A Contingency Plan for the At Sea Response to an Oil Spill Incident in the Waters around the Inner Hebrides

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ABSTRACT

The seas and coastline of the Inner Hebrides contain abundant populations of marine mammals, fish, shellfish and seabirds. It is a relatively undeveloped and pristine environment widely recognised for its natural beauty and conservation value. The natural resources of the region sustain the local economy through fishing, fish farming and tourism. Regular tanker traffic passes through the region on route to destination's outwith the region. An accident on the scale of the *Braer* or *Sea Empress* would be potentially disastrous to the environment and economy of the region. This paper aims to examine the potential risks of such an incident occurring, to examine the effects of oil spills and to go some way towards formulating a response strategy in the form of a local contingency plan for the at sea response to an oil spill in the region.

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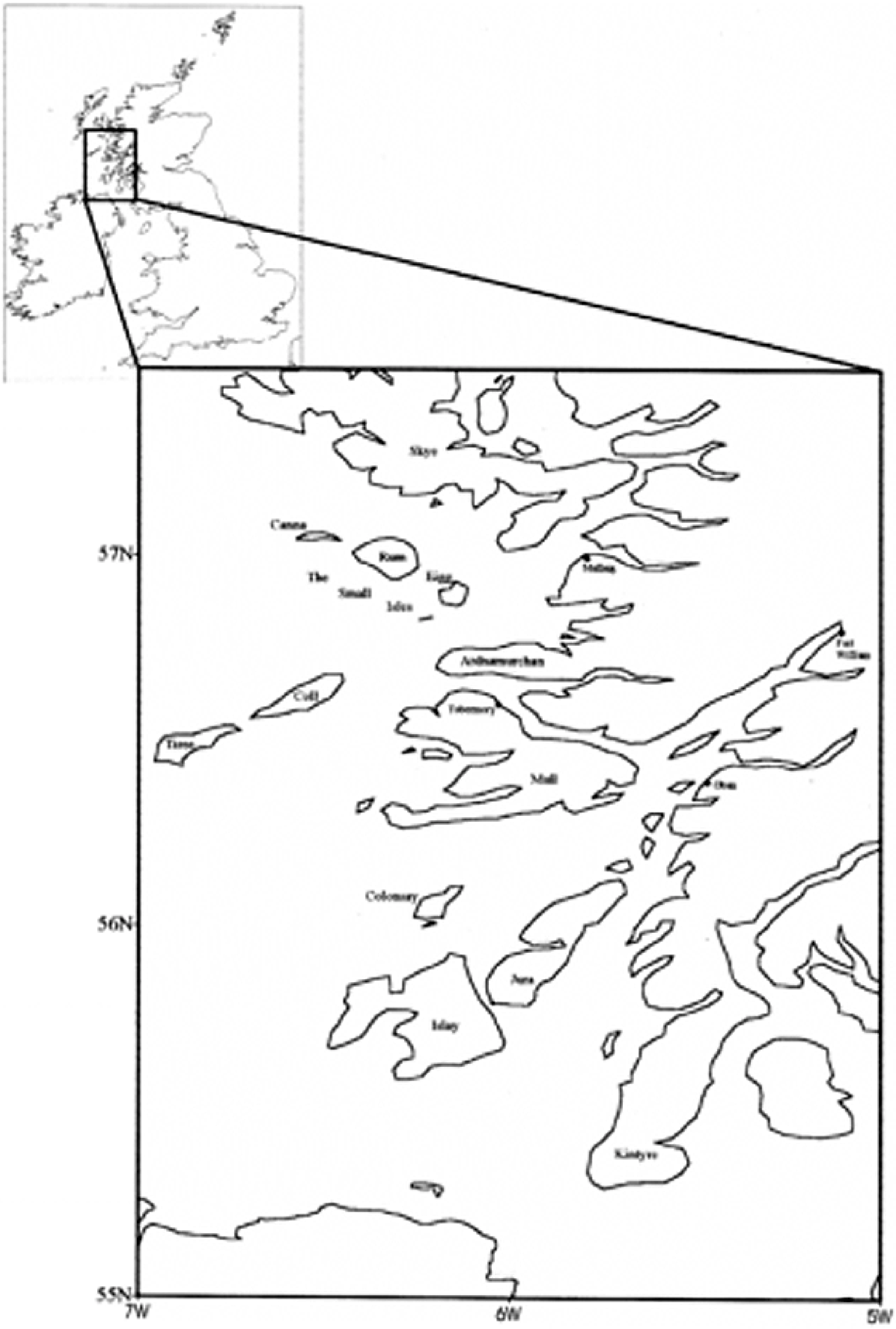
1. INTRODUCTION

It has been estimated that around 3.2 million tonnes of petroleum hydrocarbons enter the marine environment every year (ITOPF 1986). Despite this no apparent build up of oil is in evidence in the marine environment. This would suggest that on a global scale the world's oceans are able to cope with a substantial input of oil. However on a local scale oil pollution can have acute short-term effects upon the marine environment. The type of oil pollution, the climatic conditions and the sea state drives the extent and duration of this effect. These factors combine to weather the oil pollution over time and space.

The, short and long term, fate and effects of oil spills have been studied and documented for numerous incidents. The immediate effects on wildlife and beaches is often the most lasting impression of an incident. The long-term effects can be relatively short lived with oiled areas sometimes returning to a 'clean' state within months. The value of having a contingency plan in place to mitigate against the effects of an oil spill has been proven many times.

The seas and coastlines around the Inner Hebrides (Map 1) contain one of the greatest diversities and abundance of marine wildlife in the UK. The region shown in map 1 is also one of the most remote and least accessible areas around our coastline. If an oil spill were to occur in these waters it would be potentially devastating. The aim of this dissertation is to identify the areas where an oil spill is most likely to occur and to provide the relevant information to formulate at-sea response options to an oil spill incident.



Map 1. The Inner Hebrides and associated coastline; the area covered by the contingency plan.

2.TYPES OF OIL LIKELY TO BE SPILLED

The most visible source of marine oil pollution is from tanker accidents where often vast quantities of crude oil are discharged. In fact tanker accidents account for only 12% of the total input of petroleum hydrocarbons to the marine environment. The operation of all marine transportation contributes 33% of the total input of petroleum hydrocarbons to the marine environment (IPIECA 1991$_2$). The types of oil from these sources can include persistent oils e.g. crude oils and residual oils, or non-persistent oils e.g. diesel and petrol. The persistency of an oil is dependant upon its physical properties particularly its density, viscosity, boiling point and range and it’s pour point. Table 1 gives an indication of the types of oil that may be spilled in the region. Where there is no entry data is not available.

2.1 Density

The density of particular oil controls its buoyancy on the sea surface. The lower the density of an oil the more buoyancy it has. Lower density also indicates lower viscosity and a higher proportion of volatile components. Data from table 1 indicates that lower density oils will undergo a higher degree of natural dispersion.

2.3 Viscosity

The viscosity of oil is its resistance to flow. The lower the viscosity the more fluid in nature the oil. Viscosity decreases with temperature hence the importance of sea and air temperature on the nature of the oil.

2.4 Boiling point and boiling range.

The lower the boiling point and extent of the boiling range the more volatile the oil is. This effects the rate at which the oil is likely to evaporate i.e. higher volatility faster evaporation.

2.5 Pour point.

The pour point of oil is the temperature below, which it will not flow. At temperatures below pour point the oil essentially behaves as a solid.

Table 1. Types and base properties of oil likely to be spilled in the region.

Oil type	Origin	Density Kg/m^3	Viscosity @ 15^{o}C	% Dispersability low-energy	high-energy
Brent	N. Sea	837	6	45	
Gullfaks (Braer)	N.Sea	870	13	20	
Statfjord	N.Sea	835	6	35	80
Forties blend (Sea Empress)	N.Sea	820	3		
Oseberg	N.Sea	852	10	30	80
Foinhaven	Atlantic margin	907			
Medium fuel oil	Bunker/fuel mix	979	8200	5	10
Heavy fuel oil	Bunker/fuel mix	980	1500	0	5
Marine diesel		862	1	50	80
Diesel		809	3		
Gasoline		709	1		

3. THE PROBABLE FATE OF SPILLED OIL

The natural dispersion and breakdown of the oil is a combination of processes collectively termed weathering. These processes are illustrated in figure 1.

3.1 Spreading

During the early stages of an oil spill the oil will spread under the influence of gravity and then through the effect of surface tension. The extent of the spreading process is governed by the viscosity of the oil with oils of higher viscosity spreading least. At temperatures below pour point there will be only minimal spreading effects. Other factors effecting the spreading rate are the prevailing wind conditions, tidal effects and local currents.

3.2 Evaporation

Volatile components of oil will quickly evaporate from the sea surface. High temperatures, extensive spreading, high wind speed and rough seas will increase the rate of evaporation. It is likely that components of the oil with a boiling point below 200^{o}C will evaporate within the first 24 hours of a spill (IMO 1988).

Refined fuels may completely evaporate within just a few hours. Up to 40% by volume of some light crude oils may evaporate within the first 24 hours (ITOPF 1997).

3.3 Natural Dispersion

If there is sufficient turbulence at the sea surface an oil slick will be broken up. Those droplets of oil that are sufficiently small will remain in suspension in the water column, forming an oil in water emulsion, where further processes of biodegradation and sedimentation will act upon the oil to assimilate it into the environment.

The rate at which oil will be naturally dispersed is dependent upon the properties of the oil spilled, the thickness of the oil slick and the sea state. Light oils spilled in heavy sea states are likely to disperse rapidly, heavy oils in calm sea state are likely to take many weeks to disperse.

3.4 Emulsification

Oils with an asphaltene content greater than 0.5% will readily absorb water forming a highly viscous water in oil emulsion, sometimes called ‘chocolate mousse’ because of its consistency and brown coloration. This holds back the other processes acting upon the oil making it more persistent.

Like natural dispersion the rate of emulsification is dependant upon sea state and the properties of the oil spilled. ‘In wind strengths greater than about Beaufort Force 3, some low viscosity oils can incorporate between 60% and 80% water by volume within about 2-3 hours’. (ITOPF 1997).

