SCOTTISH ENVIRONMENT AUDITS

1: The Marine Environment

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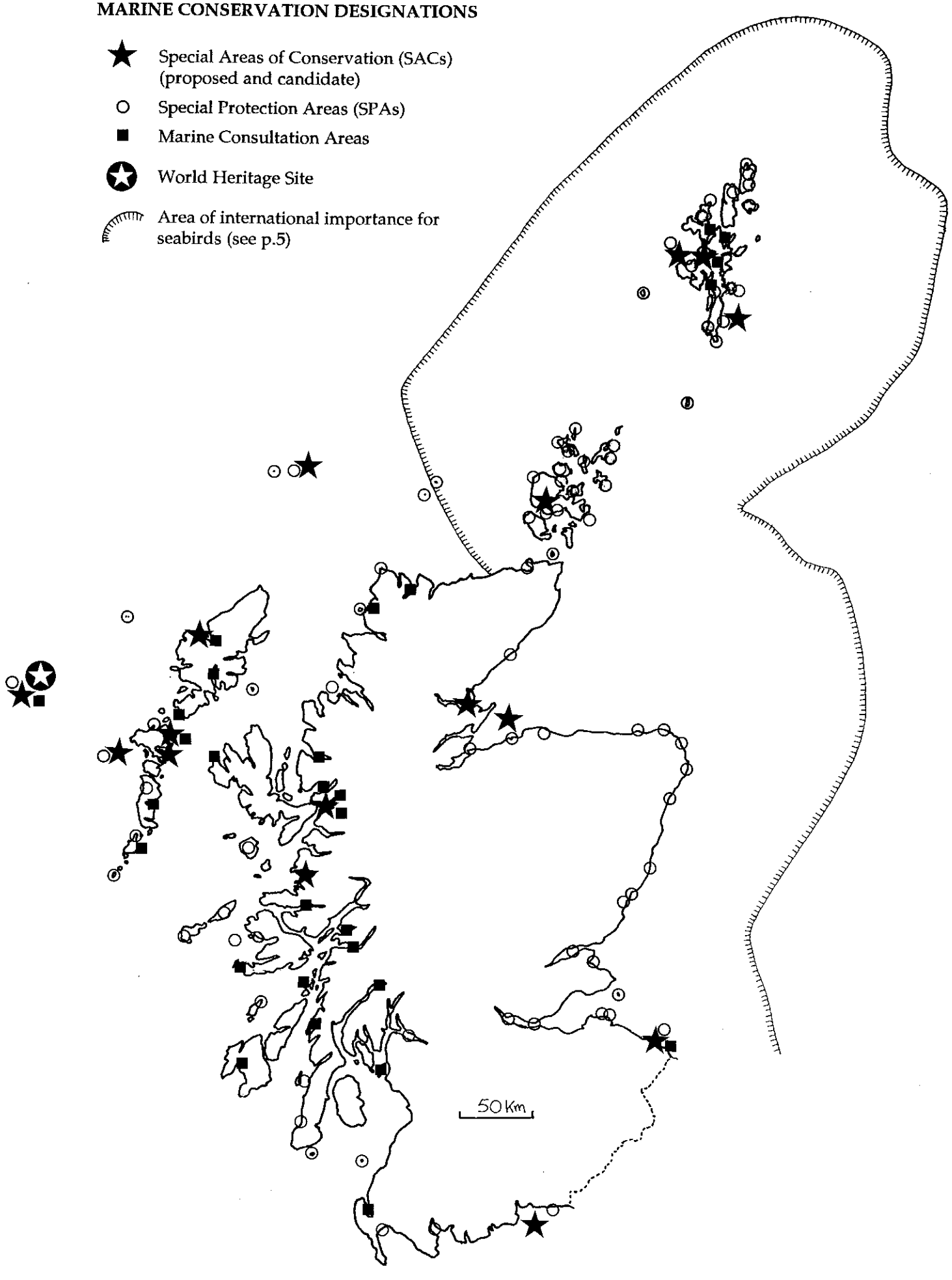
Countryside Link

MARINE CONSERVATION DESIGNATIONS



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Paper 1: The Marine Environment

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CONTENTS

INTRODUCTION

In a recent Scottish Office report, Lord Lindsay, the Minister for Agriculture, Forestry and the Environment, described the Scottish coastline as one of the most varied and beautiful in the world, home to some of the most spectacular gatherings of sea birds and mammals, and a working environment for thousands of people. The many activities taking place in this environment are acknowledged as contributing to the economy and having an impact on the natural environment [SO, 1996a].

This Audit describes major features of the marine environment and its wildlife around Scotland. It assesses present condition, changes taking place and the effects of a selection of human activities ranging from those which have a major impact on marine resources, long-standing activities and some which are relatively recent. The impacts of some are well known and regularly recorded while others are poorly understood. The Audit concludes with a view on the prospect for marine resources in Scotland.

FRONT COVER:
The illustration on the front cover shows the overall extent of Scotland to the 12 mile limit of Scottish waters. (*Courtesy Professor Michael Usher, SNH*).

1. RESOURCE CHARACTER AND CONSERVATION SIGNIFICANCE

Scotland has around 12,000 kilometres of coastline. Its marine waters, if taken as equivalent to the Scottish sector of the EC Exclusive Fisheries Zone, extend over approximately 660,000 square kilometres of sea. This is more than eight times the land area of Scotland. Approximately 65% is deep sea and 35% continental shelf. The shoreline is predominantly rocky but with substantial areas of shingle, and with sand and mud in the firths [SWCL, 1992].

The marine wildlife resource in Scottish waters is extremely rich with a great range of different habitats and species present. The resource is currently being described in the *Coastal Directories* series and, in more detail, in Marine Nature Conservation Review (MNCR) publications of the Joint Nature Conservation Committee [Hiscock, 1996].

A review of reports available in the early 1980s identified 114 sites of marine nature conservation interest in inshore waters around Scotland [Gubbay, 1985]. Subsequent surveys have improved our knowledge of these and identified many other sites, confirming the national and international conservation importance of the marine environment around Scotland.

1.1. HABITATS

A brief description of the variety of marine habitats around Scotland can be found in the overview of the natural heritage of Scotland published by Scottish Natural Heritage [SNH, 1995a].

The major physiographic features at the coast are cliffs, sounds, fjordic and fjardic sea lochs, estuaries, firths, lagoons and shallow rapids. These, together with the range of wave exposure and tidal current conditions, have resulted in the formation of a wide variety of distinctive marine communities [Hiscock, 1992].

The sea lochs of Scotland have been particularly well studied. The west coast is the only area in Britain to have glaciated, fjordic sea lochs (eg. Loch Seaforth and Loch Sunart) and fjards (e.g. Loch Maddy and Loch Roag), while the voes of Shetland and Orkney represent another type of marine inlet [SNH, 1997]. A review of Scottish sea lochs for the MNCR has highlighted 14 sites for their marine biological interest [Howson, *et al.*, 1994]. Several of these are also proposed or candidate Special Areas of Conservation under the EC Habitats Directive [see section 4.2].

The deep sheltered basins, shallow rapids and extensive saline lagoon systems of Scottish sea lochs are features of national and international conservation importance. By contrast, the Scottish coast has some of the best examples in Britain of extremely exposed habitats, such as St Kilda, with its extensive cave and tunnel systems, and Rockall, the most exposed British site, with a unique marine flora and fauna and zonation patterns.

The edge of the continental shelf to the west of Britain provides another contrast as a more remote and extensive habitat. The shelf break is a region of high productivity, often marked by dense concentrations of seabirds, shoals of fish, and cetaceans. It is a migration route for whales and the spawning ground for several commercial fish stocks [Anon, 1995]. The area is clearly of conservation importance but much remains to be learnt about this feature and its importance to marine wildlife.

Scotland's firths and estuaries have extensive areas of muddy and sandy sediments of high biological productivity, and are important feeding and overwintering areas for wildfowl and wading birds.

Whilst physical factors (especially coastal geomorphology, substratum type, wave exposure and tidal steam strength) generally determine the habitats in an area, some habitats are also created by the biological communities (Hiscock, 1985). Examples of biogenic habitats in Scottish waters are kelp beds, the reefs formed by the horse mussel, *Modiolus modiolus*, and by the tubes of the worm *Sabellaria spinulosa*, maerl beds, and sea-grass beds. The habitat formed by the marine worm *Serpula vermicularis* in Loch Creran is particularly unusual because, although *Serpula* is widespread, the formation of reefs has only been recorded from two other localities in the British Isles and in neither case are they as well developed as those in Loch Creran [SNH, 1996b]. Scotland is the world stronghold for beds of the unattached form of egg or knotted wrack, *Ascophyllum nodosum* ecad *mackaii*, a form of the brown seaweed which grows in the shelter and variable salinity of sea lochs.

Intertidal habitats can be given some protection through designation as Sites of Special Scientific Interest (SSSIs) or National Nature Reserves. Beyond low water there are very few protected areas, although sites can be designated as Marine Nature Reserves under national law, as Special Protection Areas (SPAs) or Special Areas of Conservation (SACs) under EC directives (see section 4.2), or as "Ramsar sites" under the 1991 Convention on Wetlands of International Importance, especially as Waterfowl Habitat (Scottish Office, 1996c).

1.2. SPECIES

The British Isles lies across three biogeographical regions. It is dominated by the temperate conditions of the Boreal region, but species characteristic of warmer Lusitanian regions and colder Arctic conditions also occur. All three biogeographical regions occur in Scotland. Shetland is subject to boreal-arctic conditions for example, while the influence of the North Atlantic Drift allows species more typical of warmer waters to be found off the west coast of Scotland.

The sea urchin *Strongylocentrotus droebachiensis*, and the hydroid or sea fir *Thuiaria thuja* are examples of species which have a northerly distribution and are found predominantly in Scotland while the sea anemone *Anemonia viridis* and the sponge *Axinella polypoides* have a southern biogeographical character but extend into north-west Scotland [Hiscock, 1992].

No endemic marine species have been confirmed in Scotland, although there are several species which are present in Scotland but rare or scarce in Great Britain as a whole (eg. the northern seafan, *Swiftia pallida*, and the red seaweed *Callophyllis cristata*) [Hiscock, 1992; Sanderson, 1996]. These species are, as far as current knowledge allows, being assessed at present and their distribution described in the Joint Nature Conservation Committee *Coastal Directories* series (eg. Barne *et al.*, 1996).

The deep fjordic sea loch basins harbour species found nowhere else in Britain in inshore waters, such as the sea anemones *Protanthea simplex* and *Pachycerianthus multiplicatus*, the seapen *Funiculina quadrangularis* and the featherstars *Antedon petasus* and *Leptometra celtica*. The lagoonal systems contain the most extensive British populations of the protected foxtail stonewort, *Lamprothamnion papulosum*.

Recent estimates of the number of marine species in Scotland (excluding Protozoans) lie between 10,900–13,373 (around 43,000 if Protozoans are included) [Davison, 1996], but only a few are protected under national legislation.

