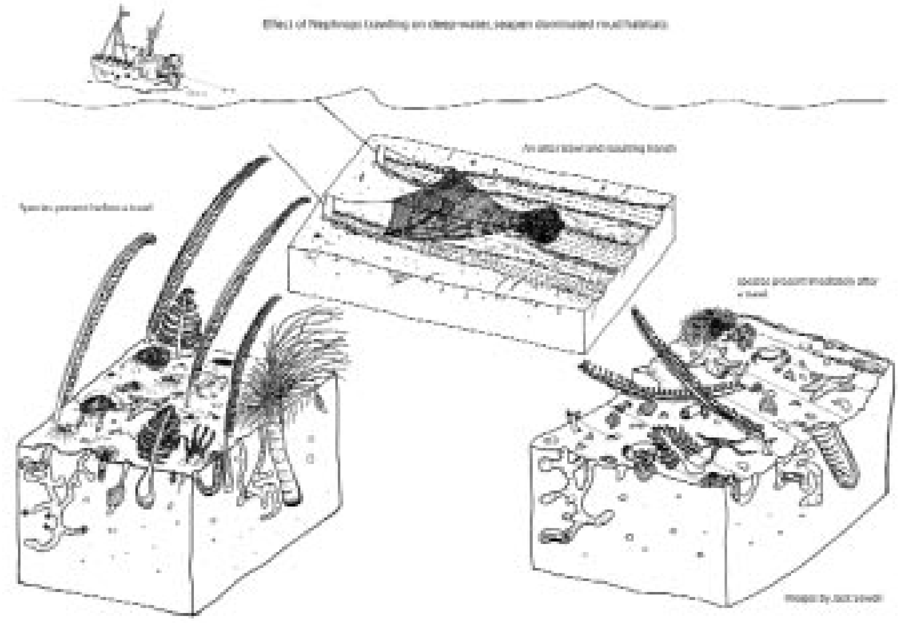
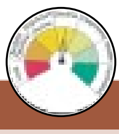


Figure 2. Diagrammatic cross-sections of sediment with fauna and the likely impact of trawling. These are representations and the sediment fauna is shown more crowded than in nature. See detailed description below.



STATUS

Decline. Extent: The majority of the habitat remains but has either shrunk in extent, exhibits cleared or disturbed patches or shows signs of erosion or encroachment at its edges. Degradation: species important for the structure and/or function of the habitat are still present but their abundance is reduced. Further degradation may result in significant decline.

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Figure 2

The diagram (above) shows burrows of the crustaceans *Callionassa subterranea, Upogebia spp* and *Nephrops norvegicus* and the fish *Lesueurigobius friesii*, a burrowing sea urchin *Brissopsis lyrifera*, the common starfish *Asterias rubens* the arms of *Amphiura spp*, terebellid worms, the sea pens *Pennatula phosphorea* and *Funiculina quadrangularis*, burrowing bivalves, *Corbula gibba*, *Nucula sulcata* and *Thyasia flexuosa*, the crab *Gonoplax rhomboids*, auger shells *Turritella communis* and the anemones *Cerianthus lloydii* and *Pachycerianthus multiplicatus*. Width of illustrated area is about 2m.
The centre diagram shows an otter trawl similar to that used for the capture of the Norwegian lobster *Nephrops norvegicus* over deep mud habitats with resulting trenches caused by the otter boards and full cod-end.
The final diagram (bottom right) shows a cross-section of sediment following a trawl: many species previously present have been damaged, removed or destroyed. Some deep burrowing species including *Upogebia spp* have avoided damage due to their deep burrows. Some scavenging species such as the edible crab *Cancer pagurus* and common starfish *Asterias rubens* have moved into the area to feed on the remains of damaged organisms.

Authors

Jack Sewell and Keith Hiscock

full explanation at end

DEEP-WATER REEFS

Deep-water reefs occur worldwide. They are present at depths in excess of 200m where surface light does not reach. The basic structure of the reef is usually stony coral, especially *Lophelia pertusa*. The reef structure provides shelter for a wide range of species and the hard surface is an attachment point for sessile species. For many years, deep-water trawlers have been fishing long-lived and slow-growing fish from the area of these reefs, often destroying the reefs in the process. Protection for the remaining reefs, together with enforcement of legislation, is urgently required.

NATURAL HISTORY

The presence of deep-water coral reefs has been known for more than a century, but it is only in the past 20 years that the technology has been developed to study them *in situ*. In the past three or four years, that information has started to be brought together[2]. The stony coral *Lophelia pertusa* is usually the dominant structural species but there are soft, black and lace corals which, together with sponges and a host of mobile species, make up these structurally diverse reefs.

Around the Norwegian/Scottish Shelf and the Faeroe Islands, *Lophelia* most commonly occurs at depths between 200 and 400m, and between 200 and 1,000m in the Massifs off west Ireland and the Bay of Biscay. Reefs may occur to depths of 3000m[3].