3.5 Dissolution

Dissolution has a very minor effect upon the volume of an oil spill. Those compounds within oil that are slightly soluble are also the most volatile hence it is likely that evaporation will act upon those compounds up to 1000 times faster than dissolution.

3.6 Oxidation

Hydrocarbons can react with oxygen to produce soluble compounds or alternatively to produce insoluble persistent compounds. This process of oxidation is enhanced by sunlight throughout the time that the oil is present on the surface. However it accounts for only a small proportion of the overall dissipation of the oil in comparison to other processes.

3.7 Sedimentation

Most oils have a lower density than seawater therefore they will not in themselves sink. However over time particulate matter may adhere to the oil thus increasing its density and allowing the oil to sink. The density of oil increases in low temperatures such that fewer particles are required to adhere before sinking occurs.

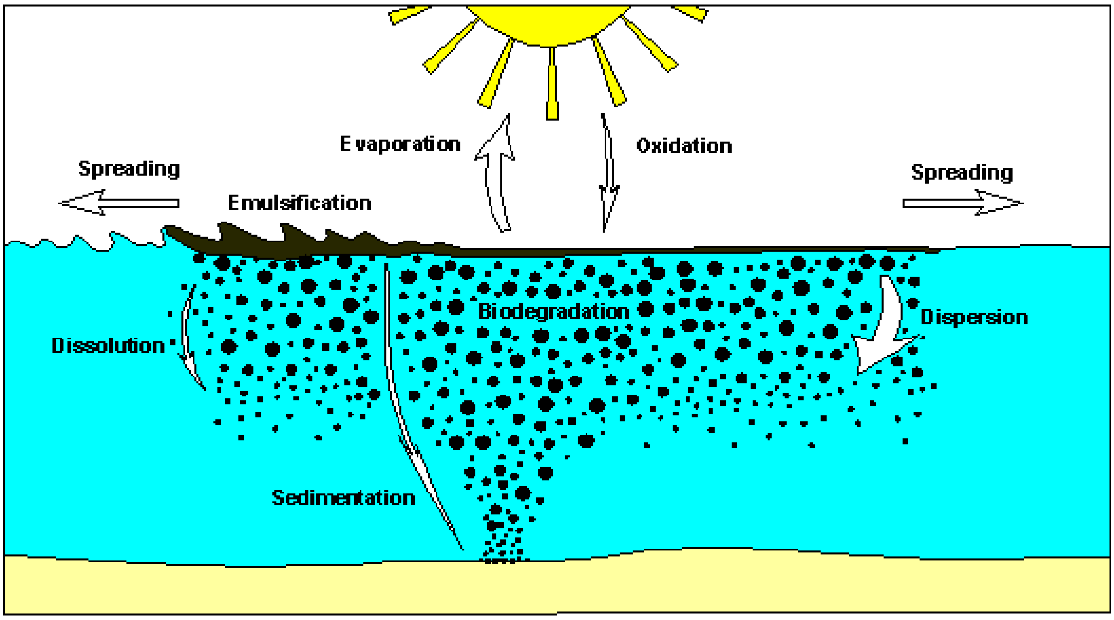
Oil, which has been washed ashore, will pick up particles of sand and small stones such that if it is subsequently washed back out to sea it will sink.

3.8 Biodegradation

There are marine micro-organisms, which can utilise oil as a source of carbon and energy (ITOPF 1997). They require an adequate source of oxygen and nutrients for this process consequently they are most abundant in polluted areas. The rate at which oil can be degraded by micro-organisms is greatly increased if the oil is naturally dispersed into smaller particles in the water column. In open temperate waters rates of 0.03 grams per tonne of seawater per day are achievable (ITOPF 1997).

The combined effects from these processes will eventually remove the oil from the sea surface however there may still be oil present in layers of sediment. In the case of the *Braer* prevailing weather conditions rapidly dispersed the light crude oil from the surface but the oil remained in deep water sediment sinks (ESGOSS 1994).

Figure 1. Processes contributing to the weathering of oil.



After ITOPF 1999

4. THE MOVEMENT OF OIL SPILLS

In considering the fate of an oil spill it is necessary to examine the factors effecting its movement. Depending upon the oils density and the quantity of oil spilled the spreading effect will have the most significant initial effect upon the movement of the slick. However it will very quickly come under the influence of external factors of wind, waves, tides and currents (IMO 1988). It is most commonly accepted that oil on the sea surface will be transported at 3% of the wind speed and 100% of any current speed. The closer inshore that a spill occurs or approaches the more complicated this model becomes with localised currents caused by tide races and outcrops making currents less predictable.

There are computer models available, which can forecast the movement of the oil as well as simulate the effect of the weathering processes upon it. These models become limited close inshore where localised currents take hold. In these circumstances it may be best to rely on local knowledge of the area to forecast the slick movement.

5. OIL SPILL RESPONSE AT SEA

In the UK, the recently created, Counter Pollution Branch of the Marine and Coastguard Agency is responsible for the co-ordination and application of oil spill clean-up at sea unless it occurs within a port or oil terminal and is within the capabilities of the port authority's clean-up response. The UK policy for response to oil spills at sea is to allow the oil to disperse naturally unless there is a threat of contamination of coastlines, fisheries or important bird populations. The primary response where practical and where the advantages, in terms of environmental protection and economic benefit, outweigh the disadvantages of cost and ecological damage is the application of chemical dispersants. Where dispersant spraying is impractical or where there is unlikely to be a net benefit from dispersant spraying then attempts at containment and mechanical recovery of the oil will be made. In some cases a stand-by response may be suitable either in readiness for dispersant spraying or for a change in the slick movement.

5.1 Monitoring

The majority of oil spills are under 700 tonnes and occur during routine vessel operations (ITOPF 1997). Spills of highly volatile oils will dissipate naturally within days through the effect of weathering processes. The more persistent oils may take weeks but by this time all that will remain is a near solid residue of low toxicity and relatively easy to collect. Many spills particularly those occurring offshore will require no action other than monitoring of their movements. For this purpose the Counter Pollution Branch (CPB) have two Cessna remote sensing aircraft on standby at Coventry and Inverness airports.

5.2 Dispersants

In cases where an oil spill threatens imminent damage to wildlife, habitat or other marine resource the UK reaction is to enhance the dispersion of the oil through the application of chemical dispersants. The decision to use dispersants is in the hands of the CPB who maintain a stockpile of approved dispersants and have on contract 7 DC3 aeroplanes on stand-by to apply the dispersant, 5 based at Coventry airport and 2 at Inverness airport (MPCU 1996). If dispersants are to be effective they must be applied within the first 24 hours of a spill occurring otherwise the oil will become highly viscous through the effects of weathering. There are other limitations to the use of dispersants depending upon the area in which the spill occurs. General guidelines suggest that dispersants should not be used in a water depth of less than 20 metres. This is because of the possible toxic effects of dispersed oil on the flora and fauna. Greater water depth allows higher dispersion. However each spill will have a unique set of conditions, the use or non-use of dispersant must be rapidly decided upon with consideration given to all factors. For example, if the oil threatened large numbers of breeding birds in an area, which had no other commercial or environmental significance then dispersants may be used close to shore. On the other hand if there was also important nursery grounds for commercial fish species in the area then the decision becomes more difficult. The window of opportunity for using dispersants is very short as such it is important that a contingency plan is in place that provides the information for a swift decision to be taken. Consideration should also be given as to whether or not the dispersant will be effective. There are a range of factors which influence dispersant effectiveness. IPIECA (1993) list eight;

1.	Viscosity	effectiveness decreases as viscosity increases
2.	Pour-point	limited effectiveness at temperatures close to pour-point
3.	Weathering	less effective over time
4.	Formulation	different efficiencies depending upon conditions
5.	Amount of dispersant	effectiveness decreases with decreasing dispersant:oil
6.	Salinity	most dispersant formulated for use in seawater
7.	Temperature	higher temp = lower viscosity = more effective
8.	Energy	turbulent energy required for mixing of dispersant and oil

5.3 Mechanical recovery.

Complete removal of the oil plus the financial benefits of regaining the oil for use make mechanical recovery of oil from the sea surface the preferred method of oil spill clean up. Unfortunately because of the nature of the receiving environment mechanical recovery at sea is also the most difficult and costly method of clean-up often recovering less than 10% of the spilt oil.

Before oil can be recovered from the sea-surface it must be contained. There are many different types of boom available for this however they are only effective in calm conditions. In current speeds greater than 1-knot oil will escape beneath the boom and in choppy conditions oil will splash over the boom. The less viscous the oil the harder it is to contain. If containment is possible then the oil can be recovered using a number of devices. In opposition to containment it is easier to recover low viscosity oils, with some high viscosity oils and weathered oils jamming the recovery mechanisms. Containment using booms is often more effective as a means of protecting a vulnerable resource such as a fishfarm or a saltmarsh. Booms can be deployed to block the entrance of oil into such an area. Along the same lines, booms can be deployed to deflect oil into a ‘sacrificial zone’ where it will cause least damage.

6. EFFECTS OF OIL SPILLS ON MARINE RESOURCES

All the factors discussed must be taken into account in assessing the possible impact of any oil spill. In some cases, particularly spills occurring offshore, there may be no discernible effects (IPIECA 1991_1). The effects of an oil spill cannot be predicted simply from the quantity of oil involved. In the case of the *Braer*, in 1993, 87400 tonnes of crude oil was spilled, however wildlife casualties and environmental damage were minimal considering the size of spill (ESGOSS 1994). On the other hand, Mead and Baillie (1981) reported that 30000 oiled birds were washed up on beaches neighbouring the Skagerrak, most probably caused by a small oil slick centred on high concentrations of birds.

The range of impacts from an oil spill can be extensive:

- Physical contamination of habitat
- Smothering
- Toxic effects
- Tainting of wild and cultivated fish and shellfish
- Fouling of fishing gears and vessels
- Loss of amenity beaches and coastal resources
- Economic loss from bad publicity

The West Coast of Scotland is a near pristine environment whose economy relies heavily upon fishing, aquaculture and tourism. It is possible that an oil spill or actions taken to clean up an oil spill could not only impact upon the environment but also effect the local economy of the area.