Marine species (excluding birds) recorded in Scotland which are protected or proposed for protection (*) (consultation paper dated 31.1.97) under Schedules 5 and 8 of the Wildlife & Countryside Act, 1981

	Cetaceans (all species)
Odobenus rosmarus	Walrus
Lutra lutra	Otter
	Marine turtles (all species)
Acipenser sturio	Sturgeon
Alosa alosa	Allis shad
Tenellia adspersa	Lagoon sea slug
Lamprothamnion papulosum	Foxtail stonewort
Alosa fallax	Twaite shad*
Cetorhinus maximus	Basking Shark*
Atrina fragilis	Fan mussel*

Seabirds also receive some protection under the Wildlife & Countryside Act, 1981. They nest in internationally and nationally important numbers on the Scottish mainland and surrounding islands. Notable sites include St.Kilda, which supports more than 400,000 pairs of breeding seabirds – one of the largest concentrations in the North Atlantic and the largest in Britain. More than 30% of the British population of the gannet nest on these islands.

The Firth of Forth is a less remote area which is important for seabirds. The Forth Islands have been designated as a Special Protection Area (SPA) under the EC Directive on the Conservation of Wild Birds (790/409/EEC) ("the Birds Directive"), because they support internationally-important numbers of gannets, shags and lesser black-backed gulls and nationally important numbers of sandwich, roseate and common terns, amongst other species [Pritchard *et al.*, 1992].

A study looking at seabird distribution in the North Sea identified an area of international importance off the east coast of Scotland, and around Orkney and Shetland [Skov *et al.*, 1995] (see map on inside front cover). More than half the world population of great skuas feed around Orkney and Shetland in July and August, and over 30% of the biogeographic population of guillemots use the waters fringing the east coast.

Marine mammals are a common sight off the Scottish coast. Islands and rocky outcrops west of the Hebrides such as the Monachs, Haskeir, Coppay and Gasker are important breeding sites for grey seals and the population in Scottish waters was estimated at 99,400 in 1994. This represents around 40% of the world population. Common (or harbour) seals are not found in such large numbers (estimated population of 26,400 in Scotland in 1994) but there are significant colonies around Orkney, Shetland and off the west coast [SNH, 1996a]. Common seals in Scotland were not seriously affected by the phocine distemper virus which killed 1,700 animals in the UK in the late 1980s.

Many cetaceans have been reported from Scottish waters. Some locations are particularly important, such as Shetland which has been identified as a stronghold of the harbour porpoise in Britain [Evans *et al.*, 1993]. Surveys carried out in 1990–92 identified concentrations of this species on the east and south coasts of the islands. The area from Mousa Sound to Helliness, and south Noss Sound were of particular importance.

Hebridean waters are also visited regularly by whales, dolphins and porpoises. Sitings include common, white-beaked, bottlenosed and Risso's dolphins, killer whales and, around

Mull, a seasonally resident population of minke whales [SNH, 1996b]. The Moray Firth is one of the few known areas in the British Isles with a resident population of bottlenosed dolphins.

The principal international measures to protect cetaceans in European waters are the Agreement for the Conservation of Small Cetaceans in the Baltic and North Sea (ASCOBANS) and the EU Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora [92/43/EEC] ("the Habitats Directive").

1.3. COASTAL LANDSCAPE

The geology, geomorphology, ecology and use of the Scottish coast and adjacent waters has created an interesting and varied landscape. Some of these places have been designated as National Scenic Areas (NSAs), although this designation is currently under review by the Scottish Office (SOAEFD, 1996c). 27 NSAs include coastal areas, covering 995 kilometres of the Scottish coast [Gubbay, 1985].

In the early 1970s, when the offshore oil and gas industry was in its infancy, a Scottish Planning Guidance document identified some areas of coast as Preferred Conservation Zones and others as Preferred Development Zones [SDD, 1974]. Preferred Conservation Zones were recognised as being areas of particular national scenic, environmental or ecological importance where major new oil and gas related developments would be inappropriate under most circumstances. These zones covered 7,546 kilometres of the Scottish coast. The whole of the north and west coast from Dounreay to Machrihanish was one such area because of the variety and high standard of its scenery and its ecological importance.

1.4. ARCHAEOLOGY

The systematic registration of archaeological material on the seabed is relatively recent, so knowledge of the range and distribution of the resource in Scotland is poor [Firth & Ferrari, 1991].

Sites of marine archaeological importance include submerged settlements and paleo-landscapes which may extend over wide areas, as well as discrete sites around shipwrecks. There is little protection for these sites with the exception of shipwrecks which can be designated 'Protected Wrecks' under the Protection of Wrecks Act 1973. Even this provides only very limited powers. There are only four Protected Wrecks off the coast of Scotland; the *Kennermerland*, a Dutch East Indiaman, and the *Wrangels Palais*, a Danish warship, both sunk off Shetland in the late 17th century; Duart Point in the Sound of Mull is thought to be the site of the wreck of the *Speedwell*, a small Cromwellian vessel lost following operations against the MacLeans of Duart; and the wreck of the *Dartmouth*, a small frigate which was lost following a storm in October 1690, lies on the seabed off the island of Mull [ADU, 1994].

2. ECONOMIC VALUE

The marine environment around Scotland is used for the extraction of living and non-living resources, the cultivation of living resources, and waste disposal, and the water space provides for activities such as shipping, recreation and military use [Eno, 1991].

The importance of all these activities to the Scottish economy is acknowledged by the Scottish Office [SO, 1996a] and can be quantified in some cases. With fisheries, for example, most landings by UK vessels take place in Scottish ports (60.2% of demersal landings [ie of bottom-dwelling species], 81.4% of pelagic landings [ie of species of the surface- or middle-waters] and 58.9% of shellfish landings). Peterhead is the largest fishing port in Europe with landings valued at £73.7 million in 1994. In the same year the figures for Shetland were £30.1 million, Fraserburgh £23.3 million and Kinlochbervie £16 million. The number of active vessels in the Scottish fishing fleet at 31 December 1994 was 2,994 [SOAEFD, 1994].

Smaller-scale inshore fisheries are also important as they are part of crofting activity, particularly along the north-west coast and the Outer Hebrides, and make a significant contribution to the local economy. Aquaculture is another important activity, and fish farming has been estimated to generate £200 million per annum in some of Scotland's most remote communities [Crown Estate, 1996].

Shipping is another vital sector with foreign and domestic traffic into Scottish ports growing steadily. The greatest trade comes through the Forth (44,359 thousand tonnes in 1994) and Sullom Voe (38,592 thousand tonnes in the same year), followed by Orkney which reported trade figures of 14,097 thousand tonnes in 1994 [DTI, 1995].

Foreign and domestic traffic in Scottish ports

Year	(Thousand tonnes)
1991	96,066
1992	98,587
1993	101,212
1994	123,805

[DTI, 1995]

Onshore jobs are created by offshore activities such as in the oil industry. Employment in companies wholly related to the North Sea oil industry was around 64,100 in 1990 [SO, 1991]. Land-based economic activity may also rely on the marine environment. A coastal location can provide more immediate access to shipping, and discharge consents allow waste disposal to the sea.

Quantifying the importance of marine resources to the Scottish economy is difficult because of the variety of uses for these resources, as well as the difficulties of putting a value on some uses. The latter point is illustrated particularly well in the case of recreation and tourism.

The natural environment is what attracts many visitors and residents to Scotland. In recent years, boat trips taking people offshore to enjoy the scenery and wildlife have become more common. Dedicated cruises for watching cetaceans or birds are also becoming popular. The dolphin-watching cruises in the Moray Firth are one example, and SNH has developed a Code of Practice (called the 'Dolphin Space Programme') with boat operators to minimise disturbance to the group of bottlenosed dolphins which they take visitors to see.

Other activities which are enhanced by, or rely on, the quality of the marine environment are angling, diving, sailing, and many watersports.

The coastline, seascape, and wildlife are part of what attracts people to Scotland and are used to promote tourism and outdoor leisure activities. It is therefore essential to include the quality of the natural environment in any assessment of the economic value of Scotland's marine resources.

3. RESOURCE USE, TRENDS, CONDITIONS AND IMPACTS

3.1. LIVING RESOURCES

3.1.1. Demersal, pelagic & shell fisheries

3.1.1.1 Fisheries policy

UK fisheries operate under the auspices of the EU Common Fisheries Policy. For most target species, an annual Total Allowable Catch (TAC) is set by the European Commission, and a percentage of this is allocated as a quota to each Member State. In Scotland, the management of quotas is largely devolved to Producer Organisations which administer the allocations on behalf of their members.

Access agreements limit where the fish can be caught within UK territorial waters. UK vessels have exclusive fishing rights out to 6 nautical miles from the coast, and other Member States may fish between 6 and 12 nautical miles where they have access agreements. These currently allow boats from Ireland into sections off south west Scotland, and French and German vessels around the Outer Hebrides, St.Kilda, the Flannan Isles, Sula Sgeir & Rona. Fishing vessels from Germany and the Netherlands may fish off southern Shetland and Fair Isle. Limits and conditions on access to fishing grounds for the conservation of fish stocks are also applied in areas defined by the EC as fisheries 'boxes' (see map on inside back cover).

3.1.1.2 Landings in Scotland

The landings of fish in Scottish ports by UK vessels have not fluctuated much between 1990 and 1994. In 1994 most of the catch by weight came from the pelagic sector, but the greatest value was from demersal landings.

Landings by UK vessels in Scotland

	1990	1991	1992	1993
Weight (thousand tonnes)				
Scotland	458.4	432.4	442.4	463.2
Demersal	184.5	171.4	162.1	184.3
Pelagic	233.3	215.0	234.2	233.6
Shellfish	40.6	45.9	46.1	45.3
Value (£ million)				
Scotland	267.6	266.7	249.9	260.7
Demersal	178.5	179.2	163.4	167.2
Pelagic	28.4	25	26.8	29.2
Shellfish	61.0	62.5	59.7	64.2

[SOAEFD, 1994]

In 1994 foreign fleets landed 22,799 tonnes of pelagic species and 19,102 tonnes of demersal species into Scottish ports [SOAEFD, 1994].

Cod, haddock, saithe, whiting, herring and mackerel dominate the landings at Scottish ports (eg. 137,521 tonnes of mackerel and 72,327 tonnes of haddock in 1994). There are also significant landings of blue whiting (18,725 tonnes in 1994), which is caught by foreign vessels west of the Outer Hebrides.

3.1.1.3 Deep water fisheries

In the early 1970s, MAFF scientists carried out surveys to assess the potential for new fisheries from the continental slope, and the lower slopes of offshore banks such as the Rosemary Bank, Bill Bailey's Bank and Rockall Bank which lie north west of the Scottish mainland [Bridger, 1978]. Loss of access to distant waters by European fleets, and the pressures on

traditional stocks such as cod and haddock, have resulted in targeted deep-water trawling in these areas. The growth of this sector can be seen in the landings of deep sea fish such as blue ling, round-nosed grenadier, and black scabbard in Scottish ports.

Blue ling and roundnose grenadier landings in Scottish ports (tonnes)

Blue ling	1990	1991	1992	1993	1994
UK vessels	4	74	76	124	112
Foreign vessels	+	58	850	1,394	1,327
Grenadier					
UK vessels	+	+	134	2	11
Foreign vessels	40	455	2,128	2,307	2,248

[SOAEFD, 1994]

3.1.1.4 Industrial fisheries

Industrial fisheries, where most of the catch is converted into fishmeal, represent another sector of the industry. Blue whiting, capelin, sand-eel, sprat and Norway pout are taken in directed fisheries, and excess production from human consumption fisheries is also put to industrial use [Anon, 1996].