The cold-water coral *Lophelia pertusa* forms patches of bushy growths composed of a network of anatomising branches that grow into thickets, coppices and eventually reefs under favourable conditions. Morphology and size are highly variable but reefs may be circular, dome-shaped or elongated, forming distinct patches or arranged in lines of “islands” along the edges of the continental shelf, sea mounts, offshore banks and other raised seabed features. Although *Lophelia pertusa* dominates, other cold-water corals may also occur.

The reef supports a species-rich assemblage of invertebrates, especially suspension feeders such as foraminiferans, sponges, sea firs, gorgonians, solitary corals, polychaete worms, sea mats, lamp shells (brachiopods), star fish, brittle stars, sea cucumbers and sea squirts[4].

Plate 1. The coral Lophelia pertusa *is the main reef-forming species.*

Species lists collated from studies of *Lophelia* reefs in the north-east Atlantic [3] recorded around 886 species, although this is probably an under-estimate. The diversity of polychaete worms, echinoderms (star fish, sea urchins and their relatives) and bryozoans (sea mats) recorded from *Lophelia* reefs is similar to that found on shallow water tropical coral reefs. However, stony corals, molluscs and fish have relatively low diversities compared with tropical reefs [3].

The damage caused to deep-water reefs makes it especially important to understand growth rates and longevity of the main reef-forming organisms – the stony corals. Reefs comprise living corals growing over mounds of dead coral and other material. The main reef-forming species, *Lophelia pertusa*, grows at a linear rate of 4mm to 25mm a year [3] and it is expected that the lifespan of the living zone of coral does not exceed 20 years [5]. However, a clearer picture of likely longevity of reef-forming species is based on growth rates, and studies point to lifespans of 100 to 200 years for some mature colonies of gorgonian corals. It is therefore concluded that, once coral grounds are disrupted, it would be many decades or even centuries before the former habitat complexity of mature reefs is restored [3].

EXISTING PROTECTION AND MANAGEMENT

- Deep-water reefs had no protection in UK waters until August 2003 when the Darwin Mounds, an area of seabed to the north-west of Scotland, received protection under a European Fisheries Regulation that prohibits the use of bottom trawls [6]. It is proposed that the Darwin Mounds will formally become a Special Area of Conservation under the EU Habitats Directive.

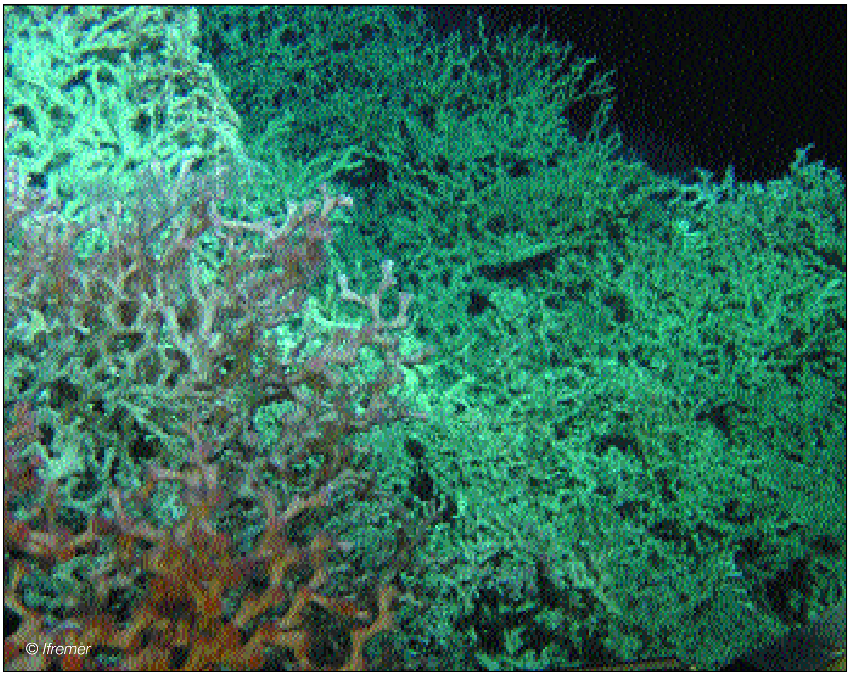


Plate 2. Deep water corals provide a complex habitat for other species to colonise.