6.1 Aquaculture

There are over 300 fish and shellfish licences issued in the region (pers comm Crown Estate). The majority are located in sheltered sea lochs on the mainland and the inner islands of Mull and Skye (Map 2 & 3). Fish farming is a major provider of income and jobs throughout the region this makes it an important resource to protect in the event of an oil spill.

6.2 Tourism

The tourism industry of the area is based upon the environment and its associated wildlife. Oil polluted beaches devoid of wildlife are not conducive to a healthy tourist industry. There is no one main attraction that could be singled out as requiring protection beyond others to this end it would only be feasible to protect the more accessible areas.

6.3 Seabirds

The region is home to many species of birds both seasonally and permanently. The vulnerability of bird populations to oil pollution is likely to change throughout the year as birds migrate to other areas. (JNCC 1995).

6.4 Marine Mammals

There are important populations of whales and dolphins resident and passing through the area. There is little evidence that oil spills have a great deal of effect upon cetaceans. It is thought that they simply avoid contact with the oil by moving to another area (Gubbay & Earll 1999).

Phocids react in the same way although during the breeding season when pups and mothers are on the beach oil pollution would be a problem.

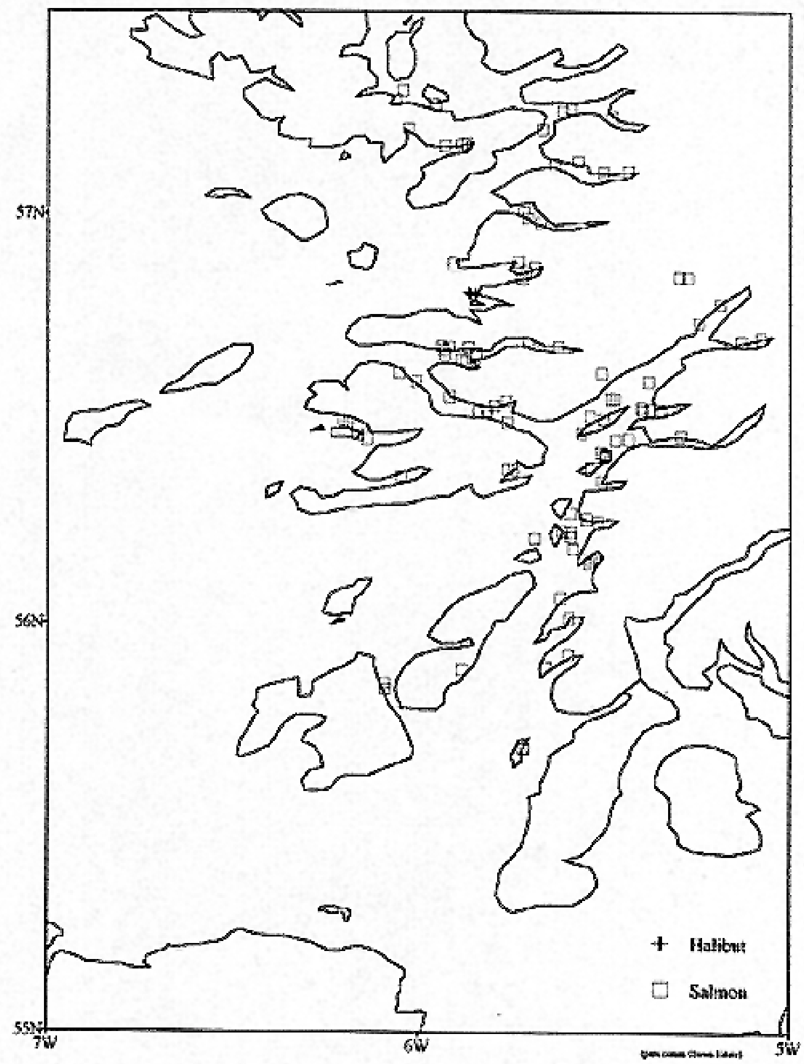
Cetaceans and adult Phocids rely on blubber for insulation so that a minor oiling event would have little effect upon their ability to retain heat. On the other hand there is a large population of sea otters in the region, these rely upon their fur for insulation consequently oiling of these animals is likely too result in high mortalities.

6.5 Wild fish

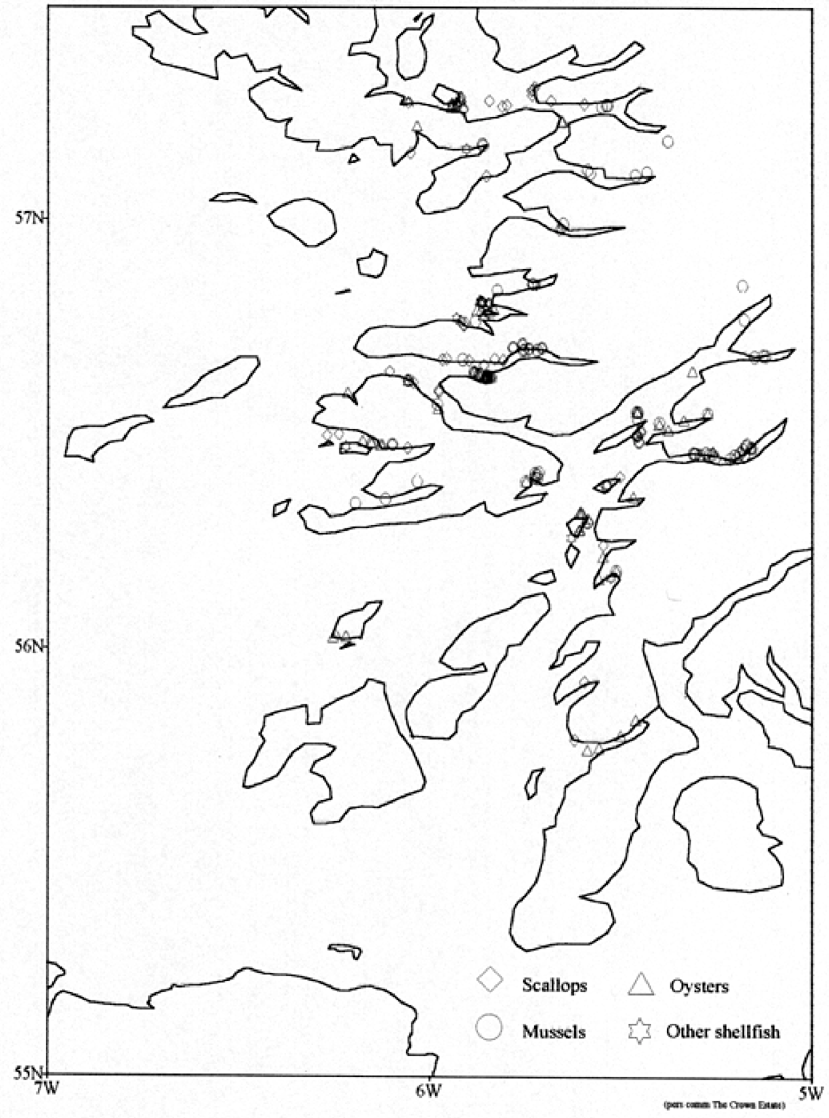
There are important nursery and spawning grounds for a number of fish species in the region. Oil on the surface presents little problem to fish however naturally or chemically dispersed oil may effect the viability of spawning grounds and young fish. There have been incidents of tainting of fish by oil (ESGOSS 1994) but this cleared itself naturally within a few months.

6.6 Shellfish

Oil poses a bigger threat to shellfish than to fish. Crustaceans feed on the bottom ingesting dispersed oil and molluscs filter oily water thus ingesting the oil. This does not necessarily cause mortality in the organism but it does create a major problem with tainting of the flesh, which takes longer to clear than that of fish.



Map 2. Location of fishfarm licenses issued by The Crown Estate.



Map 3. Location of shellfish cultivation and spat collection licenses.

7. CONTINGENCY PLANNING

‘While the environmental priority for all tanker operations is the prevention of spills, it is recognised that marine spills are a factor for which management must plan’ (IPIECA 1991_2). With the production and transportation of oil comes the inherent risk of a spillage. To mitigate the adverse effects of a spill a high priority is given to the development of contingency plans in order to ensure a timely and effective response to an oil spill.

7.1 National Contingency Plan

In the United Kingdom the counter pollution branch of the Marine and Coastguard Agency (MCA) is responsible for the national contingency plan and for the at-sea response to an oil spill. Until recently the, now disbanded, Marine Pollution Control Unit (MPCU) based in Southampton held this responsibility. The new regime which will be in place from October 1999 creates four regions in the UK each with a Principal Counter Pollution and Salvage Officer (PCPSO) based in the region. The North region, made up of Scotland and Northern Ireland, will be managed from Aberdeen MRSC. With the reorganisation comes a review of the national contingency plan, which is underway at this time. Until it is fully implemented the existing national contingency plan (MPCU 1996) is still in use.

7.2 Local contingency plans

In drawing up a local contingency plan it is important that reference is made to the national contingency plan. In terms of at sea response it will always be the responsibility of the MCA regional counter pollution branch to implement the response procedures. On shore response becomes the responsibility of the relevant local authority that can call upon expertise and facilities from the counter pollution branch if they require.

The following local contingency plan for the Inner Hebrides deals only with the at-sea response to an oil spill the onshore clean-up response will be dealt with in a separate document.

7.3 Geographical limits

This plan is developed to cover the Islands and the western coasts bounding the Sea of the Hebrides (Map 1). It is being developed to meet the needs of an area of outstanding natural assets that has been largely forgotten in plans developed for areas to the North and South.

7.4 Authorities and responsibilities

Initial alert should be to the local coastguard who will initiate search and rescue operations if necessary and contact the North Region Counter Pollution Branch (CPB) in Aberdeen. The CPB is then responsible for the at sea response to the oil spill. Local authorities should be alerted to the potential for shoreline contamination for which they have clean-up responsibility.