Sand-eels make up about half the industrial catch and some of the most productive areas for this fishery in recent years have been off the east coast of Scotland. The Wee Bankie, which lies approximately 40 kilometres east of the Firth of Forth, is one such site. Sand-eel catches from this area reached a peak in 1993 (99,000 tonnes) and then reduced to 50,000 tonnes in 1994 and 32,000 tonnes in 1995 as stocks fluctuated [Dunn, 1996].

3.1.1.5 Shell fisheries

Shellfish landings in Scotland by UK vessels stayed fairly constant between 1990 and 1994 (see table on page 7). The major ports for landings are Fraserburgh, Mallaig and Oban, each of which took more than 2,000 tonnes in 1994. Landings are smaller elsewhere, but shell fisheries are important to many ports and harbours around the Scottish coast.

The main species of shellfish which are targeted are edible, velvet and shore crabs, lobster, Dublin Bay prawn or scampi (*Nephrops*) and scallops. The emphasis varies from area to area, but potting for edible crabs, velvet crabs and lobsters takes place out of many small fishing ports on both coasts. It is widespread along the west coast, especially as a component of the crofting economy, but of more localised importance on the east and north coasts. The trawled *Nephrops* fishery is concentrated around the Firth of Clyde, the Minch, the Fladden ground (east of Shetland and Orkney), and east of the Moray Firth and Firth of Forth [ICES, 1994b].

3.1.1.6 Impacts of fisheries on stocks

The status of many of the north-east Atlantic finfish stocks is now a matter of serious concern. 42% are considered to be seriously over-exploited, 15% over-exploited, 36% fully exploited and 7% collapsed [Anon, 1996]. The 1993 overview of demersal stocks in the North Sea by the ICES Advisory Committee on Fishery Management (ACFM) recommended that fishing effort in the directed fisheries on all North Sea roundfish, except saithe, should be reduced significantly and on a sustained basis, relative to effort levels in the most recent years. The minimum appropriate reduction was considered to be 70% [ICES, 1994a].

Assessment of roundfish stocks to the west of Scotland (ICES Sub-area VI) has been difficult due to the poor quality of data, but ACFM noted that all spawning stocks, except for haddock in area VIb (whose status was uncertain), were at their lowest recorded levels in 1992. The ACFM forecast that these spawning stock levels were likely to remain stable or increase marginally, but, nevertheless, remain critically low. The ACFM's evaluation of these stocks was that they were subject to excessively high fishing rates and had critically low spawning biomass, and it recommended that fishing effort, as well as TACs, should be reduced [ICES, 1994a].

Concern has also been expressed about the effects of exploitation of deep-sea fish and, in particular, whether enough is known about their biology, life history and ecology for TACs for these species to have any real meaning or be effective in achieving a sustainable fishery. The effects of such uncertainties were illustrated in New Zealand, for example, where biologists were required to set a Maximum Sustainable Yield (MSY) for a deep sea fishery of orange roughy, despite a lack of information on the natural mortality rate for this species. Subsequent work revealed that the MSY had been over-estimated by a factor of six. An 84% decrease in the catch was recommended, but this was not acted upon and the fishery has since collapsed [Norse, 1993]. This example highlights the need for caution if deep water fisheries to the west of Scotland (see section 3.1.1.3) are to be developed.

Local collapses of shell fisheries are another sign of the pressure on certain stocks. The cockle fishery on the Solway Firth has been closed since 1992, following the collapse of the stocks after a period of intensive fishing.

No collapses of crustacean fisheries have been reported around Scotland. The view taken by ICES with regard to *Nephrops* is that some stocks are underexploited (e.g. those on the Fladden Ground), and that, in the majority of cases, the current level of fishing should not cause a problem. However, ICES added a cautionary note on the fisheries in the Minch and Firth of Clyde and recommended that these should not increase. The Firth of Forth fishery was the only one on which ICES recommended a reduction in fishing effort [ICES, 1994b].

Minimum landing sizes and restrictions on the taking of berried females of lobsters and crabs [ie those carrying eggs] are amongst measures which have been introduced to prevent overexploitation of crustaceans, but there are no quotas or restrictions on fishing effort (although some creel boats with two of a crew can lay more than 1,000 pots at a time).

The absence of effort control may put considerable pressure on stocks in some areas, but lobster stock enhancement projects – which involve rearing juvenile lobsters and placing them on the seabed to reach maturity and contribute to the fishery – may be a way of supplementing stocks. This idea has the support, for example, of the Western Isles Fisheries Association, which believes that lobster stocks in its area have declined by up to 40% since the early 1980's [*SCENES*, 1995a]. Trial enhancement schemes are underway around Shetland and Skye.

3.1.1.7 Impacts of fisheries on wildlife

There is an extensive literature describing the impacts of fishing on marine wildlife and habitats [Dayton *et al.*, 1995]. Much of this impact can be attributed to incidental take, by-catch and direct damage.

An investigation into the effects of beam trawling, which was carried out in the southern North Sea, recorded substantial by-catch associated with this fishing technique. The target species only made up between one-fifth to one-third of the catches. The remainder was by-catch. There was also nearly 100% mortality of specimens of *Arctica islandica*, a long-lived bivalve, which were caught by the trawl. Intensive beam trawling has been reported to cause significant changes in benthic communities by causing damage and mortality to species of echinoderms, polychaetes and molluscs [Bergman *et al.*, 1990].

Scallop dredging is also known to damage sessile species and infauna [ie animals living in the sediments]. Experimental dredging in shallow water in Loch Ewe showed selective removal of a fraction of the fragile and sedentary infauna, and destruction of large infauna and epifauna [ie animals living on the substrate]. Large numbers of razorshells, common starfish and edible crabs were killed or damaged, and dead sand-eels littered the seabed after dredging. There was also a substantial reduction in polychaetes, and the burrowing urchin *Echinocardium* [Eleftheriou & Robertson, 1992].

Trawling can also have an impact on deep sea benthos [ie bottom-dwelling species] and has damaged and dislodged reefs of the coral *Lophelia pertusa* [Bridger, 1978]. Many of the species which inhabit the deep sea are thought to be slow growing, long-lived and slow to mature, and to have a low natural adult mortality, and this makes them particularly vulnerable to trawling.

The incidental capture of seals, cetaceans and seabirds in drift nets and set nets is another impact of fishing activity on marine wildlife. In 1980, 107 seals were caught in the first season when tangle nets were used in the Outer Hebrides [Northridge, 1988]. In the North Sea, the harbour porpoise is one of the cetaceans most commonly caught by bottom-set gill nets and tangle nets. The EC Habitats Directive requires member states to protect this species, yet a ban on the carriage of monofilament nets off the Scottish coast was lifted in late 1996, despite widespread opposition from conservation groups [*SCENES*, 1996c].

The effect on top predators caused by removing large quantities of fish is another issue of concern. The fishery for sandeels around Shetland was closed in 1991 because of a collapse of stocks. This collapse is also thought likely to have contributed to the failure of seabirds such as Arctic terns to rear chicks for several years but no direct link with the fishery has been proven [Lloyd *et al.*, 1991]. A limited fishery has been permitted since 1995, because of stock recovery, but seabird populations have still to recover.

One study which should help to improve understanding of these sorts of issues is a research project looking at the effects of large-scale industrial fisheries on non-target species ('ELIFONTS') off the Firth of Forth. Its objective is to determine how changes in the abundance of the stocks influence top predators and predatory fish in the area.

Fish and offal which are discarded at sea have become an important part of the diet of seabirds such as great skuas, gannets, fulmars and lesser and greater black-backed gulls. The number of seabirds potentially supported by fishery waste in the North Sea has been

estimated to be of the order of 5.9 million individuals [Garthe *et al.*, 1996].

Another, more controversial interaction between wildlife and fisheries is that between seals and commercial fish stocks. Many fishermen believe that seals take a significant proportion of fish which would otherwise enter the commercial fishery. However, estimates of fish consumption by major predators in the North Sea indicate that fishermen remove 25 times as much fish as seals, and that other fish remove 30 times as much as seals [Hislop, 1992]. Nevertheless, the issue remains a concern, and has led to calls for a seal cull from a number of fishermen's organisations [*SCENES*, 1996e].

The limited amount of data from the period before major fisheries were established makes it difficult to be precise about the scale and effect of fishing in waters around Scotland, and to discriminate between changes caused by fishing activity and those resulting from natural variability. A collaborative study which should provide useful information is being carried out by 11 research groups in Europe, including scientists from the Scottish Office Agriculture, Environment and Fisheries Department (SOAEFD) marine laboratory at Aberdeen.

One element of this study involves monitoring changes in benthic communities in the Gare Loch on the Clyde during a 17-month controlled fishing experiment, followed by 15 months when the area will not be fished. Fishing has been restricted at the site since 1967, due to the presence of the navy dockyard and a submarine base, and banned since 1989, thus providing useful control sites.

3.1.2. Marine aquaculture

3.1.2.1 Salmon farming

The sheltered sea lochs and inlets of the west coast of Scotland are particularly suitable for marine aquaculture. The industry developed in the 1980s, and aquaculture facilities are now common in sheltered coastal areas.

The main species used in finfish production is the Atlantic salmon, *Salmo salar*. In 1995, there were 268 operational salmon farm sites and 91 'non-producing' sites. The number of operational sites has stayed fairly constant over recent years but production has increased. This has been attributed to improved survival and increased weight of fish [Ross, *in prep.*]. In 1995, the highest production came from Highland Region [SOAEFD, 1990-96].

Salmon production in Scotland

Year	(tonnes)
1990	32,350
1991	40,593
1992	36,101
1993	48,691
1994	64,066
1995	70,060
1996 (estimate)	83,300

[Ross, *in prep.*]

3.1.2.2 Impact of salmon farming

There has been concern about the environmental impact of salmon farming since the start of the industry in Scotland [Earll *et al.*, 1992].

Chemical biocides are used to control sea-lice infestation. The active ingredient in one widely used preparation (Nuvan or Aquaguard) is dichlorvos, which is known to be toxic to marine plankton and have sublethal effects on invertebrates and lobster larvae. The use of dichlorvos is being reduced, as it is on the UK Red List of dangerous substances [SEPA, 1996b] and because sea-lice are acquiring immunity to it.

In September 1996, the Scottish Environment Protection Agency (SEPA) licensed and began to issue consents for the use of ivermectin to control sealice, despite concerns being raised by conservation organisations and the fishing and shellfish farming industries about the likely environmental impact [*SCENES*, 1996d]. This chemical does not have a product licence for use on fishfarms, but can be prescribed by veterinary surgeons; the SEPA Fish Farming Advisory Group is currently assessing its use on fishfarms, usually as an additive to fish food [SEPA, 1996b].

Experiments on the environmental impact of ivermectin have shown that mussels bathed in a dilute solution of ivermectin accumulated the chemical to levels 750 times that of the water in six days, illustrating the potential for it to be concentrated through food chains [Bennet *et al.*, 1995]. It has sublethal effects on the feeding and burrowing ability of lugworms, and therefore may affect aeration of the sediment and the breakdown of organic matter on the seabed beneath fish farm cages [MAFF, 1995].

The SEPA Fish Farming Advisory Group is also currently assessing the use of azamethiphos and cypermethrin on fishfarms [SEPA, 1996b], and there have been newspaper reports that the latter chemical has already been used on at least one fishfarm on Shetland. Hydrogen peroxide can also be used to control sea-lice, and is believed to have much lower impact on

the environment around fishfarms, but it is much more expensive. Attempts to reduce the need for chemicals by using goldsinny wrasse as natural predators to control sea-lice have not proved cost-effective.