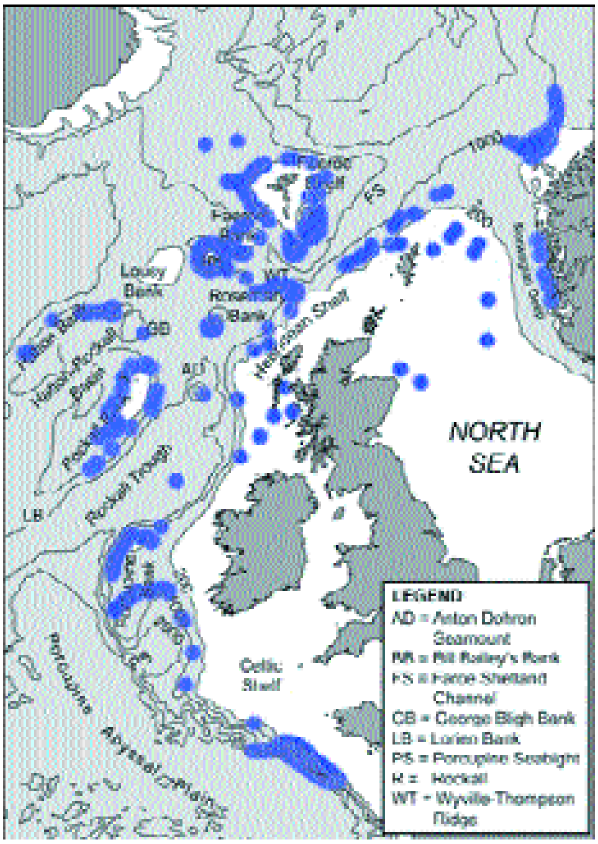


Figure 1. Distribution in the north-east Atlantic of Lophelia pertusa as reefs, mounds and patches. Source: MarLIN

STATUS

(DEGREE OF DECLINE)

The vastness of the oceans and the enormous extent of the deep seabed means that the distribution of deep reefs is poorly known. While acoustic survey techniques are improving, it may be that trawler crews have a far better idea of where reefs are than do scientists. New reef complexes continue to be found, often accompanied by signs of damage by fishing. It is very difficult even to guess at the proportion of deep-water reefs damaged by fishing or by other activities such as cable-laying. However, it has been estimated[8] that, on a typical 15-day trip in the Rockall Trough, a trawler sweeps approximately 33 sq km of seabed. The potential for significant damage to reefs is high, especially as fish tend to accumulate in such areas.

CHANGE IN STATUS SINCE 2000

Deep-water reefs continue to be damaged or destroyed by trawling and, since 2000, much research has been completed to identify its likely long-term impacts. Deep-water reefs – particularly the Darwin Mounds – have also received significant press coverage, so public awareness of the importance of protecting them has grown.

ISSUES/THREATS

At the annual meeting of the American Association for the Advancement of Science in 2004, the following documented and potential threats to deepwater coral reefs were identified:

- commercial bottom trawling and other bottom fishing;
- hydrocarbon exploration and production;
- cable and pipeline placement;
- bioprospecting and destructive scientific sampling;
- other pollution;
- waste disposal and dumping;
- coral exploitation and trade; and
- upcoming threats: sequestration of CO_2, other mineral exploitation and increased atmospheric CO_2.

At present, trawling is by far the most damaging activity, but other forms of deep-water bottom fishing such as gill nets and long-lining could also pose a threat to these fragile communities. The main concern with oil exploration is that drill mud cuttings will smother corals, although cuttings can be removed to land.

"In the summer of 2003… we found a series of deep-water reefs, the Mingulay Reef Complex, extending for over a kilometre. Samples of coral rubble from the sea floor have been dated and are more than 3,800 years old, suggesting that the coral mounds must be considerably older… The Mingulay Reef Complex is the first deep-water coral reef to be found within 12 nautical miles of the UK coastline."

Scottish Association for Marine Science Highlights 03-04[6].

"Ancient groves of invertebrates are being clear-cut by trawling just as quickly and surely as loggers felled groves of giant redwoods… we are probably losing [deep-sea] species far more quickly than we can describe them".

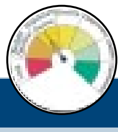
Professor Callum Roberts, University of York[1]

ACTION NEEDED

Knowing the location and character of reefs is essential if representative areas are to be protected. Since mobile bottom gear is most damaging, alternative methods of catching fish sustainably need to be explored. Representative examples of reefs need total protection and must be identified. Detailed recommendations are given in *Cold-water coral reefs – Out of sight, no longer out of mind*[2].

HOW A MARINE ACT CAN HELP

A Marine Act should include provision for designating and protecting Nationally Important Marine Sites so that locations where deep-water reefs occur can be protected from potentially damaging activities.



STATUS

Significant decline. Extent: the spatial extent (or density of key structural or key functional species) of the habitat has declined by more than 25 to 75 per cent of prior distribution or the spatial extent (or density) has declined “considerably”. The habitat has either shrunk in spatial extent or been fragmented. Degradation: The population(s) of species important for the structure and/or function of the habitat may be reduced or degraded by the factor under consideration, the habitat may be partially destroyed, or the viability of a species population, species richness and biodiversity, and function of the associated community may be reduced. Further degradation may result in severe decline.

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Author

Keith Hiscock

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WWF-UK

Panda House, Weyside Park
Godalming, Surrey GU7 1XR
t: +44 (0)1483 426444
f: +44 (0)1483 426409

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