Lead Agency	Marine and Coastguard Agency Counter pollution branch, North Region Principal Counter Pollution and Salvage Officer Aberdeen MRSC Contact - Toby Stone PCPSO Tel: 01224 592334
Local Authorities	Argyll and Bute Council Director of Development and Environment Lochgilphead Contact - George Harper Tel: 01546 604225 fax: 01546 604386
	Highland Council, Lochaber District Area Protective Services Manager Fort William Contact - Robert McCover Tel: 01397 707002

Colm Frazer

Tel: 01397 707013

Advisors	Scottish Office Agriculture Environment & Fisheries Department Tel: 0131 556 8400 Scottish Natural Heritage Tel: 0131 447 4784 Scottish Environment Protection Agency Tel: 01349 862021
Control centre	Oban MRSC – due to close Clyde MRSC Stornoway MRSC
Facilities	Inverness airport 2 Dispersant spraying aircraft, DC3 1 Remote sensing aircraft, Cessna 402 Oil dispersant stockpile Portable dispersant spray systems Shoreline clean-up resources Coventry airport 5 Dispersant spraying aircraft, DC3 1 Remote sensing aircraft, Cessna 402 Oil dispersant stockpile Paisley & Stornoway Oil dispersant stockpile Dundee Harbour 2 oil recovery systems Oil dispersant stockpile

8. OIL SPILL RISKS

8.1 Identification of activities and risks

At present there is no oil exploration or production in the area. There is however regular tanker and other heavy shipping passing through the western fringes of the area (Map 4). This traffic is heading to or from the North Channel, the main shipping route in and out of the Irish Sea. Only small cargo vessels will be heading to or from a port within the area. The International Maritime Organisation (IMO) has recommended that tankers over 10000 GRT should pass to the west of the Hebrides using a deep-water route (Map 4). Data collected by MRSC Stornoway (Table 2) indicates that tankers greater than 10000 GRT are still passing through the Minch with 32 laden tankers passing through the Minch during the first five months of 1999. The largest of these tankers were carrying in excess of 70000 tonnes of crude oil. Data from ITOPF published in IPIECA (1991_2) indicates that the highest risk of oil spillage occurs during loading and unloading of oil and fuel, with these activities accounting for 83.2% of all spills between 1974 and 1990. During this same period grounding and collision accounted for the remainder of the oil spills. The area of the Inner Hebrides has no major port or oil handling developments therefore it should be at no risk from loading or unloading. However tankers regularly discharge their ballast to alter the trim of the vessel the discharged ballast is often a mixture of oil and water. There is also a high risk to the area from collision and grounding in the restricted navigation routes between the islands and from the illegal washing of bilge’s whilst tankers are on passage. Although the risk of a collision or grounding is lower than other risks the quantity of oil released can be many magnitudes greater e.g. *Braer* 84000 tonnes, *Sea Empress* 72000 tonnes.

8.2 Accidental discharge

Tankers heading for or taking the approved route west of the Hebrides will pass as close as possible to Barra Head (Map 4) to shorten their passage time. The closer that the tankers pass to the shoreline the greater the chances of grounding. Tankers and other vessels passing through the Minch pose similar risks. The recommended shipping routes through the Minch (Map 4) do not allow a great deal of margin for error with the northbound route affording only 0.75 miles clearance from the shore and the southbound route 1.3 miles clearance from the shore. The waters between the islands are treacherous and in the past have claimed numerous vessels (Map 5). Many of the wrecks indicated are extremely old and did not benefit from a motorised power system or modern navigational technology however the final resting places of these vessels indicate the shorelines most at risk.

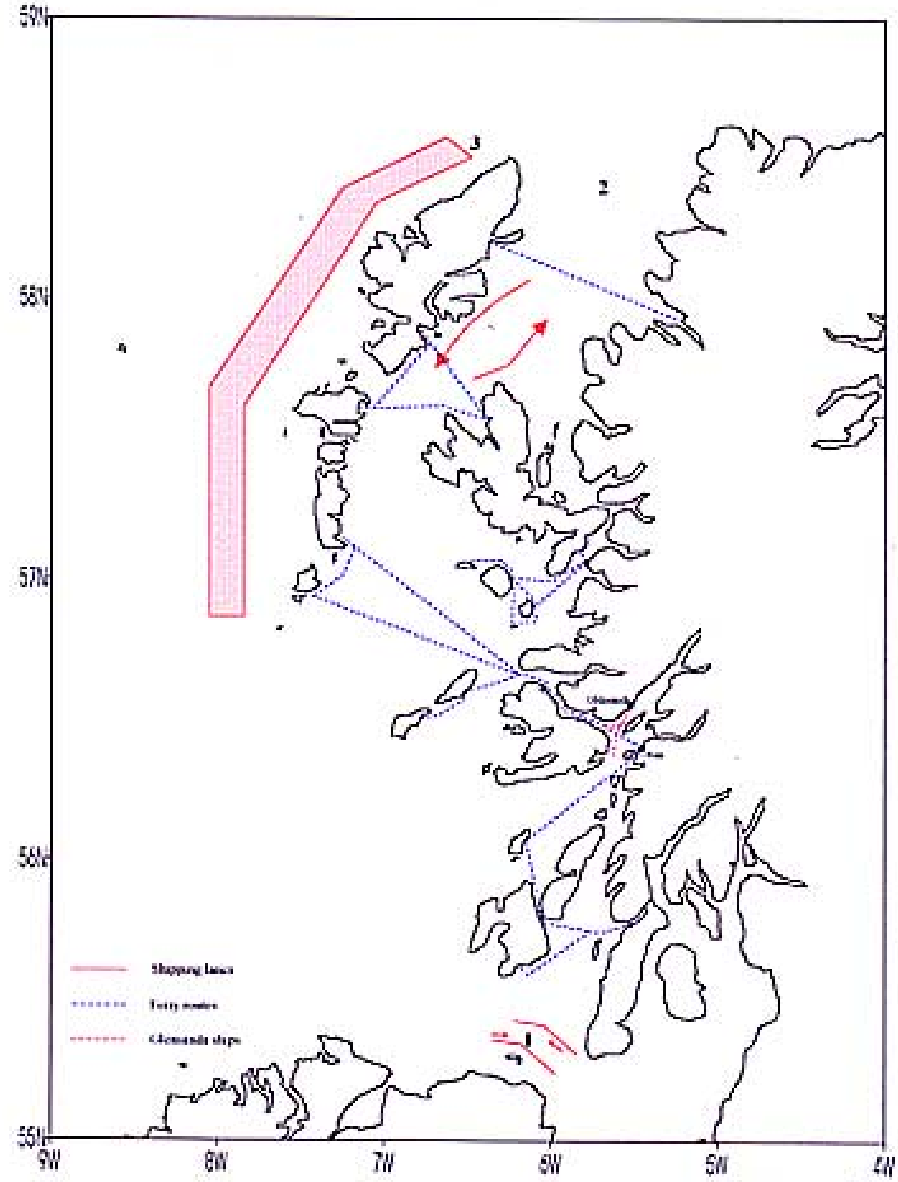
As well as traffic on passage through the area there are also vessels working almost constantly within the area, fishing vessels, ferry traffic between the islands and large cargo vessels travelling to and from the Foster Yeoman superquarry at Glensanda. Many of these vessels pass through the deep but narrow waters of the Sound of Mull. It is in areas such as this, where manoeuvring space is restricted that there is a higher risk of incident.

As yet there have been no incidents of this type in the Inner Hebrides however in 1997 two relatively small vessels grounded in waters around the Western Isles. In 1999 the *Westminster*, a tanker of similar size to the *Braer*, lost power west of the Outer Hebrides whilst carrying 80,000 tonnes of crude oil. The vessel regained power and continued its passage but the incident demonstrates the potential of such an event occurring within the area of the Inner Hebrides.

An incident involving a tanker in 1993 occurred when a ferry leaving Oban was forced to alter course to avoid collision with a tanker following the recommended route through the Minch. If the tanker had altered course she would have put herself in a hazardous position due to the confines of the narrow navigation channel.

8.3 Operational discharge

Discharge of oil and oily mixtures can legally be made 50 nautical miles from land whilst a vessel is on passage. There have been incidents where oily residue and oiled birds have washed up on island shores. It is suspected that this is the result of tankers discharging ballast or oily bilge water either just after leaving the North Channel or prior to entering it. The open stretch of water from Barra Head to the North Channel (Map 4) may be perceived as the first or last appropriate area for ballasting.



1. North Channel.
Laden tankers of over 10000GRT should avoid the area between the North channel traffic separation scheme and the adjacent coasts of Raithlin Island and the Mull of Kintyre. No laden tanker should use the narrow passage through Rathlin Sound.

2. East of the Outer Hebrides
except when due to stress of weather, or any other force majeure, laden tankers over 10000GRT should not pass east of the Outer Hebrides through the Little Minch and North Minch.

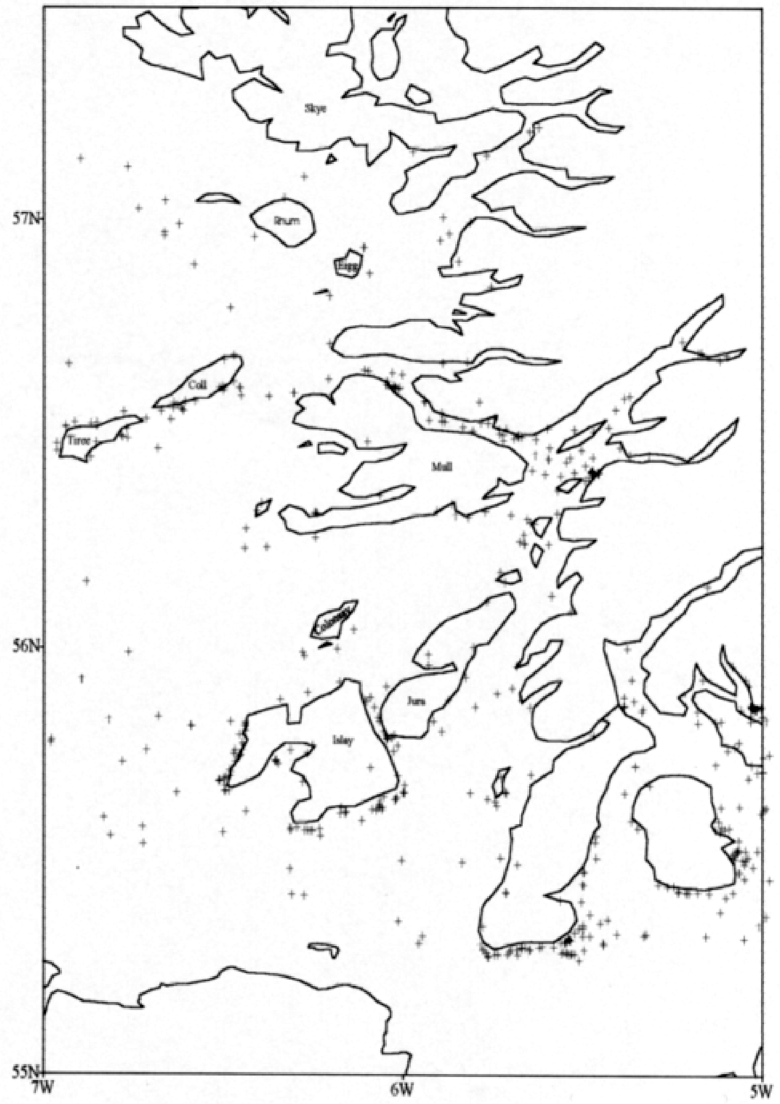
3. Deep water route
IMO recommends that laden tankers over 10000GRT use this route, weather permitting.