Antibiotics are used to treat bacterial disease in the fish and were administered widely and on a routine basis in salmon feed in the early 1990s [Ross, *in prep.*]. Their release into the marine environment in active form (eg. as uneaten pellets or fish faeces) makes them available to be eaten by other marine fauna and, although much disappears within a few weeks, residual concentrations of oxytetracycline have been found in sediments seven months after administration. Some researchers have suggested that this enhances the development of anaerobic conditions in the sediment [Jacobsen & Berglind, 1988].

Faecal and waste food material which fall to the seabed beneath fish farm cages are another source of pollution. The build up of waste causes organic enrichment and can result in anoxic conditions and the release of hydrogen sulphide gas under cages. Localised increases in concentrations of ammonia have been reported in the vicinity of fish farms and subtle effects of enrichment have been detected 100 metres from cages [Weston, 1990].

A strategy of 'fallowing' has been recommended by SOAEFD for disease control but it is also valuable in allowing recovery of the benthos. In 1995, 43% of sites were fallowed for some period and 26% of sites reported no production all year [SOAEFD, 1990-96].

3.1.2.3 Shellfish cultivation

In 1995, 1,267 tonnes of shellfish were cultivated from 315 sites in Scotland; 70% of this production was of mussels, and the balance was of oysters and scallops [SEPA, 1996b].

Shellfish cultivation does not present a problem in terms of chemical inputs, but waste can accumulate on the seabed under these facilities. Pseudo-faeces from mussels, for example, will sink to the seabed and can smother the natural communities. Other potential problems come from the ability of bivalves to deplete the standing crop of phytoplankton and remove suspended sediment, thus improving water clarity, which in turn could promote growth of benthic algae [Eno, 1991], but no such problems have been reported from Scottish operations.

A less intensive approach is the idea of 'ranching', where shellfish are laid on the seabed and left to develop under more natural conditions. The full potential of this approach has yet to be explored but it is starting to receive some consideration. However, the full development of this potential industry will depend on the granting of Several and Regulatory Orders by the Scottish Office to protect the ranched stocks, and delays and problems persist with the granting of these Orders.

3.1.2.4 Other impacts and future trends

Birds and mammals are attracted to aquaculture facilities to feed on the fish and shellfish. Grey seals, common seals, herons, cormorants, shags and otters take salmon, and eider ducks feed on mussels. Routine shooting was permitted in the past but, since January 1996, this may only be done under licence. Control of seals has also involved shooting, but there is increasing reliance on acoustic seal scarers. This has raised concern about displacing seal populations and the incidental effects of noise on cetaceans in the vicinity.

Aquaculture also has a visual impact on the coastal landscape (eg. floating cages, buoys, and industrial units associated with facilities), and the impact of salmon farming on wild salmon is another concern (see section 3.1.3).

Production of farmed fish and shellfish continues to rise, although the number of sites has not changed significantly in recent years. SOAEFD has warned that care needs to be exercised to ensure that optimal stocking levels are not exceeded and possible disease problems reintroduced. This would, in turn, lead to the use of more chemicals for treatment.

The industry is also broadening its scope with other types of aquaculture being developed. Research is underway on methods of cultivating the sea urchin *Psammechinus miliaris* in salmon farming cages as a polyculture with the salmon. Halibut are being farmed commercially at three sites, and experimental work is being carried out on the rearing of turbot and cod. The environmental implications of such enterprises are not clear, but are likely to be similar to those from other types of aquaculture eg. chemical pollution, accumulation of toxins and damage beneath cages of suspended cultures.

The growth of the fishfarming industry also has implications beyond the sites, through demand for industrial fish used in the manufacture of fish feed pellets (see section 3.1.1.4).

3.1.3. Wild salmon and sea trout

Wild salmon and sea trout are caught by rod and line, net and coble, and fixed engines. The reported number of salmon and grilse caught in Scotland in 1994 increased by 10% on 1993 and the weight of fish caught increased by 18%.

Numbers and weight of wild salmon and grilse caught and retained in Scotland.

Number (thousands)	5 year average (1989-93)	1993	1994
Rod & line	76.9	79.5	76.8
Net & coble	50.3	33.0	30.1
Fixed engine	60.3	53.8	76.4
Weight (tonnes)			
Rod & line	278.5	283.2	286.7
Net & Coble	168.2	108.0	109.3
Fixed engine	179.0	155.4	248.1

[SOAEFD, 1995]

The largest catches were from the east, north-east, Moray Firth and northern regions.

The total catch of sea trout in 1994 fell by 5% compared to 1993. This was due to a fall in catch by rod and line, and net and coble, but a 26% increase in catches by fixed engine. The weight of fish caught fell by 12% compared to 1993. The largest catches came from the east and north-east regions.

Numbers and weight of sea trout caught and retained in Scotland.

Number (thousands)	5 year average (1989-93)	1993	1994
Rod & line	33.1	33.5	29.2
Net & coble	25.0	19.7	17.7
Fixed engine	7.6	6.3	9.6
Weight (tonnes)			
Rod & line	31.2	31.9	25.4
Net & Coble	31.9	24.5	20.8
Fixed engine	8.2	6.7	9.5

[SOAEFD, 1995]

There has been concern over the fall in sea trout catches on the west coast of Scotland. Possible causes being examined are disease, food supply, predation and sea-lice. In relation to the spread of disease and parasite infestations to wild stocks there has been speculation about a possible link between the high incidence of sea-lice at salmon farms and the decline in wild sea trout populations, whose catches fell dramatically in 1989–90 and which have failed to recover [Ross, *in prep.*].

The genetic degradation of wild stocks as escaped fish breed with wild fish is another worry. Salmon of farmed origin now make up 70–80% of the populations in some rivers [Ross, *in prep.*]. Out of the total number of salmon and grilse caught and retained in 1994, 1,460 (4.6 tonnes) were known to be of farmed origin representing 0.8% of the total catch [SOAEFD, 1995].

The West Highland Sea Trout & Salmon Group was formed in 1994 because of concern about the state of sea trout and some salmon stocks in the west Highlands and Outer Hebrides. Salmon catches by rod and line have increased gradually over the last 40 years but have declined in some rivers. Assessment of the state of stocks is complicated by catches being supplemented by escaped farmed salmon [West Highland Sea Trout & Salmon Group, 1995].

In the case of sea trout, there have been "widespread moderate reductions in their availability to the fisheries", but in the West Highlands "sudden unprecedented declines, way beyond any national trends in sea trout catches" [Atlantic Salmon Trust, 1993]. Preliminary analysis suggests that the main reason is an increase in mortality at sea [Walker, 1993] and there is real concern about the adequacy of the spawning populations to sustain the stocks. An action plan has been produced with recommendations on wild fisheries management and fish farming [West Highland Sea Trout & Salmon Group, 1995].

3.1.4. Seaweed harvesting

Seaweed washed up on the shore has been collected for application to the land as part of crofting activities for many years in Scotland. Most collection is small scale and for local use, but some material is taken for commercial extraction of alginate for use in food and pharmaceuticals. The principal species is the knotted wrack *Ascophyllum nodosum* which is collected from intertidal areas in the Western Isles and Orkney. An unattached form (*A. nodosum* ecad *mackaii*) is found in very sheltered conditions, particularly in sea lochs, and complete beds have been removed in the Uists [Eno, 1991]. A habitat action plan for these unattached *Ascophyllum* beds is in preparation by Scottish Natural Heritage and the Scottish Biodiversity Group (see section 4.3).

Kelp harvesting is a commercial activity in some parts of the world, and in 1991 trials were conducted in Scotland on the feasibility of collecting large quantities of one kelp species, *Laminaria hyperborea*, by dredging. This has not been followed up, but small-scale kelp harvesting does take place in Orkney.

The calcified red seaweed, maerl (often locally known as coral), is also collected commercially. It grows in shallow sublittoral areas off the coast of Scotland and is most common off the west coast and Orkney, where it occurs in small patches and extensive beds. Living maerl beds can contain a rich mix of species, and so are of considerable nature conservation value. The EC Habitats Directive lists two species of maerl as plants whose taking in the wild and exploitation may be subject to management measures.

Maerl extraction has only recently become the focus of commercial activity in Scotland. It is licensed by the Crown Estate after consultation with other government departments through the 'Government View' procedure. Following a favourable Government View in August 1996, a licence was issued for maerl extraction from Wyre Sound in Orkney. A condition was added to the licence requiring a monitoring programme, with an annual report of the findings to be submitted to SNH. The licence allows the removal of a maximum of 4,000 cubic metres of maerl per year over a 5-year period.

Extraction of maerl causes direct damage to the maerl beds, and can effect adjacent areas of maerl and other benthic communities in the vicinity of the dredged sites.

3.2. NON-LIVING RESOURCES

3.2.1. Oil and Gas

3.2.1.1 Scale of the industry in Scotland

The first licences for oil exploration in the UK sector of the Continental Shelf were issued in 1964, but it was the discovery of the Forties Field in 1970 which marked the real start of the offshore industry. The major oil fields off the coast of Scotland are in the East Shetland Basin and the central North Sea. The Forties Field (block 21/10) in the central North Sea remains the biggest field in the UK sector.

Oil is piped ashore to the mainland at Nigg in the Moray Firth, and Cruden Bay, north of Aberdeen, then by onshore pipeline to Grangemouth on the Firth of Forth. Other pipelines take oil to Flotta on Orkney, and to Sullom Voe on Shetland (see map on inside back cover).

As shown below, total offshore oil production from UK fields north of 55° 45'N rose steadily between 1991 and 1995.

Oil production from offshore fields north of 55° 45'N (thousand tonnes)

1991	1992	1993	1994	1995
83,129	85,222	90,213	114,383	116,743

Gross gas production from fields north of 55° 45'N (million cubic metres)

1991	1992	1993	1994	1995
4,970	5,612	9,286	12,906	14,348

[DTI, 1996a]

The main gas fields in the UK sector of the continental shelf are in the southern North Sea, but some gas is piped to the Scottish mainland from the fields north-east of Shetland and from the Norwegian sector. Gross gas production has increased steadily with production figures over 2,000 million cubic metres each in 1995 from the Bruce and Miller fields.

In recent years there has been considerable interest in the 'frontier region' north and west of Orkney and Shetland and south-east of the Faeroes, with blocks being offered in the 17th round of offshore oil and gas licensing in 1994. The first licences in this area were offered in 1972, and the Clair Field was discovered in 1977, but this field has still to be developed. The discovery of major oil fields at Foinaven in 1992 and Schiehallion in 1993 have given added impetus to work in the area as these fields represent a significant percentage of remaining UK reserves.

Oil from the frontier region will be extracted using a Floating Production and Storage Operation (FPSO). It will be piped to a vessel which will hold several days production, before off-loading onto shuttle tankers to be shipped from the fields. BP expects to start production from the Foinaven Field in 1997.

A 7th onshore licensing round was announced in July 1995 and held under new regulations allowing a single licence for oil and gas exploration, appraisal and development. All unlicensed areas of onshore Britain were covered, including a number of 'watery areas' (approximately equivalent to internal waters). Around the coast of Scotland these included a sea area to the west of Scotland including the Minch, Sound of Jura and Firth of Clyde. Other areas where licences were offered were the Solway Firth, Firth of Forth, Cromarty Firth, inner Moray Firth and internal waters around Orkney and Shetland. In the event, no near-shore oil and gas activity was licensed. No reasons were given for dropping areas and they may be offered in future rounds if there is interest from oil companies [DTI, 1996b].