Map 4. Major shipping lanes and ferry routes in the region.

Table 2. Traffic summary of vessels passing through the Minch during the first five months of 1999.

Month	Tankers in ballast	Tankers loaded<10K	Tankers loaded >10K	Other vessels	Heading North	Heading South
Jan-99	38	12	6	77	74	59
Feb-99	27	13	9	72	52	67
Mar-99	45	20	2	96	87	76
Apr-99	39	15	3	91	83	68
May-99	34	14	12	76	73	62
Total	183	74	32	412	369	332

Courtsey of MRSC Stornoway



Map 5. Historic wreck sites indicating areas at risk from groundings and possible beaching sites.

9. SENSITIVITY MAPPING

The Inner Hebrides and waters around the Hebrides are important economically and environmentally. The maps contained in this document indicate areas of environmental and economic importance. It is important that when using environmental sensitivity maps reference is made to economic sensitivity maps containing information about harbours, recreation areas, fishing grounds and aquaculture sites. It is possible that on maps of a large enough scale or on a GIS system all the relevant information can be contained on a single map.

9.1 Environmental Sensitivity Mapping.

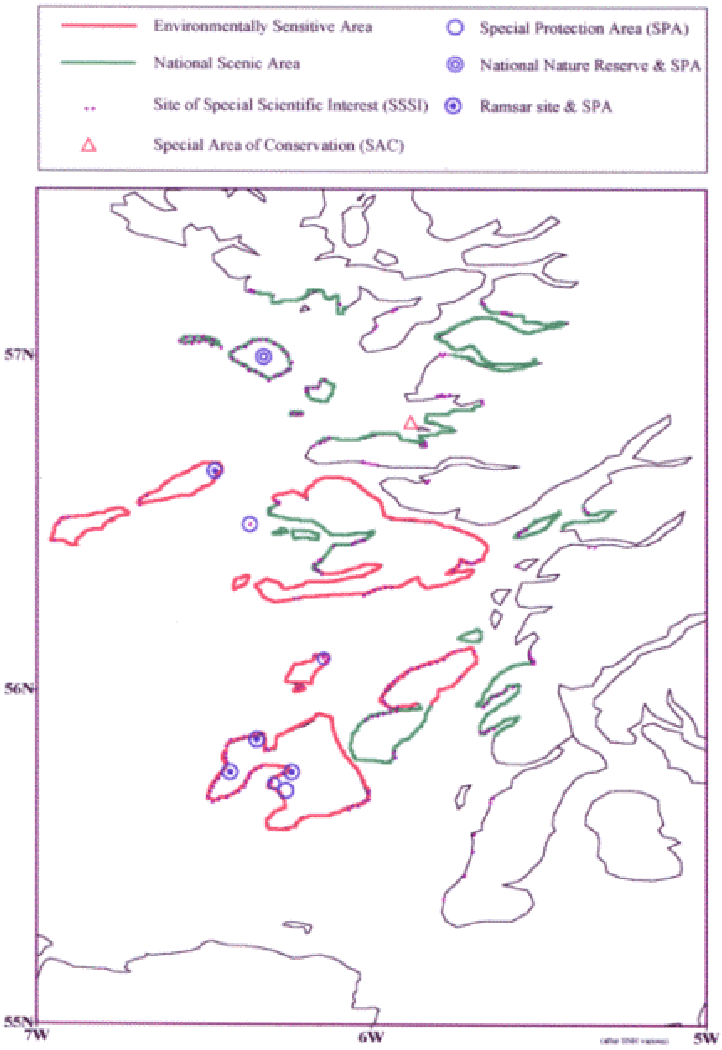
Environmental sensitivity maps are a valuable tool for assessing oil spill response (Map 6). To be effective they should present easy to read and simple information. Gundlach and Hayes (1978) developed a 10-point index of shoreline vulnerability. This was based on the principles that sensitivity to oil increases with decreasing exposure, depth of oil penetration into sediment, increasing natural retention time and increasing biological productivity. Table 3 describes the shoreline types and their associated index with 1 being least vulnerable and 10 most vulnerable.

9.2 Economic Sensitivity Mapping.

The most visible and publicised effects of oil spills are oiled shorelines and wildlife casualties. These can in some cases represent the least significant effect, as illustrated in the *Braer* case study. Of equal and often greater effect is the impact upon the local economy, which can often be dependent upon the fishing, fish farming and tourism industries. Dispersed oil can taint the flesh of fish and shellfish, as happened in both the *Braer* and *Sea Empress* incidents, resulting in area closures for fishing and the destruction of farmed salmon. Beached oil is both unsightly and noxious, on popular tourist beaches this can result in a dramatic fall in the number of tourists. Maps indicating these important economic areas are an essential component in the formulation of oil spill response strategies.

9.3 Data maps

Inherent in contingency planning is the ability to quickly assess a situation and possible scenarios. Data maps containing tidal information, sea surface temperature, shipping lanes, wind speed and wind direction, are vital in making this assessment. In inshore areas, where localised currents prevail over the offshore tidal regime, computer driven oil spill models can be inadequate. With complete local information the movements of an oil spill can be plotted manually.



Map 6. Designated & Protected Areas for Nature and Landscape Conservation.

Table 3. Classification system for common shoreline types found in the area of the contingency plan. (Gundlach & Hayes 1978)

Vulnerability Index	**Shoreline type**	**Comments**
Low 1	Exposed rocky headlands	Oil kept offshore by wave reflection.
2	Eroding wave-cut platforms	Most oil removed by natural wave processes within weeks.
3	Fine-grained sand beaches	Oil does not penetrate far into the sediment. May persist for several months.
4	Coarse-grained sand beaches	Oil penetrates rapidly. Under high energy conditions it may be removed within months.
5	Exposed, compacted tidal flats	Oil will not penetrate into compacted sediment. May wash back offshore or collect at high tide line.
6	Mixed sand and gravel beaches	Oil penetrates very rapidly. May persist for years.
7	Gravel beaches	“ “
8	Sheltered rocky coasts	Oil may persist for years under reduced wave action.
9	Sheltered tidal flats	Oil will persist for many years in low energy environment.
High 10	Salt marshes	“ “

(after Baker *etal* 1990)

10. OIL SPILL SCENARIOS

Bearing in mind the potential risks to the Inner Hebrides and prevailing local conditions a number of scenarios were generated using Oil Spill Information System (OSIS) at BP Amoco's emergency response centre in Aberdeen. OSIS predicts the movement of an oil spill using tide and wind conditions and predicts the weathering of the oil dependant upon temperature, time and sea-state. As previously mentioned the accuracy of computer spill models reduces significantly in areas influenced by local tidal currents. Attempts to run the model in enclosed waters produced unsatisfactory results as such those areas identified as high risk in terms of collision, grounding or ballasting in offshore waters were chosen to run the model from. Wind direction in the region is predominantly westerly with an average wind speed of 15 knots. (Chandler & Gregory 1976, Met Office 1984 &1985, MAFF 1981).

10.1 Scenario 1.

Position	57^0 23.00’N 07^0 00.00’W between S Uist and Skye
Incident	Collision

The Northwesterly wind was chosen as the worst case scenario for this particular incident. Within 33 hours the oil had beached on the Islands of Canna and Rum, which include a NNR, SPA, NSA and SSSI (Map 6.). Rum is home to the largest breeding colony of Manx Shearwaters in Europe. Manx Shearwaters are present during the months of March to October and because of their high contact time with the water, oil pollution poses a high threat to them. (JNCC 1995).

The area around the Small Isles is also very important as shellfish fishing grounds for both Nephrops trawl and for static gears (Coull et al. 1998).

Response options.

Initial surveillance and modelling would indicate the spill’s direction of movement. A decision to spray dispersants would need to be taken before the oil had weathered too far. Dispersant spraying would certainly reduce any impact upon the shoreline and surface feeding birds. However the impact may be transferred to the water column and eventually the benthos including shellfish. Experience with both the *Braer* and the *Sea Empress* has shown that shellfish suffer from tainting for some time after a spill. The benefit to the shoreline of Rum and the seabirds would have to be weighed up against the potential economic loss from a closed fishery.

The wind and sea state would make booming impractical plus it is unlikely that protective measures could be taken in time because of the logistics involved in transporting equipment to the area therefore containment and recovery are most probably not an option.

Oil type:	Forties	**Sea surface temp** (°C):	10
Viscosity @ 15°C:	8	**Time to 1st beaching** (hours):	29
Volume spilled (Tonnes):	10000	**Beached volume** (Tonnes):	24000
Wind speed (Knots):	15	**Evaporated volume**(Tonnes):	2540
Wind direction:	NW	**Dispersed volume** (Tonnes):	2340
Sea state (Beaufort scale):	Moderate	**Total elapsed time** (hours):	33
State of the tide:	HW spring		

10.2 Scenario 2.

Position 55^0 20.00'N 06^0 00.00'W – North entrance to the North Channel

Incident Collision

The worst case scenario for the Inner Hebrides is a Southerly wind driving the oil into the Islands of Islay and Jura. Islay has been identified as an environmentally sensitive area and the coastline effected includes a SSSI. The coastline of Jura effected is a NSA and also includes a SSSI (Map 6.). There are no nationally important bird populations in the effected zone although there are locally important populations of guillemots and razorbills (JNCC 1995). The area has economically important shellfish fishing grounds for both static gears and trawl.

Response options

Initial spill movement is influenced by the strong tides running through the North Channel and transports the oil away from the Islands. The first minor beaching occurs within 8 hours on the Mull of Kintyre, by this time the tide has changed and the combination of wind and tide transports the oil back towards Islay. Within 38 hours the majority of the oil has beached along the eastern shores of Islay and Jura.

Although environmentally important the coastline effected is replicated elsewhere in the area as such local damage incurred by the spill does not mean a loss of any unique species or habitat. On the other hand if dispersants were used to minimise this damage it is likely that the area would suffer from an extended fisheries closure for shellfish which is an important economic base for both the local community and incoming fishermen. There are 4 fish farm sites within the effected area it may be possible to protect individual sites through booming if suitable equipment can be transported in time. However in common with most of the Inner Hebrides transport links are poor. Using dispersants may prevent salmon mortalities on the other hand the dispersed oil may still taint the flesh making it unmarketable for some time (see *Braer* Case study).

Oil type:	Forties	**Sea surface temp** (°C):	10
Viscosity @ 15°C:	8	**Time to 1st beaching** (hours):	8
Volume spilled (Tonnes):	10000	**Beached volume** (Tonnes):	17700
Wind speed (Knots):	15	**Evaporated volume**(Tonnes):	3570
Wind direction:	S	**Dispersed volume** (Tonnes):	2660
Sea state (Beaufort scale):	Moderate	**Total elapsed time** (hours):	38
State of the tide:	HW spring		

10.3 Scenario 3 (a) and (b).

Position 56^0 44.00'N 07^0 40.00'W – Barra Head

Incident grounding

Barra Head was identified as an area of risk because the tankers steer close to shore to shorten their passage. It is feasible that in poor weather, bad light or early morning grounding may occur. The quantity of oil spilled was set at 1000 tonnes, the same scenario with a 10000 tonne spill showed similar results in terms of direction and time.

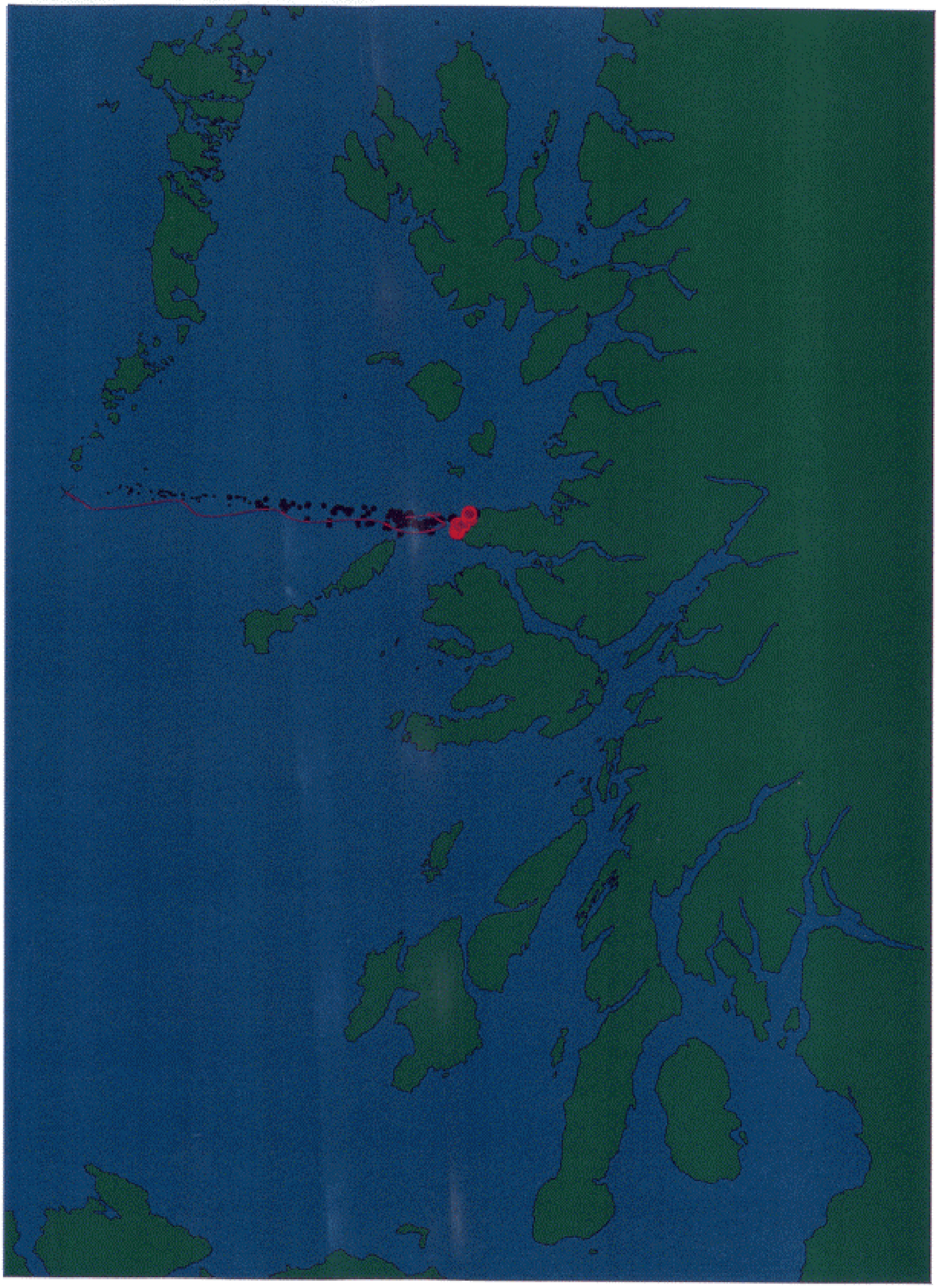
(a) With the wind westerly at 15 knots the oil took 50 hours to reach Ardnamurchan point. By this time around 75% of the oil had dispersed or evaporated naturally however a significant quantity of viscous emulsion still reached the shoreline. The impacted shoreline is a NSA and a SSSI (Map 6.) and includes high-energy rocky shores and extensive sandy bays.

(b) With the wind in the Northwest at 15 knots the oil will impact the northern shore of Islay in 70 hours. These shores are similar to Ardnamurchan point but are given a higher level of importance including a SPA.

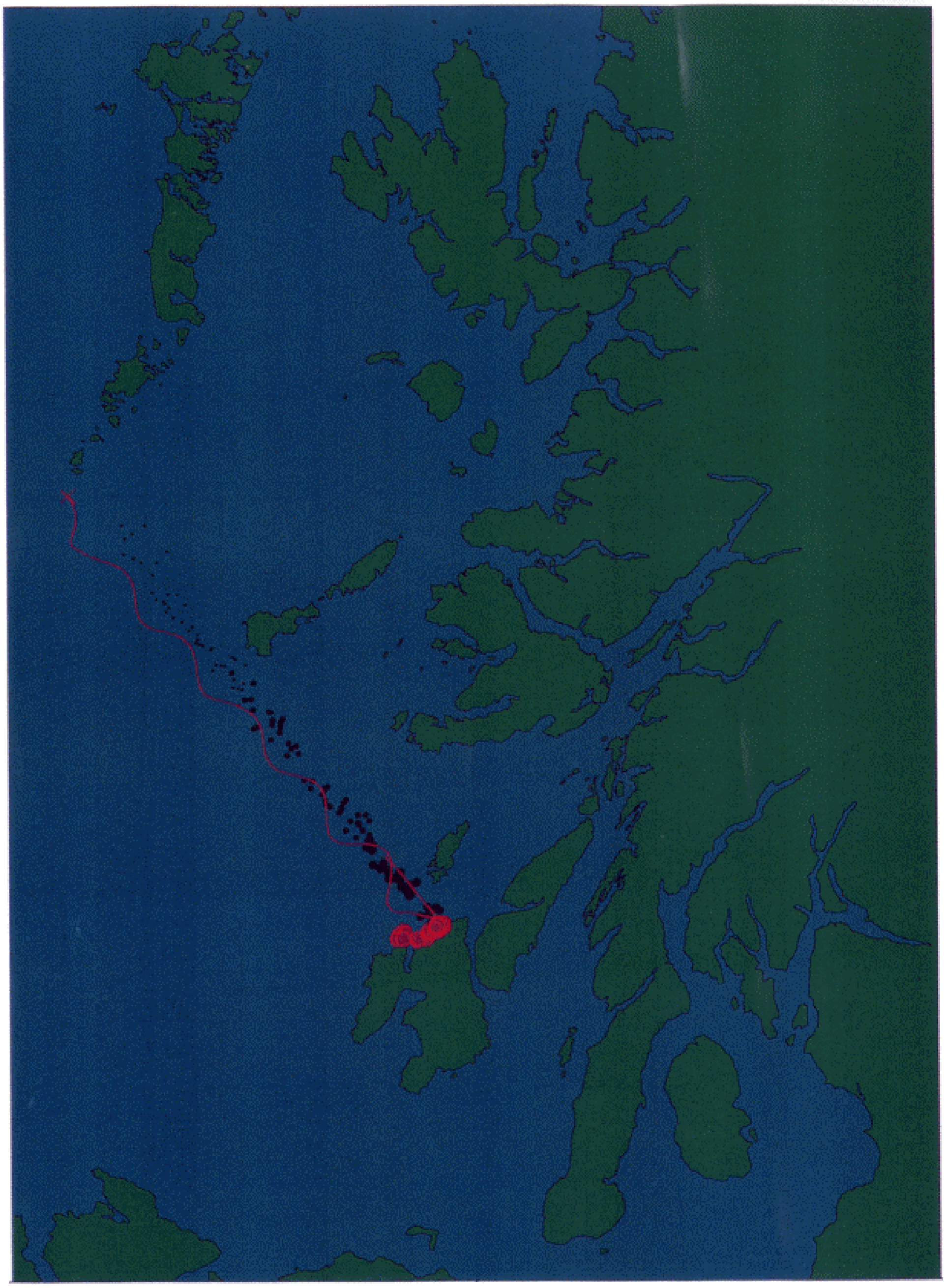
In common with most of the area the seas are important as fishing grounds for shellfish. Minke whales and dolphins are commonly sited in the area and a small whale watching industry services the tourists during the summer season.