The onshore round included a number of blocks that straddle land and sea boundaries. A licence was awarded for a block at the head of the Solway Firth, but with a condition prohibiting oil and gas activity below the low water mark.

3.2.1.2 Environmental impacts of oil and gas

There are concerns about the environmental impact of the oil and gas industry at all stages from evaluation, to exploration, development, production and refining [Neff *et al.*, 1987], as well as the decommissioning of production structures at the end of their useful life (see also section 3.4.1 for impacts of oil shipping).

At the evaluation stage, the impacts of seismic surveying on marine mammals has yet to be determined and there is ongoing research on this issue. Concerns which have been raised include the potential disturbance, damage to auditory systems, stress response lowering resistance to disease, and disturbance of food sources [Pullen, 1996]. A recent study into the effects on common dolphins suggests an avoidance reaction and possible tolerance beyond 1 kilometre from the source [Goold, 1996].

At the exploration, development and production phases, environmental effects include those caused by discharge of drilling fluids, muds and cuttings, acute and chronic discharges of petroleum and other pollutants, risks of blowouts, and seabed damage [Davies & Wilson, 1995]. Around 1,600 chemical substances or preparations were registered for use offshore on the DTI List of Notified Chemicals in 1994, but no details were given as to their function or quantities used. MAFF has estimated that at least 100,000 tonnes of these chemicals are discharged into the UK sector of the North Sea every year [Ryecroft *et al.*, 1995].

The total annual quantity of production, utility and drilling chemicals used in the UK sector was 184,588 tonnes in 1990, 309,311 tonnes in 1991, and 222,010 tonnes in 1992, more than 50% of which was discharged into the marine environment each year [MAFF, 1994]. Sublethal effects on organisms exposed to contaminated drill cuttings include decreased feeding activity in deposit-feeding bivalves, changes in immune responses of fish and reduced spawning by herring in oil-contaminated sediments [Pullen, 1996].

Surveys in the Ekofisk and Eldfisk fields for the Norwegian government have shown effects within a 3-kilometre radius around structures. The most significant biological impact reported has been on the burrowing brittlestar *Amphiura filiformis* where densities have fallen from more than 100 per square metre to zero within 1–2 kilometres of the platforms [Pearce, 1995].

Drilling muds are used by the oil and gas industry to cool and lubricate the drill bit, to remove rock chippings from the well, and to maintain safety during drilling by assisting in well pressure control [UKOOA, 1994]. The three main types are water-based muds (WBMs), oil-based muds (OBMs) and pseudo-oil-based muds (POBMs). They contain components such as barites, with variable amounts of toxic heavy metals, bentonite, inorganic salts, detergents, a variety of organic polymers, corrosion inhibitors, biocides and lubricants, suspended in dissolved water or oil/water emulsions [Zevenboom *et al*, 1992]. Where drilling has been carried out using OBMs, elevated hydrocarbon concentrations have been found more than 2 kilometres from platforms at least 5 years later.

The use of OBMs is no longer permitted by certain North Sea states (eg Norway and the Netherlands) but they can still be used and discharged in the UK sector, representing a major source of hydrocarbon input. Although POBMs are generally less harmful, they are not without problems as they have been used with a linear alkyl benzene which is known to be extremely persistent and toxic to benthic infauna [MAFF, 1994].

Latest statistics of oil spills and oil discharges from offshore installations show that significant quantities enter the marine environment, although there has been a levelling off or reduction from some sources.

Reported oil spills and discharges from offshore installations (tonnes)

Year	Offshore spills	Oil from offshore operations		
		spills	with produced water	on drill cuttings
1991	234	192	5,490	11,230
1992	194	225	4,850	7,169
1993	183	224	4,232	4,588
1994	147	174	4,418	3,820
1995	145	84	5,855	3,180

[DTI, 1996a]

The environmental impact of the oil and gas industry on waters and seabed off the coast of Scotland is not easy to gauge. Details of chemical discharges from platforms are difficult to obtain, and the environmental risks associated with many of the chemicals used by the industry and discharged into the marine environment have never been evaluated. However, 20% of those chemicals which have been evaluated, fall into the most environmentally toxic categories [MAFF, 1994].

An additional problem in coming years, will result from the growing need to maintain reservoir pressure in older fields. To achieve this, increasing volumes of seawater will need to be injected and, as this water breaks through into production wells, more oil will be discharged in the produced water (discharged after separation of the oil) during the remaining years of the field, along with production chemicals, many of which are very toxic to marine life. Re-injection in the substrate would help reduce this risk, but the feasibility will depend on the geology.

A further impact of the industry results from measures to decommission and dispose of redundant oil and gas platforms. Plans for such contingencies are becoming more urgent as

structures used in the North Sea reach the end of their effective life. The proposal for deep-sea disposal of the *Brent Spar*, a 14,500-tonne platform from the Brent Field, brought much public attention to this issue in 1995. The structure is currently moored in a Norwegian fjord awaiting a decision on its disposal.

3.2.2. Marine Aggregates

The Crown Estate issues prospecting and production licences for the extraction of marine aggregate, following consultation with the public and government departments. The outcome is presented as the Government View. The Department of Transport may also need to give permission if navigation is likely to be affected and, if dredge material is to be returned to the seabed, a licence is required under the Food & Environment Protection Act, 1985.

There are only two areas off the coast of Scotland where marine aggregate extraction has been licensed [M. Cox, *pers. comm.*]. Sand extraction has been taking place in the Tay estuary since the 1950s and continues under the current licence, issued in 1990 for a 10 year period. The second area is in Spey Bay where a licence was issued in 1989, following a Government View permitting the extraction of 120,000 cubic metres (m^3) over a 10-year period, with a maximum of 30,000m^3 in any one year. A subsequent Government View in 1991 allows for a further one-off take of 120,000m^3 from the area, but no extraction has been carried out at this site to date.

The very limited extraction of marine aggregate around Scotland means there has been a negligible environmental impact. There has never been a detailed appraisal of the quantity and quality of the resource, although there are reserves which could be taken. The level of activity may increase if there is a local demand for aggregate to supply beach nourishment schemes or for construction works. The range of environmental impacts which will need to be considered include direct damage to benthic communities, and indirect effects caused by plumes of suspended sediment.

3.2.3. Renewable energy

There has been long-standing interest in the generation of electricity from wave and tidal power, and experimental facilities have been set up on the Scottish coast. A small, experimental wave-powered generator is in operation on Islay, but there are no commercial operations at present.

A wave-powered electricity generator was launched from the River Clyde in 1995 and towed to the north coast of Scotland to provide energy, via a submarine cable, to the grid at Dounreay. The OSPREY (Ocean Swell Powered Renewable Energy) facility was designed to sit on the seabed and produce electricity both from waves and from a wind turbine on the top of the structure. Installation was unsuccessful, following damage to ballast tanks which could not be repaired before the device was destroyed by bad weather. It has since been salvaged and may be repaired or replaced [*New Review*, 1995].

Offshore wind farms are another potential source of renewable energy. There are three operational sites in the world (in Scandinavia and the Netherlands) and plans to build one off the coast of East Anglia [*Financial Times*, 1996]. If successful, this may lead to interest in building similar facilities off the Scottish coast. Little is known about the likely environmental impact of such operations. Apart from direct damage to seabed habitats and communities in the vicinity of anchored structures and intrusion on the landscape, there may be little cause for concern.

The open conditions off the coast of Scotland have considerable potential for wave and wind generated power but much remains to be done to make commercial operation feasible and economic. There has also been interest in using tidal barrages to generate energy, despite the potential impact on the tidal waters thus impounded. Schemes have been advanced in other parts of the UK, but no suitable sites have been identified to date in Scotland. It is intended to consider these issues in a later *Scottish Environment Audit* on energy.

3.3. WATER QUALITY AND WASTE DISPOSAL

In April 1996, routine measurement and monitoring of various aspects of water quality moved from being the responsibility of the River Purification Authorities to the newly-formed Scottish Environment Protection Agency (SEPA).

Run-off from agricultural land, which may contain nitrates, phosphates and pesticides, is one of many factors which can affect water quality in inshore waters. Direct discharges from point sources are another, and, although these must be licensed, it is difficult to get an accurate picture of their effects on the marine environment.

Two programmes which combine a number of measures into an overall indicator of water quality are the coastal waters and estuary quality classification schemes. The coastal

water classification is based on the aesthetic, biological, bacteriological and chemical condition, and an analysis of whether it is fit for all uses or only particular uses. These are combined to classify waters into four categories: Excellent, Good, Unsatisfactory and Seriously Polluted. Estuarine water quality classification is based on a scoring system which allocates points for biological quality, aesthetic quality and chemical quality (based on dissolved oxygen content) with the combined scores indicating whether the estuary is of Good, Fair, Poor or Bad Quality.

The rounded figures for 1995 are shown in the tables below. These are based on a new classification system which SEPA claims to be more rigorous, and are therefore not directly comparable with figures for earlier years.

Coastal water quality in Scotland, 1995

	(kilometres)
Good	6,278
Fair	478
Poor	219
Bad	42

Estuarine water quality in Scotland, 1995

	(square kilometres)
Excellent	619
Good	152
Unsatisfactory	28
Seriously polluted	9

[SEPA, *pers. comm.*]

3.3.1. Effluent discharges

Consents for the discharge of industrial effluent are the responsibility of SEPA. Nearly 25% of discharges go into coastal or estuarine waters and the majority of all discharges have been classed as 'satisfactory', in that they comply with discharge consents.

Number of direct industrial discharges in Scotland, 1991

Coastal	179
Estuarine	96
Inland	838
Satisfactory	974
Unsatisfactory	113
Borderline	26

[SO, 1996b]

Raw and treated sewage is also discharged into coastal waters around Scotland. The EC Bathing Waters Directive sets standards for faecal and total coliforms in locations designated as 'Bathing Beaches'. There are 23 of these sites in Scotland and, as the table below shows, the number passing the Mandatory (minimum) standard has increased in recent years.

Number of designated bathing beaches in Scotland which pass or fail the Mandatory standard of the EC Bathing Waters Directive

	1991	1992	1993	1994	1995	1996
Pass	15	15	18	16	19	21
Fail	8	8	5	7	4	2

[SO, 1996b]

Although the majority pass the Mandatory standard, there is debate as to whether this is sufficient for safe bathing, and many fewer beaches meet the higher Guideline standard. In 1994, the EC put forward a number of proposals to upgrade the standards for designated recreational waters (including diving and surfing sites), but these are still being debated.

Only four of the designated bathing beaches (Cullen, St.Andrews West Sands, Aberdour Silversands and Gullane) have a 4-star grading in the Marine Conservation Society (MCS) *Good Beach Guide* [MCS, 1996]. These are places where 100% of the water samples pass the Mandatory Standards, 80% pass the higher Guideline Coliform Standards, and 90% pass the Guideline Faecal *Streptococcus* Standard. One beach, Dunbar–Belhaven, received a 3-star grading representing a 100% pass of the Mandatory Standard and 80% pass of Guideline Coliform Standard. Overall only 9.1% of Scottish beaches tested were considered safe for bathing in the 1995 MCS guide, and 10.5% in the 1996 guide.

The EC Urban Waste Water Treatment Directive (91/27/EEC) seeks to make secondary treatment the standard minimum level of treatment of sewage throughout the EU for all coastal sewage discharges serving populations of more than 10,000 and estuarine discharges which serve more than 2,000 people. Smaller outfalls and large outfalls in High Natural Dispersion Areas (HNDAs) are exempt from this requirement but must nevertheless comply with standards set by SEPA. In 1992 no coastal outfalls in normal areas complied with the requirements for treatment, and only 6.25% of those in HNDAs complied. The combined figures for freshwater and estuaries show that 80.27% of outfalls comply in normal areas and 13.8% in HNDAs [SO, 1996b].

Nutrient enrichment from sewage discharges can contribute to eutrophication as well as being a human health hazard. Pathogens in the effluent may cause ill effects in bathers and contaminate bivalves and crustaceans. A link with algal blooms may also be a possibility, but there is no co-ordinated monitoring to

investigate this issue. In August 1996 thousands of lugworms, sea urchins and shellfish were washed up on beaches from Islay to Orkney following the largest bloom recorded in 20 years. The alga concerned was *Gyrodinium* and the mortalities were thought to be caused by the large amount of decaying algae smothering the animals [ENDS, 1996].

A more recent concern is the release of hormone-disrupting chemicals, which may cause a "feminising" effect in fish or produce intersex individuals (exhibiting features of both sexes) in invertebrates (SEPA, 1996b). Alkyl phenol ethoxylates (APEs), used in detergents and some industrial processes, and phthalates, used as plasticisers, can produce these oestrogenic effects, and may enter effluent discharges.

A survey by SEPA in 1996 of 84 effluent samples from around Scotland found these compounds in a number of the samples. Most were at levels below what the Water Research Centre has defined as 'safe', although there is considerable uncertainty about what constitutes a 'safe' level for these substances [Lyons, 1995]. 13 sites were assessed by SEPA as possibly exceeding these 'safe' levels at certain times; 9 of these were sewage treatment works, 3 were sewer outfalls and one was at a cashmere factory. However, there have been no reports of feminising effects on fish in Scotland, and the only reported instance of intersexuality is in copepods in sediment near Edinburgh's sewage outfall, although this was not linked to any particular pollutant [SEPA, 1996a].

3.3.2. Radioactive discharges

Radioactive discharges which affect Scottish waters come from Sellafield on the Cumbria coast and nuclear power stations at Dounreay, Hunterston, Torness and Chapelcross. Monitoring figures show both increases and decreases in the discharge of various components of liquid radioactive waste from these nuclear sites [SO 1996b].

Accidental releases of radioactive material have also occurred. The discovery of radioactive particles at Dounreay in June 1995 and subsequently, some of which were on beaches, was thought to be the consequence of an explosion in a waste shaft in 1977 [*SCENES*, 1995c]. More recently, in September 1996, the facility had to be closed down following accidental discharge of radioactive material with cooling waters.

3.3.3. Sea dumping

A variety of substances have been dumped in Scottish coastal waters for many years. The government is committed to phasing out the disposal of sewage sludge at sea by the end of 1998, but the disposal of dredge spoil and fish wastes from fish-processing vessels will continue.

Quantity of dredged material and sewage sludge disposed in Scottish waters (wet tonnes)

Year	Dredge spoil	Sewage sludge
1989	3,154,756	1,940,575
1990	2,109,114	1,946,430
1991	2,788,611	1,984,035
1992	4,026,861	1,984,525
1993	2,025,525	1,946,340

[Scottish Office, 1996b]

In the case of both sewage sludge and dredge spoil, contamination by heavy metals such as chromium, copper, nickel, lead and zinc results in contamination of sediments in the immediate vicinity and can therefore enter food chains. There is also evidence that pollutants from dumped material can spread further afield. This has been the case with the sewage sludge dumping ground at Garroch Head in the Firth of Clyde, where only 10% of the contaminants contained in the sludge are thought to remain within 3 square kilometres of the dump site. Levels of dieldrin, DDT and PCBs exceed proposed safe limits to protect aquatic life at the site, and a further 260 square kilometres has been classed as contaminated. A survey carried out in 1977 found that shellfish in the area of the dump site had the highest levels of organochlorine pollution found in the British Isles [*SCENES*, 1996b].

An estimated 1.17 million tonnes of conventional and chemical weapons are known to have been dumped in the sea around Britain since the Second World War [Edwards, 1995]. Sites off the Scottish coast include an area in the Firth of Clyde between Ardrossan and Arran, and the Inner Sound of Raasay, but the largest known dump in British waters is Beaufort's Dyke off the Mull of Kintyre, containing an estimated 1 million tonnes of munitions.

In autumn 1995 more than 4,500 incendiary bombs washed up on the shores of the Firth of Clyde, the Mull of Kintyre, and the islands of Arran, Islay, Jura and Gigha. They included mustard gas, phosgene-charged weapons and nerve-gas-charged munitions which had been disturbed during the construction of a trench for an undersea gas pipeline between Scotland and Northern Ireland, and posed a hazard to human health and fisheries [Edwards, 1995]. A survey of the seabed sediments in the vicinity showed that levels of heavy metals were similar to "safe levels" found elsewhere on the Scottish coast,

although the levels of lead, copper and zinc were more than double national averages [*SCENES*, 1996a].

3.4. USES OF WATER SPACE

3.4.1. Shipping

The environmental impact of shipping, and particularly of shipping accidents, has been brought to public attention in recent years following the grounding of the *Braer*, off the coast of Shetland in 1993, and the *Sea Empress*, off south Wales in 1996. Smaller spills or illegal cleaning of tanks occur on a regular basis and it is not always possible to identify the source.

Source of oil spills

(Number of incidents)	1990	1991	1992	1993
Coastal tanker/VLCC/ULCC	12	18	10	13
Non-tanker ship	32	66	52	71
Wreck/ offshore installation	346	238	179	183
Oil pipeline/ terminal/ jetty	7	12	8	3
Industrial premises/ sewers/ other	25	39	25	30
Not known	62	61	53	70

VLCC = Very Large Crude-oil Carrier; ULCC = Ultra Large Crude-oil Carrier

[Scottish Office, 1996b]

As part of the response to the sinking of the *Braer*, the government commissioned a general inquiry on shipping around the UK chaired by Lord Donaldson [Anon, 1994a]. Routeing systems, the identification of Marine Environmental High Risk Areas (MEHRAs) and the provision of salvage tugs were some of the many issues which were covered and the committee made 103 recommendations, only some of which have so far been put into operation by the government.

Environmental problems associated with shipping concern the cargoes, routine operation of vessels and port development. Oil spills tend to receive the most attention and the effects depend on a combination of the type of oil, the weather conditions, location and any treatment. The more obvious effects can be seen when oil comes ashore, but there are also sea-bed effects and contamination of seafood. In the case of the *Braer* accident, the Ecological Steering Group on the Oil Spill in Shetland (ESGOSS) concluded that the overall impact of the spill on the environment and ecology of south Shetland had been minimal with adverse impacts localised and limited, largely as a result of the prevailing weather conditions at the time of the spill. However, even with rapid dispersal of the oil, fin fisheries closed for 3 months, crustacean fisheries for 12–18 months, scalloping for 2 years and the prawn and mussel fisheries were still closed more than two years after the incident [*SCENES*, 1995b]. The impacts on non-commercial species, offshore waters and the seabed are more difficult to assess.

Other forms of pollution from shipping include anti-fouling paints, used on vessels, which leach into the environment. In some sheltered waters tributyl-tin (TBT) from such paints reached concentrations which caused imposex in dog whelks and subsequent reductions or total loss of local populations of this species. The use of TBT-based paints on small boats was banned in 1987, and TBT concentrations in affected areas have decreased since then, with a recovery of marine species [Anon, 1994b].

The discarding of ship-generated waste overboard is another source of pollution. The North Sea has been defined as a Special Area under the MARPOL Convention and, although this does not apply to the west coast, the UK expects the same standards to be met there. The dumping of plastic wastes and packaging materials is prohibited in the Special Area. Such material causes problems for marine animals, which become entangled and mistake some plastics for food. Fifty species of birds, including petrels, shearwaters, and auks are known to consume plastics, as do fish, turtles and marine mammals [Eno, 1991].

Special Area status for oily discharges is being sought for the North Sea through the International Maritime Organisation (under the MARPOL Convention), with a westwards extension covering waters west of Scotland.

Ports need to provide reception facilities for ship-generated waste. The Department of Transport (DoT) recommends the production of waste management plans for the reception and disposal of waste from ships and all other sea-going vessels. This is currently voluntary for ports and harbour authorities and marina and terminal operators, but the DoT is seeking to make it a statutory requirement [MSA, 1996]. This is one of a number of measures being considered as part of the Merchant Shipping & Maritime Security Bill, which was under debate in parliament as this *Audit* went to press.

Another concern relating to shipping is the introduction of alien species via discharged ballast water. This brings a risk of disease, and of competition and predation on native species. The International Maritime Organisation promotes a voluntary code of practice which recommends that vessels exchange ballast in open seas to avoid bringing in species able to survive in coastal conditions. Work is underway to develop a new annex to the MARPOL Convention on ballast water discharges.

4. RESOURCE MANAGEMENT AND PROTECTION

4.1. COASTAL MANAGEMENT

The management and protection of Scotland's marine and coastal resources is undertaken by a variety of agencies and government departments. It is implemented through voluntary measures and legal provisions, with an emphasis on sectoral rather than integrated management [Burbridge & Burbridge, 1994].

In the UK, interest in Integrated Coastal Zone Management (ICZM) took off in the late 1980s. An inquiry into the subject by the House of Commons Environment Committee in 1992 was a significant landmark, with the committee giving its full support to the idea. It also stated that the conclusion and recommendations were of national relevance and hoped that the ideas would be considered for application throughout the UK [Anon, 1992]. Subsequent work has highlighted specific areas for action in Scotland [Gubbay, 1995] but there has been very little progress.

A discussion paper on Scotland's coasts issued by the Scottish Office in March 1996 described the coastal resource and the current framework for its management [SO, 1996a]. Two options for the future of planning and management of the Scottish coast were described but rejected. These were an extension of planning control to include near-shore waters, and a statutory basis for ICZM. The paper concluded with proposals for a Scottish Coastal Forum (which was duly set up with a first meeting in March 1997), encouragement of more local coastal management groups, and support for groups involved in coastal planning and management.

An analysis of the responses to the discussion paper concluded that many respondents were disappointed with the discussion of future options and the lack of positive suggestions for management. The proposals put forward by the Scottish Office were seen by respondents as a minimum requirement and a good starting point for discussion on what should happen [Milner, 1996].

A draft National Planning Policy Guideline (NPPG) on Coastal Planning was published for consultation in February 1997 (Scottish Office Development Department, 1997) and included a number of important elements. The need for a co-ordinated approach to planning between local authorities was recognised, as was the fact that coastal zones are subject to pressures operating outside the jurisdiction of local authorities. The need for local authorities to have regard to cumulative impacts on the coast was another positive step, as was recognition of the effects of developments on the coastal landscape.

The draft NPPG recommended that coasts be categorised into developed, undeveloped and remote areas, with policies to reflect these different conditions. There was no guidance however on how different types of coastal plans should mesh together, and CZM plans were to remain non-statutory. There was clear encouragement for local authorities to work with others through coastal fora to advance elements of CZM, although this approach was not seen as appropriate for the entire length of the Scottish coastline. The problem of how much influence local authorities have when it comes to developments in near-shore areas outside their jurisdiction remains to be addressed, as does a regional perspective to CZM.

Action on ICZM in Scotland has been taking place at a local level, and particularly through the establishment of coastal groups. SNH's Firths Initiative has supported the establishment of coastal fora in the Moray Firth, Firth of Forth and Solway Firth. There is also a liaison group for the Cromarty Firth and a Clyde Estuary Forum. The emphasis of work varies, but they are all involved in bringing together the many groups with an interest in these areas with a view to improving management and minimising conflicts of use. Two other initiatives are the Minch Project, and a CZM pilot study by the former Highland Regional Council. Reports, issue papers, conferences and workshops have taken place or been prepared under the auspices of these groups, and work is on-going on the preparation of ICZM strategies in these localities.

4.2. MARINE PROTECTED AREAS

The EC Habitats Directive was adopted in May 1992. The principal means of introducing it into GB law is the Conservation (Natural Habitats, &c.) Regulations 1994. The regulations are supported with general advice in Scottish Office Circular No. 6/1995 and a number of publications [SNH, 1995b; SOAEFD, 1996].

The directive calls for the establishment of Special Areas of Conservation (SACs) which, together with Special Protection Areas (SPAs) (designated under the EC Birds Directive), are intended to form a coherent European ecological network to be known as 'Natura 2000'. SACs must be designated to protect habitats and species listed in Annexes to the directive. Seven marine habitats and seven species which are either fully marine or spend part of their life in the sea are listed in these Annexes. All occur in Scotland. A further four marine

species no longer occur in UK waters and may therefore be candidates for restoration, which is another element promoted by the Directive.

Marine Habitats listed in Annex 1 of the Habitats Directive

Estuaries
Large shallow inlets
Submerged or partly submerged sea-caves
Sandbanks which are slightly covered by seawater all the time
Mudflats and sandflats not covered by seawater at low tide
Reefs
Lagoons

Annex II marine species found in UK waters

Halichoerus grypus	Grey seal
Phoca vitulina	Common seal
Tursiops truncatus	Bottlenosed dolphin
Phocoena phocoena	Harbour porpoise

Annex II species which spend part of their life in the sea

Lutra lutra	Otter
Alosa spp.	Shad
Salmo salar	Atlantic salmon

Annex II species which used to occur in UK waters

Lampetra fluviatilis	Lampern
Petromyzon marinus	Sea lamprey
Acipenser sturio	Sturgeon
Coregonus oxyrhynchus	Houting

A list of sites qualifying as possible SACs was published by the UK government in March 1995. There are 38 marine sites. 14 of these are in Scotland and 2 are cross-border between England and Scotland (see map on inside front cover). All except Lochs Duich, Long and Alsh Reefs, and the later proposal of the Dornoch Firth were forwarded to the EC in October 1996 as 'candidate SACs'. A small number of further proposed sites, and changes to the boundaries of some sites on the original list, were due to be published for consultation in 1997, but it is not known whether any of these are marine.

Non-governmental conservation bodies have criticised the marine SAC list on a number of grounds: the omission of many marine sites which these organisations believe should have been put forward for consideration; the lack of representation of the full range of Scotland's marine habitats; the absence of any proposals for sites to protect the harbour porpoise, which is listed on Annex II; limited proposals for sites for the grey seal and bottlenosed dolphin; the limited boundaries proposed for some of the candidate SACs; and the methodology used to define certain marine habitats which, in the case of shallow marine inlets, has resulted in the absence of any proposed SACs covering complete Scottish fjordic sea loch systems [WCL, 1995 & 1996; Warren, 1996].

The directive also requires Member States to take action beyond the boundaries of these protected areas. Measures for the wider environment include assessment of the potential impact of schemes not directly connected with SACs, and of any cumulative impact of plans and projects on the listed habitats and species. These and other measures are intended to ensure that the listed habitats and species are maintained, and, if necessary, restored to "favourable conservation status", although the criteria for assessing such status have yet to be defined.

The sorts of measures which will be introduced to manage marine SACs are not known. A paper giving general guidance on marine SACs in England and Wales is currently undergoing consultation and suggests that there will be few changes at the proposed sites. No comparable guidance has been published yet for SACs in Scotland, although further information on habitat definitions and site selection has been issued [SOAEFD, 1996].

The designation of Marine Nature Reserves (MNRs) would complement marine SACs and SPAs by protecting marine wildlife and habitats of national importance, but there are no MNRs in Scotland and little prospect of the situation changing in the near future. Following local opposition to a proposed MNR in Loch Sween, Argyll, the chief executive of SNH has stated a view that MNRs are not feasible or practical for the necessary protection of the marine environment [*SCENES*, 1993].

There has also been very little progress on voluntary marine nature reserves. The St. Abbs and Eyemouth Voluntary Marine Reserve in Berwickshire, which was set up in 1984, is the only reserve of this type in Scotland. Recent interest in using this approach around Fair Isle is being explored as part of a project led by the National Trust for Scotland.

Marine Consultation Areas (MCAs) are not a statutory designation, but are identified by SNH to indicate areas where fish farming and other developments may be inappropriate. There were 29 sites in 1994 [SO, 1996b] (see map on inside front cover), but the success of MCAs in conserving marine wildlife interest has been questioned. An analysis carried out in 1990 revealed that in cases where the Nature Conservancy Council objected to licensing, more licences were issued for aquaculture in MCAs than outside them [Anon, 1990].

In late 1996, the Scottish Office published a discussion paper on natural heritage designations (SO, 1996c), but this did not consider designations in the marine environment.

4.3. BIODIVERSITY

The conservation of 'biodiversity', has become a widely stated objective of environmental programmes since the Convention on Biological

Diversity came into force in 1993. It is highly relevant to the marine environment, as the oceans and seas are vital for the functioning of both terrestrial and marine systems, as well as contributing to the overall diversity of life of Earth [Angel, 1992].

The conservation and sustainable use of marine and coastal biodiversity was the focus of working meetings at the 2nd Conference of the Parties to the Convention which was held in Jakarta in November 1995. This resulted in the issuing of the 'Jakarta Mandate on Marine and Coastal Biological Diversity' which encourages the use of Integrated Marine and Coastal Area Management as the most suitable framework for addressing human impacts on coastal and marine biodiversity, and encourages parties to establish and/or strengthen the institutional, administrative and legislative arrangements to put this into practice.

Biodiversity Challenge; an agenda for conservation action in the UK was prepared by a consortium of six voluntary conservation organisations and published in December 1993 [RSPB, 1993], as a means to influence the Biodiversity Action Plan then being prepared by the British government. It emphasised the importance of setting targets so that appropriate actions could be specified and progress measured. The second edition [Wynne *et al.*, 1994] included targets for a selection of marine habitats and species as well as some marine species action plans.

The UK government published *Biodiversity: the UK Action Plan* in 1994 [Anon, 1994c]. 59 summary action points were listed, 14 of which were specific to the coastal and marine environment. The majority of these were concerned with the designation or definition of protected areas and on supporting the development of ICZM. Other topics included research, species conservation, and interactions with fisheries. A progress report was published a year later [JNCC, 1995].

One of the recommendations in the UK Biodiversity Action Plan was to set up a steering group to develop a range of specific costed targets for key species and habitats, to examine the feasibility of a single UK Biota Database, to develop a public awareness campaign on biodiversity and to establish a review process for commitments in the plan.

The recommendations of this steering group were published in December 1995 [Anon, 1995]. Habitat statements were prepared for the full range of UK habitats, out to the edge of the continental shelf. There were full action plans for more than 100 species and 14 habitats, which included 3 Scottish marine species (allis shad, twaite shad, and harbour porpoise) and two Scottish marine habitats (saline lagoons and sea-grass beds). Action plans for a further 286 species and 24 habitats, including maerl beds and deep mud, were recommended for completion within three years [Anon, 1995], and action plans for *Ascophyllum nodosum* ecad *mackaii* beds and machair are in preparation, but many other species and habitats could still benefit from special attention in this way.

A Biodiversity Information Service is being established by the JNCC mainly to provide the focus for reporting on UK obligations under the convention and various EC directives. A UK Biodiversity Group has been established to coordinate follow up work to the steering group report and includes a marine sub-group.

Country groups for England, Wales, Scotland and Northern Ireland have been set up to help implement action plans and assist the development of plans for further species and habitats. The Scottish Biodiversity Group is chaired by the Scottish Office with a wide membership, including representatives from the Scottish Fishermen's Federation, Scottish Environment Protection Agency, Scottish Natural Heritage and Scottish Wildlife & Countryside Link.

5. MARINE EDUCATION

Providing information about the marine environment to the general public, and incorporating such material into formal education programmes, are valuable ways of increasing awareness and understanding of the marine environment. There has been considerable development of marine education programmes in Scotland in recent years.

Locally-based educational material with a marine theme is an important element of the SNH 'Focus of Firths' initiative [SNH, 1995a] As part of the Moray Firth project, for example, a *Directory of Educational Use of the Firth* has been prepared, suggesting ideas on how the Firth can be used for marine education. There is a supporting slide pack and a 'Sea Chest' containing marine publications, posters and videos aimed at raising awareness on environmental issues to do with the Firth. A multimedia touch screen software package is also being tested in local schools and museums.

In 1995, the Marine Conservation Society (MCS), in partnership with SNH and the Scottish Museum Council, organised the 'Ocean Watch' project on the Moray Firth. The local museums in the area co-ordinated the involvement of schools, community groups and families to initiate a programme of shore monitoring, and set up displays about the project at local museums.

The national guidance for education of the 5–14 year age group and the *Higher Still* initiative in Scotland are further opportunities to promote awareness and understanding about the marine environment. A study pack prepared by the MCS illustrates what can be done. The pack contains fact-sheets and work-sheets on topics such as marine mammals, pollution, coastal management and alien species, and gives guidance to teachers on how to introduce marine conservation into the curriculum. Although many aspects are relevant to targets for work on Environmental Studies, the pack also shows how more can be learnt about the marine environment as part of religious and moral education, expressive arts, English language and mathematics [MCS, 1995].

An advisory panel on environmental education was set up in June 1995 as part of a Scottish Strategy for Environmental Education. The Scottish Association for Marine Science (SAMS) is currently investigating the possibility of bringing together marine educators to prepare a paper for the advisory panel aimed at encouraging a higher profile for marine education in Scotland.

6. RESOURCE PROSPECTS

Many activities have an impact on Scotland's marine resources, but our understanding of their effects, extent, and significance is far from complete.

Concern about the impact of fishing around the British Isles was voiced as far back as the 14th century [Hardy (1959) in Boaden, 1983] but natural fluctuations of fish stocks, and the absence of data on the pre-fishing condition of marine habitats, communities and species make it difficult to assess the scale and extent of any impact. Despite this, it is clear that spawning stock biomass of the majority of finfish stocks in the NE Atlantic are in a seriously poor condition. The limited action taken by governments, despite advice from ACFM to make substantial reductions in some quotas, may have minimised social and economic impacts in the short term, but could jeopardise the existence of a viable fishing industry in the long term. Also, in spite of a long-standing recognition of the need to reduce fishing effort, the UK's progress in reaching even the modest targets agreed by the EU has been slow.

Under these circumstances the prospect for commercial stocks is likely to be a pattern of boom and bust, with new fisheries being sought to maintain the industry. The move to develop deep water fisheries is a special concern in this respect, because the limited knowledge of the ecology of these species makes it even less likely that any such fishery could be managed sustainably.

Aside from impacts on commercial fish stocks, the effects of the fishing industry on the marine environment and marine wildlife around the coast of Scotland can be assumed to be extensive. The impacts of many types of fisheries and gear are known and, although research into gear design and advice on deployment of gear can help to reduce this, there are few examples of fisheries being restricted or closed for environmental reasons.

There is some interest in establishing closed areas or refuges to allow recovery and restoration of stocks, but not enough support for it to be taken forward at present. The environmental impacts of fisheries are therefore likely to continue as a major issue and will probably increase as a result of pressure to move into new areas, take previously unexploited stocks, and/or increase effort in order to compensate for poor catches.

Although the marine aquaculture industry in Scotland has benefited the economy of remoter parts of Scotland, it has also had a significant environmental impact. In the immediate vicinity of facilities, there are instances of benthic communities being smothered and anoxic conditions developing beneath cages. The introduction of chemicals and antibiotics into the marine environment has extended the areas affected by salmon farming, and sublethal effects have been recorded some distance from the facilities. The continued presence and likely expansion of this activity further offshore, and for additional species, means that the pressures will continue, unless far greater attention is given to the need for sustainable management of these marine areas.

The recent approval of the use of ivermectin in some fish farms suggests that there has been little change in attitude towards the use and discharge of chemicals into the marine environment from aquaculture facilities since the licensing of dichlorvos for a similar purpose in the early 1990s.

The practice of 'ranching' is likely to have fewer environmental impacts, and it has considerable potential to be the basis of a sustainable fishery. This idea, together with stock enhancement programmes, needs further technical development in Scottish waters, as well as a sound management system and a legal framework in which to operate. Growing interest in more local fisheries management and the wider use of Several and Regulatory Orders could make an important contribution towards achieving this.

The impacts associated with oil and gas extraction from offshore areas started in the 1970s. The environmental effects in the immediate vicinity of platforms are already known to be significant, but the scale of chronic and acute effects further afield is poorly understood.

Independent research, reporting and monitoring and the public availability of information on discharges from offshore platforms is essential if there is to be a better understanding of these impacts. The inadequate regulation and assessment of the risk associated with the discharge of chemicals used by the offshore industry should also be viewed as a serious concern and a matter which must be addressed in order to limit the environmental impact of the industry.

The opening up of new oil fields in the frontier region, and possibly in inshore waters, will make these impacts more widespread. At the same time, decommissioning and disposal of redundant structures is now imminent and will bring new problems to the fore, with the option of abandoning these structures on the seabed still supported by the industry and government.

Some of Scotland's marine resources are being damaged by human activity, even before adequate information about their status can be compiled. Sites of marine archaeological importance are an example; they have been damaged by fishing activity and dredging, but it is not possible to assess the scale of damage as there are many uncertainties about the type and extent of the resource. One initiative to raise awareness of the need to consider marine archaeology in advance of development has been the production of a Code of Practice for sea-bed developers [JNAPC, 1995] but much remains to be done to provide adequate protection for the full range of archaeology underwater.

Existing activities exert considerable pressure on marine resources, and although we may be familiar with some of the resulting impacts and are working to address them, other aspects may be poorly understood or unknown. Sewage treatment schemes have improved the quality of effluent discharged into coastal and estuarine waters, but industrial discharges continue on a large scale. The effects of the mix of contaminants being discharged into coastal waters is difficult to determine and should be a cause for considerable concern. The hormone-disrupting effects of APEs and phthalates in sewage effluent are one recent example of the discharge of substances which can have major consequences for human health, as well as for marine wildlife, but about which very little is known.

New activities, such as seaweed harvesting, raise new management issues, and it is essential to have thorough environmental assessments to determine whether such activities should be permitted. Good baseline data against which to judge effects will be critical. There should also be a clear recognition that the requirements for sustainable development, which now underpin government policy, mean that environmental assessments can no longer be regarded merely as a procedural step towards project approval; in some cases, measures to minimise impact may not be enough to ensure sustainability and projects will have to be rejected.

Resource management measures try to keep up with new and existing pressures. Gradual improvements in certain aspects of water quality, for example, show that progress is being made on some issues, but in other cases there has been little progress. The lack of action on the designation of marine protected areas, and particularly Marine Nature Reserves, is one example where progress has been slow. The introduction of the Habitats Directive and the timetable set by the European Commission for the Natura 2000 Network to be in place by July 2004 should change this, but a great deal of effort will be needed to keep to the timetable. It will be particularly challenging for marine sites (both SACs and SPAs), as there is limited experience of managing marine protected areas in the UK, especially in Scotland.

The prospect of a network of marine protected areas is a positive, if long overdue, development and should be encouraged. It brings many new opportunities, including statutory backing for the setting of marine conservation objectives and the development of management schemes to achieve them. There is also the prospect of the establishment of refuges to enhance, and perhaps help restore, degraded marine communities and habitats and fish and shellfish stocks.

Amendments to the Habitats Directive to include a greater range of marine habitats and species would bring even greater benefits, and should be pursued urgently. At the same time, provision must be made for maintaining a basis for comparative assessment of the importance of different areas after the Marine Nature Conservation Review comes to an end in 1998, because substantial areas of the Scottish coastline will remain unsurveyed or reported upon.

The Scottish Office appears to take the view that there are few pressures and problems relating to the management of Scotland's coast. The draft NPPG on coastal planning, for example, does not identify increased pressure

or conflicts of use on the coast as reasons for updating planning guidance. There are also clearly contradictory policies and actions, such as the lifting of the ban on monofilament nets off the Scottish coast, despite a requirement for the conservation of the bottlenosed dolphin and harbour porpoise under the Habitats Directive.

There are many pressures and impacts on Scotland's marine resources, as well as difficulties relating to their management. The draft NPPG starts to address this but, as it is clearly limited to the planning system and therefore the landward part of the coastal zone, much remains to be done. There is a real danger of complacency: recognising that Scotland's marine resources are of considerable environment, economic, social and cultural value, but failing to act to safeguard these resources until they are in a critical state or have been lost.

The lack of a framework for coastal and marine management in Scotland, and the absence of any system by which environmental considerations can underpin decision-making, are two of the largest issues which must be addressed, but they cannot be achieved without widespread support and commitment.

The increasing number of marine education programmes in Scotland should help in this respect, by building a constituency of people who are more informed about the management and potential impacts of marine activities and the need for resource conservation. The protection of the natural environment from long-term or irreparable change as a result of human activities will only be accepted as of highest priority when there is overwhelming public perception and desire to ensure maintenance of our marine heritage. That perception will require knowledge, education and influence.

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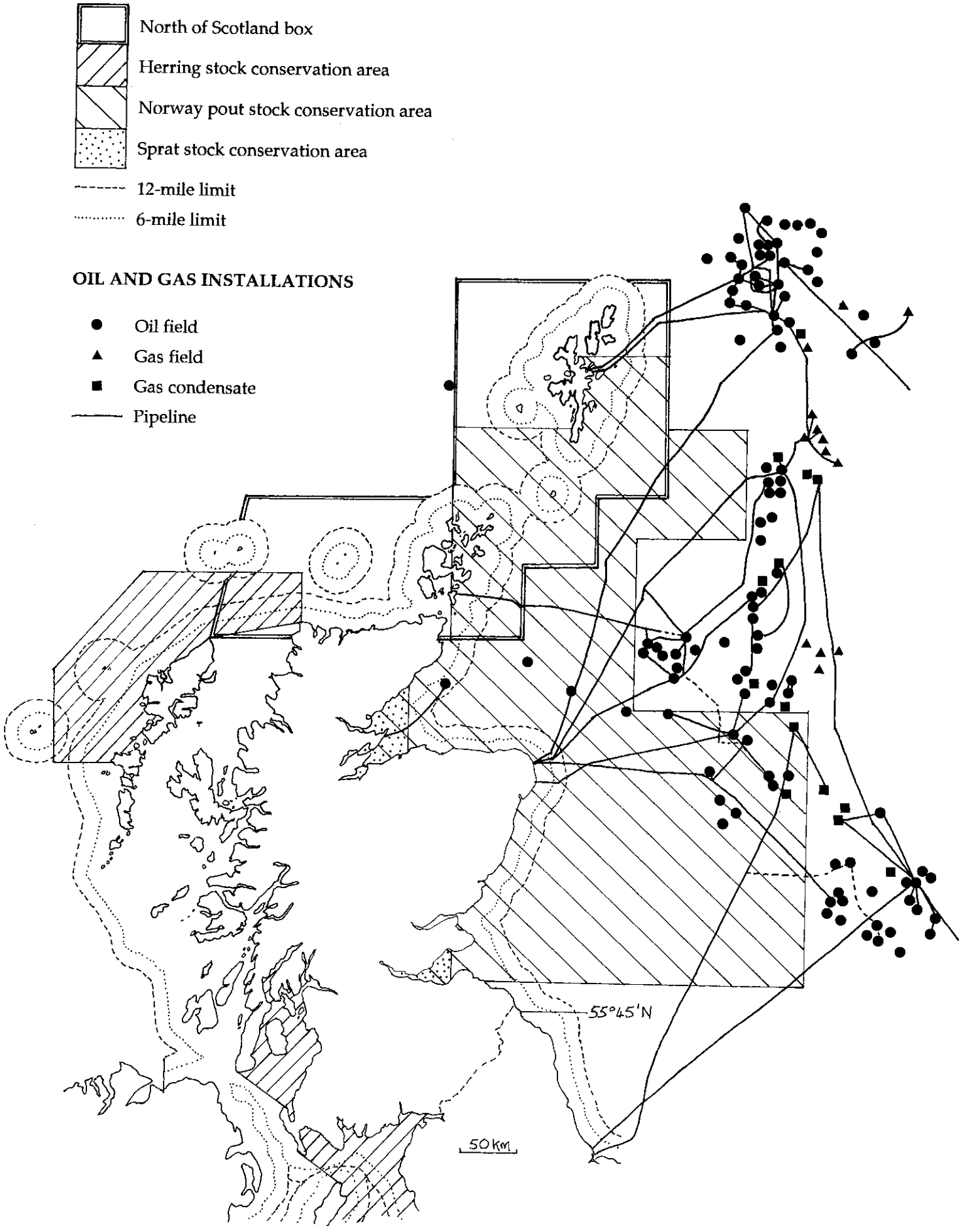
FISHING BOXES AND STOCK CONSERVATION AREAS
North of Scotland box
Herring stock conservation area
Norway pout stock conservation area
Sprat stock conservation area
12-mile limit
6-mile limit
OIL AND GAS INSTALLATIONS
Oil field
Gas field
Gas condensate
Pipeline
55°45'N
50km

THE AUTHOR

Dr Susan Gubbay has worked in marine conservation for 15 years, specialising in marine protection areas and coastal zone management. She has a detailed knowledge of how these aspects of marine conservation are being developed and implemented in the UK and elsewhere in Europe, and she has published extensively on these subjects. As Senior Conservation Officer for the Marine Conservation Society and, more recently, as a freelance consultant, Dr Gubbay has sat on a number of government committees including the UK Biodiversity Action Plan Steering Group, provided advice on marine matters to the European Commission, and worked extensively with non-governmental organisations as an advocate for marine conservation.

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