Response options

The spill occurs in shallow water but rapidly moves into deeper waters. The use of dispersants at an early stage would be ideal. The oil would disperse into a high volume of seawater and quickly dilute into low concentrations, which should not effect the benthic environment. There have been no reported impacts upon whale and dolphins from oil pollution, it is thought that they simply avoid areas of contamination and that minor oiling of their bodies does not effect them in the long term (Gubbay & Earll 1999). The dispersant response should enhance the natural dispersion by a further 25% (Lunel *et al* 1997) leaving the shoreline unimpacted. There is a possibility that the whales and dolphins may leave the area for an extended period of time however there is no evidence, as yet, to suggest that this will happen.



Oil type:	Forties	**Sea surface temp** (°C):	10
Viscosity @ 15°C:	8	**Time to 1st beaching** (hours):	50
Volume spilled (Tonnes):	1000	**Beached volume** (Tonnes):	1060
Wind speed (Knots):	15	**Evaporated volume**(Tonnes):	412
Wind direction:	W	**Dispersed volume** (Tonnes):	363
Sea state (Beaufort scale):	Moderate	**Total elapsed time** (hours):	54
State of the tide:	HW spring		



Oil type:	Forties	**Sea surface temp** (°C):	10
Viscosity @ 15 °C:	8	**Time to 1st beaching** (hours):	70
Volume spilled (Tonnes):	1000	**Beached volume** (Tonnes):	473
Wind speed (Knots):	15	**Evaporated volume**(Tonnes):	416
Wind direction:	NW	**Dispersed volume** (Tonnes):	483
Sea state (Beaufort scale):	Moderate	**Total elapsed time** (hours):	75
State of the tide:	HW spring		

10.4 Scenario 4.

Position 56° 12.48'N 07° 28.03'W – Stanton banks

Incident Operational discharge

With the wind in the Southwest at 15 knots oil will reach the western shores of Tiree in 24 hours. It will impact on high-energy rocky shores and sandy beaches. The coastline includes 2 SSSIs and is recognised as an environmentally sensitive area (Map 6). The area sustains important shellfish fisheries, many whales and dolphins are sited and it is a popular destination for windsurfers and surfers enjoying the unbroken Atlantic swell.

Response options

In this scenario because of the time involved it is important that dispersant operations are commenced as soon as possible. Just over 50% of the oil will be naturally dispersed. If dispersant can be applied quickly enough and in a large enough quantity the shoreline should experience only a minor impact. Dispersant operations this far offshore will not inflict significant damage to the shellfish fisheries which are prosecuted closer inshore. Should any oil impact upon the shoreline it may not be necessary to physically remove it because the high-energy environment created by the Atlantic swells will self clean the shores.

Oil type:	Forties	**Sea surface temp** (°C):	10
Viscosity @ 15°C:	8	**Time to 1st beaching** (hours):	24
Volume spilled (Tonnes):	1000	**Beached volume** (Tonnes):	2280
Wind speed (Knots):	15	**Evaporated volume**(Tonnes):	325
Wind direction:	SW	**Dispersed volume** (Tonnes):	190
Sea state (Beaufort scale):	Moderate	**Total elapsed time** (hours):	26
State of the tide:	HW spring		

11. CASE STUDY - *BRAER*

On the 5th of January 1993 the oil tanker *Braer* grounded at Garths Ness on the South West coast of Shetland. This resulted in the release of 84,700 tonnes of light Norwegian Gullfaks crude oil. The oil was released over a period of 7 days until the vessel broke up on the 12th of January. Prevailing weather conditions were gale force winds from the Southwest with little abatement during the release time. The winds generated exceptionally large waves because of the length of fetch to the Southwest and the duration of the storm conditions. The stormy conditions rapidly dispersed the oil into the water column where currents transported it mainly north and west with some transport to the south. In these areas it was subsequently deposited in deep sediment basins. Only a very small percentage of the oil made landfall as such the major impact was on the sub-tidal ecology of the area. In its conclusions ESGOSS 1994 state that *'…we have determined that in all areas of concern, except for the rate of degradation of small areas of oil that remain in the fine sediments in deeper water to the west and south of Shetland, the impact has been minimal both in extent and duration.'*

11.1 Response

The initial alert was sounded fully 6 hours before the vessel grounded as such the response to the incident was timely and well organised. The following timetable illustrates the event and response timings.

5/1/93	0519	lost all power 15 km from Sumburgh Head
	0700	3 emergency centres set-up
	1100	
	1119	Confirmed grounding on Garths Ness, oil leakage
	1445	Aerial surveillance confirms movement of oil
	1600	MPCU staff arrived emergency centre set-up in Sumburgh airport
6/1/93	1010	Successful trial of dispersant spray
	1545	Spraying ceased (100 tonnes dispersant used). No spraying N of 60
7/1/93		Aerial surveillance indicates further spreading
	1100	Helicopter spraying using pods from Sullom Voe
	1200	
	1500	Aerial surveillance indicates no northerly spreading

8/1/93	1500	Fisheries exclusion zone declared
9/1/93	0845	Aerial surveillance indicates further leakage from wreck
		Concerns voiced for public health because of spraying
	1130	Spraying recommences after discussions
12/1/93		*Braer* breaks up releasing remaining oil
23/4/93		Fisheries exclusion lifted for wild fish.
8/12/93		Fisheries exclusion lifted for farmed fish.
2/95		Fisheries exclusion lifted for most shellfish.

The timetable indicates that although MPCU staff and aircraft were mobilised and in place within 5 hours of the *Braer* grounding they were unable to carry out any dispersant spraying until 23 hours after initial grounding. Weather conditions and darkness prevented any action before this time. It should be noted that had conditions not been so stormy it is likely that the oil would not have dispersed so readily by natural wave action and by dispersant spraying.

11.2 Specific effects

Although the impact was minimal there were some effects upon the ecology of the area particularly on a local scale.

Birds

A relatively small number of birds were oiled with only 1600 being recovered. This is unusual when such a large quantity of oil is spilled however the time of year and the stormy conditions combined to keep many birds away from the area.

Mammals

The situation was similar for marine mammals with virtually no deaths being directly attributable to the spilled oil. It is commonly thought that where possible mammals will simply avoid areas that are oiled.

Farmed fish

The Shetland salmon farming industry did suffer from the *Braer* oil spill. The Scottish Office imposed a fisheries exclusion order on an area off Southwest Shetland. caged salmon are unable to swim clear of suspended oil as such they were contaminated by the suspended oil. Of particular concern were the levels of polycyclic aromatic hydrocarbons (PAH) and any detectable tainting of the flesh. Living organisms will cleanse themselves naturally of hydrocarbon contaminants over time however the damage to the reputation of Shetland salmon was the prime concern. As a measure to reassure the public the Shetland salmon industry voluntarily culled the 1991 and 1992 year classes within the exclusion area. By July 1993 there was near normal PAH levels and no taint to the flesh as such the order was lifted in December 1993.

Wild fish

Wild fish were able to swim clear of the contaminated area and very rapidly cleansed of contamination. The fisheries exclusion order for wild fish was lifted in April 1993. There was some concern over the effect upon sandeels a major component of the diet of seabirds, fish and mammals, however there was no apparent effect on population or distribution.

Shellfish

Shellfish live mainly on or in the sediment as such they had higher concentrations of contamination from oil contaminated sediments. In the case of filter feeders such as scallops and mussels these levels were even higher and more sustained. The fisheries exclusion order for shellfish was not fully lifted for all species until February 1995 even now there are isolated exclusion areas for Nephrops (Shetland Fishing News April 99).

Benthos

Even in the areas of fine sediment where oil was deposited there was only minimal disturbance to populations and community structure.

Shoreline

There was localised impact on coastline close to the wreck but with only a small proportion of the oil beaching the impact overall was minimal.

11.3 Discussion

Given the quantity of oil spilled it was a combination of factors, which prevented a major ecological disaster. Gullfaks crude oil because of its chemical and physical properties is particularly amenable to natural and chemical dispersion. The extreme weather conditions rapidly dispersed the oil and the strong currents acting around the South of Shetland carried the suspended oil away from the coast.

Parallels can be drawn with the Shetland Islands and the West Coast of Scotland, particularly the Hebridean Islands. Both areas are economically dependent upon fishing, fish farming and tourism and are reliant upon sea and air transport. The coastlines are predominantly rocky, interspersed with sandy bays and sheltered inlets. The western coasts of the Shetland Isles and the Hebrides are open to the full force of the Atlantic swells. Both areas are sparsely populated and relatively unspoilt.

After the *Braer* incident ESGOSS came up with a number of recommendations on future response to oil spills.

In terms of at sea response the main recommendations were;

- Improved modelling of oil spill movement.
- Provision of relevant information for response decisions to be taken promptly.
- Sensitivity maps should be digitised for use in a GIS system.

12. CASE STUDY – *SEA EMPRESS*

On the 15th of February 1996 at 2007 hours the oil tanker *Sea Empress* ran aground at the entrance to Milford Haven. Over the next seven days a total of 72000 tonnes of Forties blend crude oil and 364 tonnes of fuel oil were released into the marine environment. Forties blend crude is a light crude oil as such approximately 40% evaporated. According to Edwards and White (1998), natural dispersion accounted for around 28% and an additional 24% was dispersed chemically. Weather conditions were at the upper limit for effective mechanical recovery of the oil as such only around 2% was recovered. Winds during the release period were predominantly northerly driving the oil offshore. Consequently only 6% of the oil beached.

12.1 Response

Milford Haven coastguard were informed immediately after the vessel grounded, they first mobilised search and rescue facilities then alerted the MPCU in Southampton. From this point on MPCU took command of the situation. The timetable of action and events illustrates the speed of response by MPCU.

15/2/96	2007	*Sea Empress* grounds at the entrance to Milford Haven Estimated spillage of 200 tonnes of Forties blend crude Local coastguard and MPCU alerted
	2100	*Sea Empress* refloated and anchored
	2110	MPCU Southampton marine emergency operations room manned.
	2236	MPCU Cessna surveillance aircraft on-scene
16/2/96	0105	MPCU staff arrive on-scene
	0800	All 7- DC3 dispersant spraying aircraft arrived
	1200	Trial dispersant spraying unsuccessful on emulsified oil Fisheries exclusion zone declared
17/2/96		*Sea Empress* breaks moorings regrounds estimated 5000 tonnes oil released
	2000	2 tonnes of dispersant + 2 of demulsifier applied successfully
18/2/96		estimated 2000 tonnes oil released
	1000	29 tonnes dispersant + 6 of demulsifier applied successfully

	2100	further 5000 tonnes oil released over 3 hours
19/2/96	1000	estimated 8000 tonnes oil released over 3 hours
19/2/96	1300	57 tonnes dispersant applied
	2200	further 2000 tonnes of oil released over next 3 hours
20/2/96		Forth Explorer and Sefton Supporter clean up vessels arrive
	1000	estimated 15000 tonnes oil released over 3 hours
		110 tonnes dispersant applied
21/2/96		*Sea Empress* refloated
	1100	estimated 5000 tonnes oil released over 4 hours
22/2/96		67 tonnes dispersant applied
		French clean-up vessel arrives on-scene
5/96		Fisheries exclusion lifted for fin-fish
10/96		Fisheries exclusion lifted for most shellfish except mussels
6/97		Ban lifted on edible seaweed collection
9/97		Fisheries exclusion lifted for mussels

This incident illustrates an almost textbook response to an oil spill incident. MPCU staff and aircraft arrived within 12 hours of the first alert and were in a position to commence dispersant spraying at first light the morning after the incident. Harris (1997) maintains that overall the response to this incident has been judged a success in terms of speed and effectiveness. Lunel *et al* (1997) agree with Harris and place most of the credit on '.*a targeted and successful dispersant operation*'. Oil did reach the shoreline but in a spill of this size some degree of damage is inevitable.

12.2 Specific effects

The coastline around Milford Haven is an area of high environmental value for both wildlife and for tourism. It includes a coastal national park, 35 SSSI's, 2 NNR's and 1 MNR. Initial reactions to the spill were that it would create an environmental and economic disaster of huge proportions. Fortunately time of year, prevailing winds and a timely and effective response minimised the overall impact.

Birds

The spill occurred in February before the return of many migrant birds to the area consequently losses were not as severe as first feared. A total of 7000 oiled birds were washed ashore with the same number again thought to be have died at sea. Of these birds around 23% were Guillemots and 66% were Common Scoter. According to Edwards and White (1998) birds have recovered but as yet have not reached pre-spill numbers.

Commercial Fish

'*No mortalities of commercial finfish, crustaceans or molluscs, which might be attributable to the oil spill, were recorded. Furthermore there is no evidence that spawning of these species was damaged*.' (Edwards & White 1998)

A fisheries exclusion order was placed upon an area of 2100 square kilometres as a precautionary measure. This remained in place, for finfish, for a period of 3 months. The fisheries exclusion order for most shellfish remained in place for 8 months but for mussels remained until September 1997.

Non-commercial species

There were high mortalities of bivalve molluscs, starfish and heart urchins close to the site of the grounding. These were almost certainly attributable to the oil spill.

Shoreline

Of the 72000 tonnes of oil released a relatively small proportion, around 13000 tonnes of emulsion, reached the shoreline. This was spread over a 200-kilometre stretch of coastline including rocky shores, sandy bays and saltmarshes. Most clean-up operations were complete within 6 weeks of the spill .

12.3 Discussion

The *Sea Empress* was one of the largest spills to occur in the UK. The potential for an environmental and economic disaster was allayed by natural and artificial factors. There were adverse impacts upon the environment and the economy of the area, but all the signs point towards a healthy recovery.

The area of the Inner Hebrides is similar to that of the area of South Wales close to the spill. Both areas are nationally recognised as important for wildlife with many designated areas of protection. Unlike South Wales the Inner Hebrides has no major ports, oil terminals or centres of population. The national contingency plan worked effectively at Milford Haven because personnel and facilities were available on site and were able to be rapidly transported to the scene. The Inner Hebrides do not face the same level of risk as the South Wales coastline, however were an incident to occur would face the same level of damage but may not be able to enjoy such a timely response.

13. DISCUSSION

The transportation of oil by sea will continue well into the foreseeable future. Regulations governing the construction and operation of tankers should ensure a continual reduction in the number of oil spill incidents. There will always be a certain level of risk, hopefully though greatly reduced. It is likely that the amount of traffic passing through the Sea of the Hebrides will increase as developments on the Atlantic Frontier come on stream. This increase in traffic will increase the risk of accident in the region.

It is heartening to review the *Braer* and *Sea Empress* incidents and find that the environmental impacts of both were mitigated by weather conditions and prompt response. The weather conditions under which both occurred are very similar to those experienced on the West Coast of Scotland for the majority of the year. Those areas of the Inner Hebrides most at risk from a major incident are mainly west facing coastlines experiencing high energy wave action. On the whole this type of coastline contains the least vulnerable shoreline types, as indicated in Table 2. It is however the case that the wind is not always westerly and there are periods of calm. During the *Sea Empress* incident dispersant spraying aircraft were used effectively as were protective booms. In the case of the *Braer* the facility to use aircraft was available but conditions did not allow their use. In both these incidents suitable airfields with dispersant stockpiles were close to the scene as were experienced personnel and spill containment equipment. The Inner Hebrides are not so well served. The nearest dispersant aircraft are stationed at Inverness, the nearest airport with dispersant stockpiles is Glasgow. The air speed of a DC3 is roughly 120 knots so for an aircraft to reach a point in the Inner Hebrides could take anything between 40 minutes to 1 hour after it is in the air. This may not seem like a long time but if you include initial mobilistaion time plus assume that more than one run would be required then additional time spent returning to base and restocking/refuelling must be considered. The scenarios run on the OSIS model at BP Amoco in Aberdeen produced times of anything from 20 hours upwards until beaching. Accidents such as collisions or groundings occur most frequently during the hours of darkness and in poor visibility. The dispersant spraying aircraft cannot operate in these conditions as such the response could be delayed by up to 12 hours depending upon the time of year. This leaves a very short ‘window of opportunity’ for successful spraying operations.

Although the OSIS model is not accurate close inshore it was run from points between the islands, where tidal currents can be very strong, the spilled oil took less than 3 hours to beach. These results are not accurate but give a good indication of likely beaching times. In areas like this shoreline vulnerabilities are very much higher because they tend to be sheltered low energy environments. Clearly this close inshore dispersant spraying would not be an option. Containment of the oil would be very difficult since, on the whole, current speed is well in excess of 3 knots in many areas. It is also likely that, given the isolation enjoyed by the area, suitable equipment would be unlikely to arrive in time.

At present facilities in the area would be inadequate to deal with an emergency. Both the *Braer* and the *Sea Empress* grounded near to an oil receiving facility where oil spill equipment was close at hand. Granted in Shetland the equipment was at the other end of the island but it was available very much quicker than would be the case in the Inner Hebrides.

For some areas beaching of the oil may be preferred to dispersal of the oil into the water column where it could be ingested by wild or farmed fish and eventually after it reaches the sediment by shellfish. Coull *et al* (1998) identify almost the entire area, covered by this contingency plan, as very important shellfish grounds for both trawl and static gears. This is not just on a local scale, in terms of relative value the shellfish fishery is the most important in the country.

Map 6 clearly indicates the importance placed on the area in terms of natural and landscape conservation. There is a growing tourism industry centred on these natural assets and the associated wildlife. At the same time though it has to be realised that a large section of the population still make their living from the sea in other ways such as fishing and fish farming. In deciding upon the response option for a particular situation regard must be given to all factors not just one. It is difficult to place greater importance against one factor over another. Hopefully accurate and up to date sensitivity maps make this task both clearer and quicker.

14. RECOMMENDATIONS

This document only goes part of the way towards a complete local contingency plan for the Inner Hebrides. Firstly it does not cover the onshore response it is covered in another document. Secondly there are a number of recommendations which would greatly increase the efficacy of this document. These are a combination of the authors own thoughts and recommendations arising from previous incidents.

1. Detailed hydrographic survey of the region identifying and charting localised currents for input into a dedicated computer model of the area.
2. Digitised sensitivity maps for use in a dedicated GIS system, interfaced to the computer model giving greater accuracy and speeding up the decision making process.
3. Dispersant and equipment stockpile in Oban providing a rapid response to local incidents.
4. Retention of the Oban Coastguard station providing a command and control function as well as invaluable local knowledge.
5. Tightening controls over tanker movements through the region by introducing a total ban on tanker traffic through the Minch and extending the route West of the Outer Hebrides South to the North Channel.
6. Mandatory reporting by tankers to include type and quantity of oil being carried.
7. Tagging of oil tankers to allow satellite tracking and assist in identifying the culprits of illegal ballasting operations.

These recommendations would greatly reduce the risk to the region and vastly improve the response to an incident. It is an unfortunate fact of life that these recommendations are unlikely to be carried out because the expense involved outweighs the perceived risk. This document should be viewed as a starting point from which to build a local contingency plan for the at-sea response to an oil spill in the Inner Hebrides. In common with all strategic plans covering a large area there is a requirement for consultation at community, region and national level so that an acceptable and agreed document is produced through co-operation and partnership with all concerned parties.

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GLOSSARY

ESGOSS	Ecological Steering Group on the Oil Spill in Shetland
IMO	International Maritime Organisation
IPIECA	International Petroleum Industry Environmental Conservation Assoc
ITOPF	International Tanker Owners Pollution Federation
JNCC	Joint Nature Conservation Committee
MCA	Marine and Coastguard Agency
MPCU	Marine Pollution Control Unit
NNR	National Nature Reserve
NSA	National Scenic Area
OSIS	Oil Spill Information System
SAC	Special Area of Conservation
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
SOAEFD	Scottish Office Agriculture Environment and Fisheries Department
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest