IPIECA REPORT SERIES

1990–2005

Oil Spill Preparedness and Response

Report Series Summary

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INTRODUCTION

The IPIECA *Oil Spill Preparedness and Response Report Series Summary* brings together, for the first time, the complete IPIECA oil spill report series under one cover. It provides a complete overview of issues that can be referenced in the preparation for, and response to, oil spills at sea. The core content of this publication is made up of report summaries which reference the full report series contained on the CD-ROM in English, French, Spanish and Russian. Arabic and Chinese language sets are planned for the future.

The 17 reports in the series focus on the biological impacts of spills on sensitive environments and other general and specific aspects of oil spill contingency planning and response. A number of the reports have been produced in collaboration with the International Maritime Organization (IMO) and the International Tanker Owners Pollution Federation Limited (ITOPF).

In preparing these reports IPIECA has mobilized expertise both from within its membership and beyond. The reports represent a consensus of industry views on good practice in oil spill preparedness and response. They are made available to guide oil spill response managers, practitioners, trainers and government officials alike.

Whilst the report series focuses on key aspects of oil spill preparedness and response, it is recognized that it is of paramount importance to concentrate on preventing spills. In this context, a guide to the intergovernmental and industry organizations involved in the prevention and mitigation of oil pollution in the marine environment, entitled *Action Against Oil Pollution*, was collectively published in 2005 by key international stakeholders. *Action Against Oil Pollution* is included on the CD-ROM that accompanies this publication.

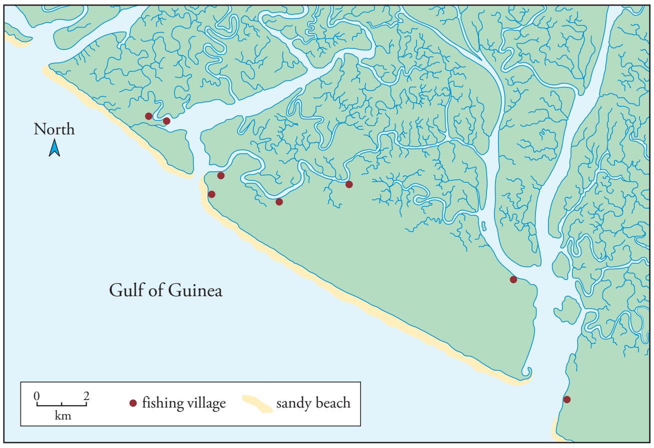
PART 1

Biological impacts of oil pollution

IPIECA REPORT SERIES
VOLUME ONE

GUIDELINES ON BIOLOGICAL IMPACTS OF OIL POLLUTION

These Guidelines summarize what is known about the biological effects of oil pollution. The scope is global, with examples from tropical, temperate and cold environments. The emphasis is marine with some reference to other environments.



A small part of the extensive mangrove swamps of the Niger Delta. The intricate sheltered creek systems can act as an oil trap, with potentially serious effects on the mangrove trees.

Oil pollution damage and biological concerns

Initial impact can vary from minimal to the death of everything in a biological community, such as a mangrove swamp. Recovery times can vary from a few days to more than ten years. A case history is included on 'The importance of coastal wetlands and shallows'.

Factors influencing impact and recovery

Oil type

Oil products differ widely in toxicity. The greatest toxic damage has been caused by spills of lighter oil. Spills of heavy oils can kill organisms through smothering rather than through toxic effects. Toxicity is reduced as oil weathers.

Oil loading

High oil loading encourages penetration into sediments; if stones and gravel are incorporated in the oil, asphalt pavements may be formed. These can form a physical barrier which restricts recolonization. Removal of bulk oil by clean-up teams can speed recovery by minimizing smothering effects and asphalt pavement formation.

The *Metula* spill in the Straits of Magellan was not followed by a clean-up. Mousse masses with sand, gravel and stones hardened into asphalt pavements, remnants of which could be found 16 years later. After the *Exxon Valdez* spill in Prince William Sound, there was a massive clean-up and asphalt pavement formation was largely averted.

Geographical factors

In the open sea, oil slicks may disperse. Close to shore, most damage occurs in sheltered bays and inlets, where oil becomes concentrated. This is also true of inland lakes and some rivers.

On the shore, the fate and effects of oil vary with exposure to wave energy and shore type. On exposed rocky shores, effects tend to be minimal and recovery rates rapid. The most sheltered shores have high biological productivity and are the worst oil traps.

If oil penetrates into the substratum, residence times are likely to be increased. Shores with sand, gravel or stones are porous, and oil penetrates relatively easily. If it weathers *in situ* to become more viscous, it may remain in the sediment for many years. In contrast, oil does not readily penetrate into firm waterlogged fine sand or mud. However, sheltered sand and mud shores with high biological productivity provide oil pathways in the form of animal burrows and plant stems and roots. Oil penetration can kill the organisms that normally maintain these pathways, which then become filled with sediment; oil trapped within them degrades very slowly.

Climate, weather and season

High temperatures and wind speeds increase evaporation, which decreases the toxicity of the remaining oil. Temperature also influences the rate of microbial degradation which is the ultimate fate of oil in the environment.

According to season, vulnerable birds or mammals may be congregated at breeding colonies, and fish may be spawning in shallow waters. In winter large groups of migratory waders feed in estuaries. Winter oiling of a salt marsh can affect over-wintering seeds and reduce

Riverine forest, Amazonia

germination in the spring. Marked reduction of flowering can occur if plants are oiled when the flower buds are developing, leading to loss of seed production.

Biological factors
Different species have different sensitivities. A table summarizes the sensitivities of the main groups of plants and animals.

Clean-up and rehabilitation
Clean-up efforts can decrease or increase damage. Sometimes there has to be a trade-off between different biological concerns.

The physical removal of oil from the water surface decreases overall damage, by reducing the threat to birds, mammals and shorelines. The physical removal of thick oil

Mangrove rehabilitation programme

from shorelines can also decrease damage. However, there seems to be little point in disturbing the shore to remove residual deposits *if biological recovery is progressing*. It may be justifiable if absorbed oil is hindering recovery.

Biological trade-offs are most often made when dispersants are used. Dispersants may break up a floating slick and so reduce the threat to birds and mammals but the dispersed oil enters the water column. In deep, open waters it is rapidly diluted but in shallow waters it may increase the threat to plankton, fish eggs and larvae. Dispersant use may be prohibited from some areas at certain times of year.

Rehabilitation can speed up recovery, notably in marshes and mangroves where transplant programmes have been successful.

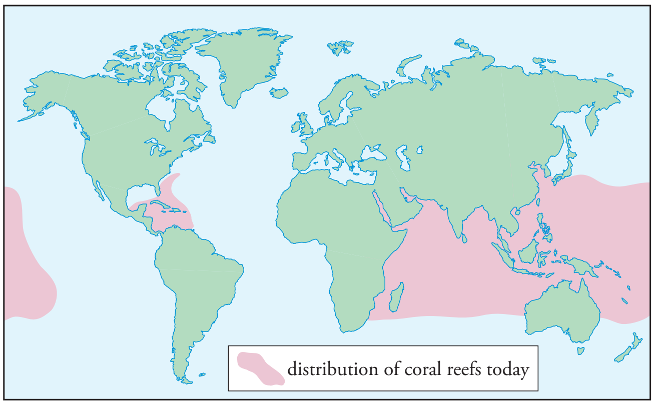
The Guidelines conclude with case histories on 'What is recovery?' and 'An example of a sensitive inland area: the African Great Lakes'.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME THREE

BIOLOGICAL IMPACTS OF OIL POLLUTION: CORAL REEFS

Coral reefs are extremely productive ecosystems found in tropical and sub-tropical areas. There is a potential danger to corals from tanker accidents, refinery operations, oil exploration and production. This report summarizes information on the effects of oil on corals, and provides background information on coral reefs. Clean-up options and their implications are also discussed.



Coral reefs occur in warm tropical and sub-tropical seas: this map shows the global distribution of coral reefs today.

The coral reef ecosystem

Significance

Coral reefs cover more than 600,000 km^2 and are the most diverse and complex marine communities. They are the source of an important fishery resource and provide a barrier to coastal erosion. Their amenity value is often the basis of tourist economies.

Distribution and types of reef

Coral reefs occur where the average minimum water temperature is not less than 20°C. There are three types: fringing reefs, barrier reefs and atolls.

Structure and function

A reef consists partly of living corals but mostly of corals that have been broken down and re-consolidated into calcite rock. Lime-encrusted algae give some protection against storms. Reefs include stony reef-building corals and soft corals which do not have solid skeletons.

The stony corals have a symbiotic relationship with algae (zooxanthellae).

Threats to coral reefs

Serious damage can result from:

- oil pollution;
- sedimentation;
- heated effluents from power plants;
- sewage and nutrient pollution;
- the use of dynamite to catch fish;
- collection for the aquarium and souvenir trades;
- anchor damage from recreational boating.

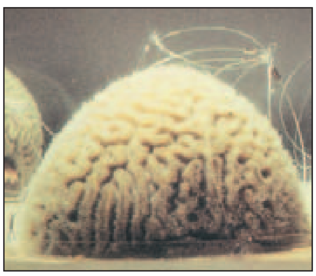
Major natural disturbances, such as hurricanes, also affect coral reefs. Increasingly warm temperatures have resulted in 'coral bleaching' in which corals release the algae from their tissues.

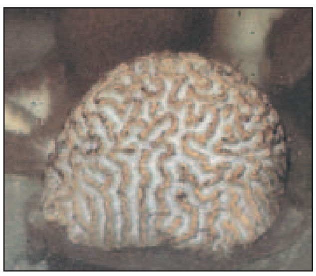
Effects of oil pollution

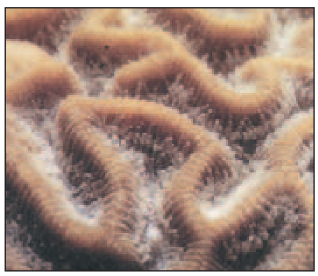
How oil comes into contact with corals

Oil is less dense than water so it generally floats over reefs. However, some reef areas are exposed to the air during low tides. Waves can also create droplets of oil that may come into contact with the corals. In some areas, oil can combine with mineral particles and sink, thus affecting the corals. Weathering can cause oil to sink and come into contact with deeper corals. The use of oil dispersants can also increase the potential for contact with the corals.

The effects of exposure to oil on brain coral. A healthy coral is shown on the left; the centre picture shows a coral after exposure to oil, with oil sticking to mucus. Compared with the healthy coral, the polyps (coral animals) are retracted, as the detail on the right indicates.







Laboratory studies

The effects of exposing corals to oil in the laboratory include decrease in growth, decrease in reproductive and colonization capacity, negative effects on feeding and behaviour, and alteration of secretory activity of mucous cells.

Field studies

Few reports deal specifically with the effects of oil spills on corals. A study in the Gulf of Eilat, Red Sea, has shown that a steady discharge of oil onto a coral reef area causes decreased colonization, decreased coral viability, coral mortality, damage to the reproductive system and many other changes. A study downstream from a major oil refinery on the Caribbean island of Aruba also showed decreased viability of the reef over time, over a distance of 10–15 km from the refinery.

A field experiment in the Arabian Gulf showed no long-term effects from exposure to a floating crude oil film of 0.10 mm for five days. Work in a lagoonal reef system on the Atlantic coast of Panama showed that shallow corals (0–0.5 m) were only slightly affected by a 24-hour exposure to fresh oil. However, a recent study in Panama showed substantial damage, even at 3–6 m depth.

Factors influencing impact and recovery

The most obvious factors are:

- the amount and type of oil spilled;
- the degree of weathering of the oil prior to contact with corals;
- the frequency of the contamination;
- the presence of other factors, such as high sedimentation;
- physical factors such as storms, rainfall, currents and the tide;
- the nature of the clean-up operation;
- the type of coral; and
- seasonal factors such as coral spawning.

Clean-up and rehabilitation

Mechanical clean-up

Navigation can be difficult or impossible over coral reefs, and often natural clean-up is the only option—although in lagoonal areas, booms and skimmers can be used.

TROPICS experimental site with oil being released.

Dispersants and the TROPICS experiment

In the TROPICS experiment in Panama, booms were deployed around three sites and crude oil was delivered to one site, oil and chemical dispersant to the second, while the third remained as a control. Untreated oil had severe long-term effects on mangroves, and relatively minor effects on seagrasses, corals and associated organisms. Chemically-dispersed oil caused a decline in the abundance of corals, sea urchins and other reef organisms, reduced coral growth in one species, but had minor or no effects on seagrasses and mangroves.

These results suggest that no action after a spill will affect mangroves and some inter-tidal organisms but corals would remain healthy. Dispersants could expose sub-tidal organisms to more oil, and result in more coral and seagrass damage. However, the mangroves would be less likely to be affected.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME FOUR

BIOLOGICAL IMPACTS OF OIL POLLUTION: MANGROVES

Mangroves have traditionally provided plant products, fish and shellfish for coastal communities in the tropics. They also provide services such as coastal stabilization and food chain support for near-shore fisheries. This report provides information on the ecology and human use of mangroves, and on the fate and effects of oil. These topics, together with clean-up methods and rehabilitation, are discussed with reference to case history experience and results from field experiments.

Ecology of mangrove forests

Mangroves are salt-tolerant species which grow in the tropics and some sub-tropical regions. They desalinate sea water by a filtration process. Mangrove roots typically grow in anaerobic sediment and receive oxygen through small pores on the aerial roots and trunks. Mangroves support many different biological communities, and can be one of the most productive ecosystems, supporting large populations of invertebrates, fish, birds and mammals.

The mangrove Sonneratia*, showing aerial 'breathing roots' (pneumatophores), Strait of Malacca, Indonesia*

Human use of mangroves

Sustainable uses

The mangrove ecosystem produces both 'goods' (products) and 'services'. Products include fuelwood, paper pulp, poles, railway sleepers, wood for furniture, roof thatching, bark for tannin, medicines, sugar, alcohol and dyes. Mangroves also provide fish and shellfish.

Services include:

- protection of shorelines;
- trapping of water-borne pollutants;
- nursery and feeding grounds for fish, prawns, crabs and molluscs;
- nesting sites for birds; and
- resources for tourism and recreation.

Net cages for fish culture, Pulau Ketam, Malaysia

Non-sustainable uses

Non-sustainable uses lead to loss of the mangrove habitat, and associated losses of shoreline, organic matter and species. Mangrove forests are felled to make room for aquaculture, salt pans, rice fields, airport and road construction, port and industrial development, resettlement and village development. The report includes a case history on the uses made of mangroves in Malaysia.

Conservation

Conservation objectives include:

- maintenance of 'reservoirs' for natural restocking of adjacent exploited areas;
- protection of breeding and feeding areas for fisheries;
- protection of shorelines; and
- preservation of rare and endangered species.

Several countries have established national mangrove committees, and the Malaysian committee has recommended that not more than 20 per cent of mangroves in any one area should be cleared for pond construction. Other countries have developed special policies on coastal areas. The report includes a case history on conservation and development in Venezuela.

Fate and effects of oil

Oil slicks enter mangrove forests when the tide is high, and are deposited on the aerial roots and sediment surface as the tide recedes. Mangroves can be killed by heavy oil that covers the trees' breathing pores and by the toxicity of substances in the oil, which may impair the salt exclusion process.

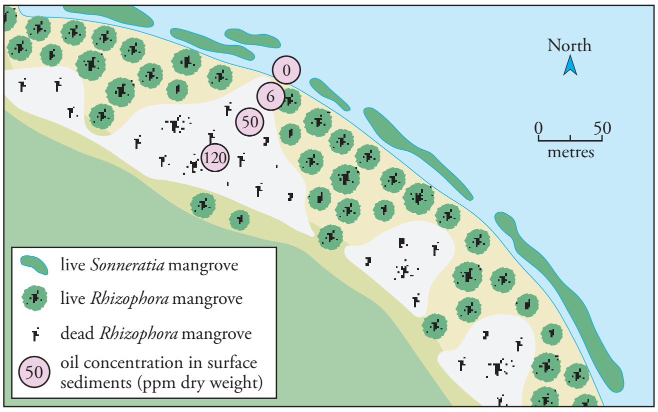
Oil may kill many organisms in the mangrove habitat. For example, it can penetrate burrows in sediments, killing crabs and worms. Furthermore, dead trees rot quickly, leading to a loss of habitat.

With time, the amount and toxicity of oil is reduced by rain and tides, by evaporation and by oxidation. Degradation can be rapid in the tropics, with regrowth occurring within a year of a spill.

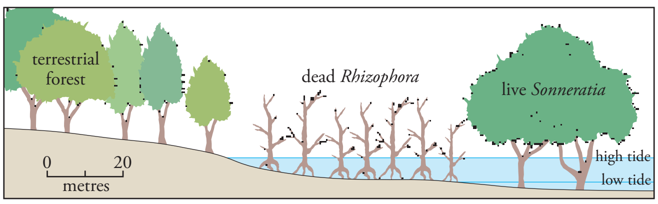
Oil spill response

Mangroves are priority areas for protection by:

- mechanical recovery offshore;
- dispersal offshore; and
- booming of mangrove shorelines and inlets.



Survey results from the Strait of Malacca, Indonesia, illustrating patchiness of oil effects:
Above: Patches of oil-killed mangroves, Pemping Island. The figures are oil concentrations in the surface sediments (ppm dry weight).
Below: Transect through mangroves, Kepala Jernih Island. These results were obtained two years after the Showa Maru *spill, but chemical analysis of oil from the sediments indicated more than one source.*



The dispersal option gives rise to the most debate. Mangrove trees tolerate dispersed oil better than untreated oil. If the objective is to protect the trees, the habitat they provide and some wildlife species (notably water birds), then chemical dispersal offshore can be effective. However, the effects on organisms in the water also need to be considered (see the summary of the IPIECA report *Dispersants and their Role in Oil Spill Response*, on page 28).

If oil enters mangroves, the main clean-up options are:

- booming and skimming in mangrove creeks;
- pumping of bulk oil from the sediment surface;
- water flushing of free oil from sediment surface and mangroves; and
- use of absorbent materials.

Clean-up may be difficult because some forests are virtually impenetrable, and heavy clean-up operations may cause physical damage. If a large spill of light oil enters a forest, damage can occur very quickly and it is unrealistic to expect to save many trees.

Rehabilitation

Rehabilitation of oil-damaged mangroves is possible though most schemes have to focus on one or a few key species, and wait until toxicity has been reduced. The time that must elapse depends on the kind of oil spilled, the type of soil, local tidal flushing and rainfall. It is not necessary to wait until all oil has been eliminated. Natural regeneration may be slow because of residual toxicity or because seeds cannot reach the affected sites because of barriers of fallen branches, roots and trunks of the killed forest.

It is useful to set up a nursery to grow mangroves. Rehabilitation was successful in Panama, where more than 75 hectares of oil-killed mangrove forest were replanted with some 86,000 nursery-grown seedlings. More than 90 per cent of the seedlings survived.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES VOLUME SIX

BIOLOGICAL IMPACTS OF OIL POLLUTION: SALTMARSHES

Saltmarshes are priority areas for protection following oil spills because they can trap large quantities of oil and are difficult to clean. While some marshes take decades to recover, others do so within one or two years. This report considers factors affecting the fate and effects of oil on saltmarshes, and provides guidelines on clean-up options.

Saltmarsh ecology and dynamics

Saltmarsh vegetation develops between the high-water levels of neap and spring tides. Saltmarshes are found all over the world; depending on latitude, the vegetation may be dormant for some periods or may grow all year. This affects what may happen to oiled vegetation.

Tropical saltmarshes are species poor and species richness increases with more temperate conditions. Saltmarshes often occur in conjunction with mangroves.

Saltmarshes in tropical regions, such as this one in north-east Sumatra, Indonesia, have no dormant seasons and are thus vulnerable to oil spills throughout the year.

Species are often zoned according to tidal height. With time, sediments may build up, leading to a change in conditions favouring other species. Sometimes the grass *Spartina* brings about waterlogged conditions that cause natural dieback. This needs to be distinguished from oil pollution effects.

Salinity also affects species composition. The uppermost reaches of some estuaries may contain virtually non-saline water but oil may be carried into them at high tide. Low salinities may also be caused by freshwater seepage from inland.

Saltmarsh fauna include crabs, molluscs and worms, whose burrows can provide pathways for oil penetration. Saltmarshes are an important habitat for birds and fish.

Human use of saltmarshes

The importance of marshes as nursery grounds for fish is well documented. Plant material from marshes also contributes to the food webs which sustain near-shore fisheries. Some marshes provide valuable grazing for sheep, cattle and horses.

Saltmarshes are important in dissipating wave energy, and preserving them thus helps protect coastlines—especially important with increasing concern about rising sea levels and coastal erosion.

Marshes are useful for assimilating sewage nutrients such as phosphorus. They are also valued for conservation reasons, and are a resource for 'ecotourism'.

Fate and effects of oil

Saltmarshes tend to trap oil, and the damage caused and the recovery times are very variable. Lighter, more penetrating oils are more likely to cause acute toxic damage than heavy or weathered oils. Three different scenarios are analysed:

- Light to moderate oiling, with little penetration of sediment; recovery in one to two years.
- Oiling of shoots with substantial penetration of light oil into sediments; recovery is delayed, with traces of oil detectable for many years.
- Thick deposits of viscous oil or mousse on the marsh surface. Persistent deposits inhibit recolonization for a decade or more.

Two years after a light fuel oil spill. There is a belt of marsh where Spartina *was killed by the oil, which penetrated into the sediments.*



Nineteen years after the Metula *spill, thick mousse deposits are inhibiting recolonization (left). This site is being used experimentally to test new approaches for treatment. Where thinner deposits are weathering and cracking some plants have become established (middle). This is a result of seeds lodging in cracks and germinating (right).*

Delayed recovery can also occur if species composition is altered.

Oil spill response

The protection of saltmarshes after an oil spill is a high priority because cleaning of vegetation and sediments is very difficult. The main options are:

- mechanical recovery offshore from the marsh;
- dispersal (using oil spill dispersants) offshore; and
- booming of saltmarsh shorelines and inlets.

If saltmarshes become oiled, the best option is often to allow natural recovery. Intervention may be needed if:

- free oil is present which may be spread with tidal action;
- oil on the marsh surface threatens birds or other wildlife;
- recovery time of vegetation is predicted to take several years.

The main clean-up options are as follows.

Physical containment and recovery

Booming and skimming of oil on the water in creeks, and pumping bulk oil from the marsh surface, depressions and channels.

Low pressure water flushing

Results are variable, and the method must be used before oil penetrates the sediment.

Sorbents

The rapid deployment of sorbents can reduce penetration into sediments.

In-situ burning of oiled vegetation

While burning can increase damage, in winter much of the vegetation is dead, and the ground is likely to be wet enough to protect underground systems from heat damage.

Vegetation cutting

Cutting may be justified if there is a threat to birds or other wildlife. There is least effect on subsequent yield in autumn and winter.

Combined vegetation/sediment removal

An extreme method used for serious cases, usually followed by rehabilitation (seeding and/or transplanting). The technique caused severe problems (described in a case history) following the *Amoco Cadiz* spill.

Rehabilitation

Restoration has often been successful and examples are described. Restoration is needed if natural recovery may take an unacceptably long time, or if vegetation and sediments have had to be removed. Re-vegetation can be done with seeds or seedlings. Fertilizer may be needed, and transplant performance should be monitored.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME SEVEN

BIOLOGICAL IMPACTS OF OIL POLLUTION: ROCKY SHORES

Rocky shores have a range of vulnerabilities to oil. While some are quickly cleaned by natural forces, others can trap oil and take years to recover. This report describes the factors that make rocky shores sensitive to oil spills, and considers the most appropriate methods of clean-up.

The importance and variety of rocky shores

Rocky shores dominate the world's coastlines and play important roles within their local marine ecosystem.

Seaweeds are common on rocky shores and their productivity can be very high. Rocky shore animals also play a part in this productivity, releasing enormous numbers of eggs and larvae into the sea. When the tide is in, fish and other animals move in to feed directly on the animals and plants of the rocky shore; when the tide is out, many birds and some mammals do the same.

Human economic benefits include seaweed collected for food, fertilizer or alginate production, and fisheries and aquaculture based on, for example, limpets, sea-squirts, barnacles and mussels. Rocky shores are variable. Bedrock shores range from vertical cliffs to gradually sloping platforms. In tropical regions they may be formed from raised fossil coral reefs. The rock may be pitted or cracked, with rock pools, overhangs, gullies and caves. Some shores are dominated by porous boulders.

Ecology and dynamics

Rocky shore organisms have adapted to many environmental regimes, resulting in distinct vertical zones and substantial differences between the communities on exposed and sheltered shores. Lower shore communities are the most diverse and productive. Communities on exposed shores have fewer large algae and more barnacles and mussels than sheltered shores. Exposed boulder shores usually support only small mobile crustaceans.

The areas that support soft-bodied animals such as sea anemones are also the places where oil can become concentrated. Rich animal communities underneath the rocks on stable boulder shores are also the most vulnerable to oil pollution.

The extremely wave-exposed Cliffs of Moher, on the west coast of Ireland

Most rocky shore organisms reproduce by producing large numbers of larvae or spores. This distributes the species over larger areas and helps it colonize new areas. Plankton can therefore recolonize shores affected by oil spills fairly rapidly. Direct developers are more vulnerable.

Fate of oil

Vulnerability varies widely. A vertical rock wall on an exposed coast is likely to remain unoiled if an oil slick is held back by reflected waves. A sloping boulder shore in a calm backwater can trap enormous amounts of oil. Some shores act as natural collection sites for litter and oil is carried there in the same way. Oil tends not to remain on wet rock or algae but is likely to stick on dry rock.

The rate of weathering depends mainly on exposure, weather conditions and shore characteristics but water temperature, the presence of silt and clay particles, and grazing animals also play a role. As oil is weathered it becomes more viscous and less toxic, often leaving only a small residue unlikely to cause ecological damage.

Impacts of oil spills

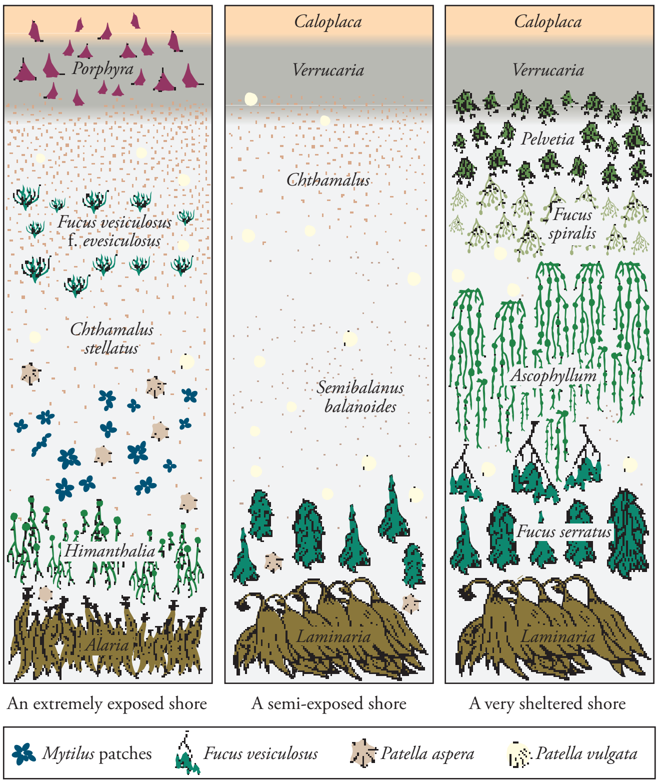
The impact of oil depends on the toxicity, viscosity and amount of oil, the sensitivity of the organism and length of contact time. In some spills, rocky shores have been coated in a large amount of oil that caused little effect. In other spills, a moderate amount of oil has caused heavy mortality. Long-term damage is generally rare, and recovery over two or three years is common. This is because oil is not normally retained on rocky shores in a form or quantity that causes long-term impacts and because rocky shore species can quickly re-establish their populations.

The brown seaweeds are relatively insensitive due to the slimy mucilage which coats their surfaces. Many animals have also been found to withstand heavy oiling. Barnacles and intertidal sea anemones are typically only killed after being smothered by a viscous oil for a few tides. Limpets, snails and other grazing molluscs are more susceptible.

The effect is related to the toxicity and freshness of the oil. Weathered crude oil may have limited effects while fresh diesel or gasoline can cause acute toxic effects.

Clean-up methods

Natural weathering will remove the oil from most rocky shores within a few years. The clean-up response must therefore either greatly reduce recovery time or be driven by over-riding economic, amenity or wildlife concerns.



Typical zonation patterns of rocky shores. Pelvetia *is one of the few seaweeds that can survive being almost completely dried out between high tides while* Fucus serratus *and* Laminaria *have to remain moist. Barnacles close their valves to stop moisture escaping while limpets have a 'home' where the shell and the rock form a perfect fit. Soft unprotected animals have to remain on the lower shore unless they can find a moist crevice or pool.*

Hot water washing of a beach in Prince William Sound, Alaska, that had been oiled by the Exxon Valdez *spill in 1989. Much of the shore life could not survive temperatures that reached 60°C.*

Examples are given of clean-ups that resulted in greater impacts and longer recovery times for shore organisms. Techniques that remove bulk oil without causing severe physical or chemical damage are preferable. A summary of the main techniques is given under the headings:

- suction devices;
- low-pressure flushing with ambient temperature seawater;
- high-pressure cold or hot water flushing and steam cleaning;
- dispersants;
- sorbents; and
- manual removal.

The choice will need to take into account ease of access.

Rehabilitation

The least sensitive shores, and those with the greatest potential for natural recovery, are found on exposed coasts. Attempts to clean these shores are normally unnecessary. Rocky shores in sheltered areas are more sensitive to both oil spills and damage from clean-up measures.

Rocky shores vary greatly in value. Some deserve a considerable protection effort. It is essential that contingency plans tailor the response to the particular shore. A pre-requisite for a good plan is a good set of sensitivity maps, shoreline access details and clean-up guidelines, and good communication between the environmental advisors and the clean-up managers.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME EIGHT

BIOLOGICAL IMPACTS OF OIL POLLUTION: FISHERIES

This report describes the effects of oil spills on commercial fish and indirect effects on their habitats. The impact on fishing gear and aquaculture is also considered. Response to spills is discussed, and case histories described.

Ecology of fisheries species

The species covered include fin-fish (or fish), crustaceans and molluscs. Pelagic fish swim in open water. Most commercial species, such as herring, tuna and mackerel, are caught within 200 metres of the surface. Benthic species live on the seabed; they include plaice, rays, most crustaceans and almost all shellfish. Demersal fish live near the seabed, mostly feeding on bottom-living animals.

Most bony fish produce large numbers of floating eggs. Sharks and rays lay small numbers of eggs in protective capsules and some give birth to live young. Most bivalves shed their eggs into the water where they develop into floating larvae which drift away.

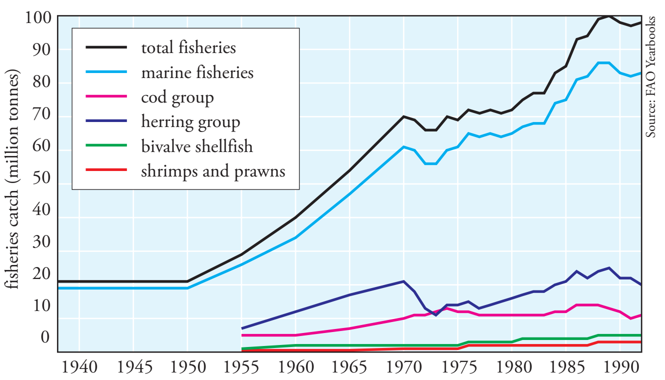
The ecosystems in which fish play a major part include coral reefs, mangrove forests, seagrass beds and estuaries.

The sea's harvests

Half the world's commercial catch comes from two main groups:

- pelagic species, of which herring, sardines and anchovies are the most important; squid are the only molluscs in this category; and
- demersal fish, such as cod, hake and haddock, and shrimps and prawns.

Changes in world fisheries catch, 1938–92



Most of the world's catch comes from the highly productive waters overlying the continental shelves, relatively close to land. Small-scale traditional fisheries are widespread among coastal people. The 10 per cent of the world's catch provided by such fisheries is vitally important to many communities.

Many marine and freshwater species are cultivated. Efforts are mainly concentrated on those that command high prices (such as salmon and prawns) and those that produce a high yield under intensive culture (such as mussels). More than 80 per cent of aquaculture production is in Asia (on which there is a detailed case history).

Effects of oil spills

Direct effects on fish

Kills

There is no evidence that any oil spill has killed sufficient fish to affect adult populations. Shipping incidents in inshore areas can cause potentially more damage. The direct effects of oil on inshore shellfish beds, and fish and shellfish in aquaculture units, are of particular concern.

Effects on plankton

Eggs and young stages are more vulnerable to oil pollution than adults. Even though many commercial species spawn over large areas, direct effects on plankton have been recorded.

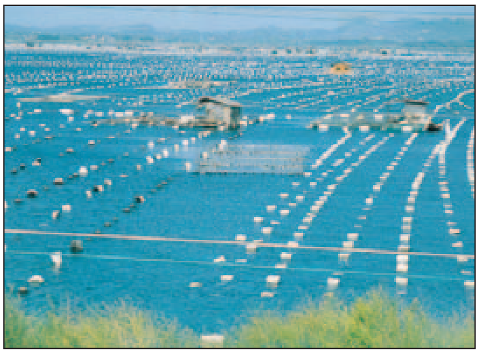
Effects on fish behaviour

Wild fish swim away from oil spills and long-term effects on local populations are avoided. However, fish populations moving back into an area following a spill may take some time to recover. Fisheries can also be disrupted if migration routes are changed as a result of an oil spill. Spills that affect spawning migration into rivers can affect fisheries in subsequent years.

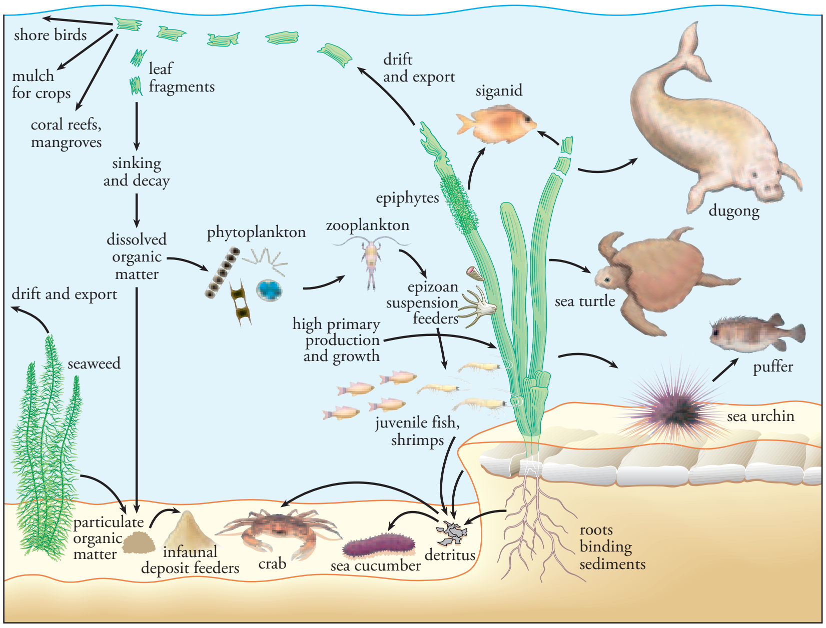
Sub-lethal effects

Even very low concentrations of oil can affect reproduction and feeding in fish and shellfish. Unfortunately, laboratory studies cannot take full account of aspects such as continuous dilution

After a five-fold increase over 40 years, the world catch in marine fishing areas appears to have reached a plateau. Estimates suggest that around 90 per cent of the world's fish stocks are now being over-fished.



Extensive oyster farms near Xiamen, China. Aquaculture is particularly susceptible to oil spills.



Philippine seagrass ecosystem showing food chains and interrelationships with fisheries

with time, animal predation and human predation (fisheries), which may in nature completely hide the studied effects.

Direct effects on fisheries

Tainting

Fish exposed to oil may become tainted by oil-derived substances. Tainting is of particular concern in caged fish and immobile shellfish which cannot swim away. Commercial catches may also become contaminated from contact with oil-fouled fishing gear. Taint is usually lost through the normal processes of metabolism once the oil source has gone, but testing is needed to determine when fish are fit to eat. Studies have not demonstrated any increased risk of diseases in humans through eating seafood from areas where oil spills have occurred.

Fishing activities

Major spills can result in loss of fishing opportunities with boats unable or unwilling to fish due to the risk of fouling. Exclusion zones may be imposed until the target species has been declared taint-free. This may cause temporary financial loss to commercial fishermen and temporary food shortage to artisanal fishermen.

Aquaculture and shellfish

As aquaculture expands, so too does the potential for oil spill impacts. Oil may contaminate fixed aquaculture equipment and intertidal shellfish, and will damage stock in tanks or ponds if there is an intake of contaminated sea water.

Indirect effects: ecosystem disturbance

Natural dispersion and dilution of oil is relatively restricted in semi-enclosed, estuarine and shallow near-shore areas, where oil spills may affect the plant and animal species used for shelter and food by fish and shellfish.

Clean-up and rehabilitation

Knowledge of ecosystems and species in vulnerable areas, and their relative sensitivities to oil pollution, is essential for contingency planning. Government agencies charged with the management of fisheries or environmental resources are likely to have information on local fisheries. Local people can also provide inputs and, in the case of traditional fisheries, may be the only source of information. Relevant information includes the location of spawning and nursery areas, fixed equipment and fish farms, fleets and fishing areas, and the seasons in which they operate.

Fish farmers and fishermen should be quickly notified of oil spills. Consideration may also be given to harvesting the resource before impact. Fishing is normally suspended in an oil spill area if there is a risk of contamination. Such restrictions must be quickly lifted once the problem has been removed.

Methods used to protect fishery interests include deflective booms and the priority clean-up of relevant areas. The implications to fisheries of the use of dispersants is analysed.

Case studies of the *Braer* and the *Exxon Valdez* oil spills describe the effects of these spills on fisheries and the responses that were made.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME NINE

BIOLOGICAL IMPACTS OF OIL POLLUTION: SEDIMENTARY SHORES

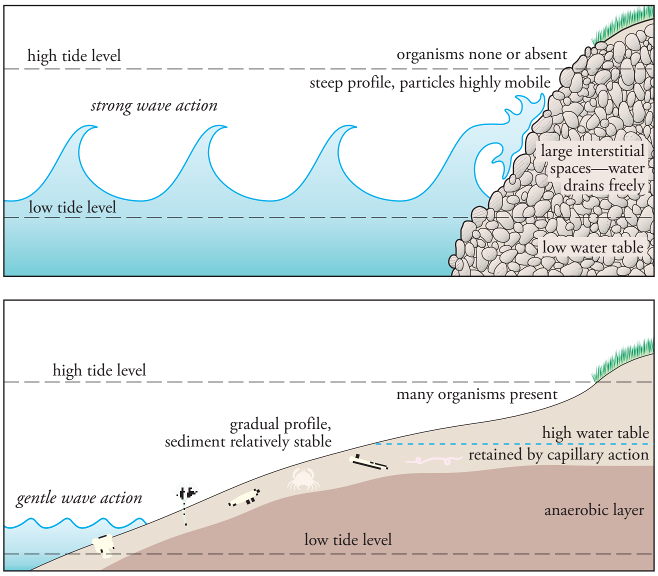
This report describes the main types of sedimentary shores—including pebble and sandy beaches and mudflats—their vulnerability to oil spill damage, the techniques available for clean-up and their capacity to recover.

The variety and ecology of sedimentary shores

Sedimentary shores range from coarse cobble beaches through sandy beaches to mudflats. The more exposed the shore, the steeper it is and the coarser the material accumulated. Sheltered areas tend to have gentle gradients and finer particles. Mudflats in estuaries are also formed from the material brought down by the river.

Cobble and pebbles are usually unstable, drain quickly and support little life. Sand and mud, however, hold water after the tide has retreated, providing a habitat for many burrowing species and for micro-organisms.

The distribution of organisms on the shore is influenced by their ability to avoid predators when the tide is out. This results in zonation of species.



The nature of a sedimentary shore is influenced by the degree of exposure to wave action.

Turtles drag themselves across sandy beaches to lay their eggs above the high tide mark.

The longer the tide is out, the greater the exposure of intertidal organisms to any material, such as oil, stranded by the retreating tide. Relatively few species can exist on the upper reaches of the shore, and numbers increase towards low water. In tropical areas, strong sunlight and monsoon rains also limit numbers. All intertidal animals have to exist under adverse conditions and but they recover quickly when more favourable conditions return. This helps them recover from an oil spill.

Some species are particularly vulnerable to changes in beach use or pollution. Turtles, for example, lay their eggs above the high tide and have to drag themselves across the beach since their flippers are not strong enough to support their body weight. Their meat and eggs are highly sought after and most species have become seriously depleted. Some marine mammals—such as seals—also use sedimentary shores.

Human uses

Humans use sedimentary shores for recreation, aggregate extraction and reclamation. They also provide shellfish beds, bait species, fish or prawns that come in with the tide and a site for the mariculture of oysters and other bivalves.

Fate and effects of oil

Oil may be cleaned from the shore surface by natural processes, particularly wave action. Self cleaning is usually faster on coarse beaches than on sheltered mud. Clay-oil flocculation can promote self-cleaning by reducing the adherence of oil to pebbles or cobbles. Oil may persist for long periods if it is buried by wind-blown or water-moved sediments, if it penetrates deeply into the sediments, or if it forms asphalt pavements. Depth of penetration is influenced by particle size, oil viscosity, drainage, animal burrows and root pores.

Asphalt pavements or oil crusts form when large quantities of oil or mousse consolidate the surface sediment. Such pavements can be persistent, though wave action eventually breaks them up.

Oil biodegradation is not likely to be significant until physical processes have removed much of the oil. Biodegradation can then make a greater contribution, particularly to reducing oil toxicity. However, biodegradation is slow where oxygen is limited—for example in poorly-drained fine sediments.

The greatest concern is likely to be the effects of oil on sheltered sediments. These retain oil and many worms, molluscs and crustaceans may be killed.

Recovery depends partly upon the sensitivity of the species concerned. For example, following the *Sea Empress* spill, populations of mud snails recovered within a few months but some amphipod populations had not returned to normal after a year. Recovery is also related to the persistence of oil in the sediments.

Long-term depletion of sediment fauna could have an adverse effect on birds or fish that use tidal flats as feeding grounds, and on turtle breeding. There have been some cases of oil killing seal pups, and adult seals may fail to breed in oiled areas.

Detailed examples are described for the *Sivand* oil spill of 1983 in the Humber estuary, United Kingdom, and of how oil penetrates animal burrows.

Oil spill response

Responses include protection and clean-up. Protection is particularly important for mudflats because they are highly productive but difficult to access. Shores important for birds or turtles, or which are amenity, tourist or fishing beaches should receive high priority. However, seasonal variation in importance should be taken into account.

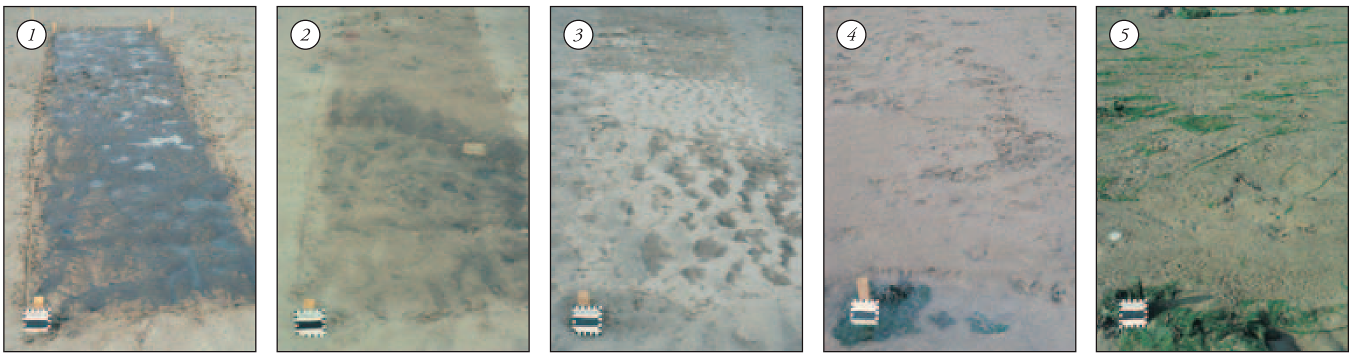
Protection techniques

A number of techniques are described including booms, dispersants and the construction of sand barriers.

Clean-up and rehabilitation

Natural cleaning is suitable where wave action is sufficient to remove oil. It is also appropriate for sheltered shores where other techniques would cause unacceptable damage. The other options described include flushing, manual removal, mechanical removal, mechanical relocation, sorbents, tilling, vacuum pumping and bioremediation.

The full report is contained on the CD-ROM included at the end of this publication.



Serial photographs showing changes in appearance of an experimentally oiled sheltered sandflat over time:

1. *immediately after experimental application of 1 litre/m^2 of Nigerian crude oil;*
2. *four days after oiling, having been covered by one high tide, the sediment oil concentration was over 90,000 mg/kg;*
3. *seven days after oiling, clean sand ripples migrated over the oiled surface;*
4. *44 days after oiling, the oil crust was being undercut from the left, but average oil content was still almost 20,000 mg/kg;*
5. *388 days after oiling, oil concentration was about 5,000 mg/kg. The green algae are transient features of the sandflat and not related necessarily to the oil.*

PART 2

Contingency planning for, and response to, marine oil spills

IPIECA REPORT SERIES
VOLUME TWO

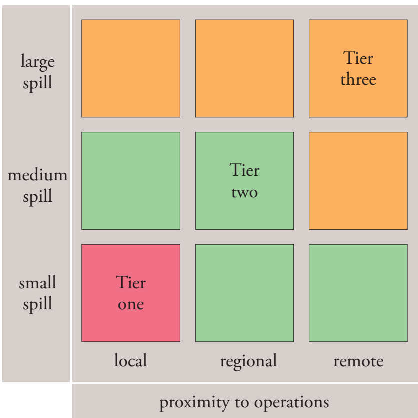
A GUIDE TO CONTINGENCY PLANNING FOR OIL SPILLS ON WATER

This Guide is provided by IPIECA to assist industry and governments in the preparation of oil spill contingency plans. It focuses on spills on water, primarily from ships, but also contains information relevant to spills from exploration and production activities.

The Tiered response

Oil risks and the responses they require should be classified according to the size of spill and its proximity to a company's operating facility. This leads to the concept of a 'Tiered response' to oil spills.

A contingency plan should cover each Tier and be directly related to the company's potential spill scenarios.



The Tiered response:
Tier 1: operational-type spills that may occur at or near a company's own facilities as a consequence of its own activities. An individual company would typically provide resources to respond at this Tier.
Tier 2: a larger spill in the vicinity of a company's facilities where resources from other companies, industries and possibly government agencies can be called in on a mutual aid basis.
Tier 3: larger spills where substantial further resources will be required and support from national or international cooperative stockpile may be necessary.

Cooperation with government agencies

Governments are encouraged to ratify the IMO International Convention on Oil Pollution Preparedness, Response and Cooperation, 1990 (the OPRC Convention), and to develop their own laws and procedures to prepare for, and respond to, oil spills.

It is crucial that industry works with governments to develop a clear, common interpretation of the national requirements and responsibilities of government agencies, industry and others.

Information gathering and risk assessment

Historic data, oil properties, climate, local meteorology and environmental sensitivities are important factors in assessing the risk, behaviour, fate and potential consequences of spilled oil.

Oil properties

The base properties of an oil will determine the physical and chemical changes that occur when it is spilled onto water, and will account for its persistence and toxicity.

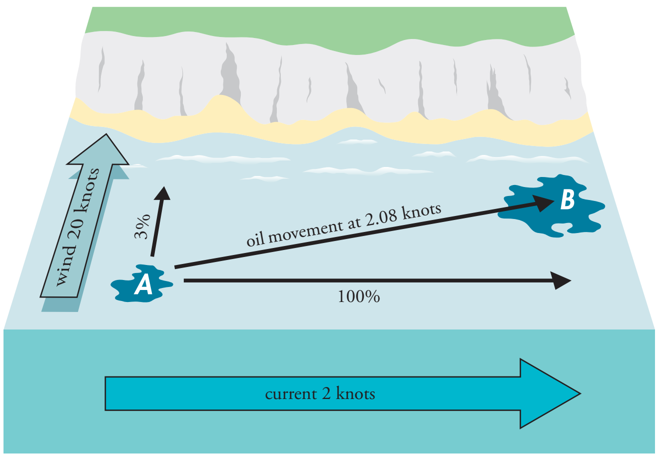
It is recommended that organizations prepare a list of the properties of oils commonly traded or produced in their area.

Current and wind data

Local current data and weather forecasts will assist in determining oil spill response strategies and allow prediction of the movements of a slick.

Sea conditions

Sea conditions influence the behaviour of spilled oil and determine effectiveness of response techniques.



The influence of 3 per cent of the wind speed combined with 100 per cent of the current speed results in the movement of oil from A to B.

Computer trajectory modelling

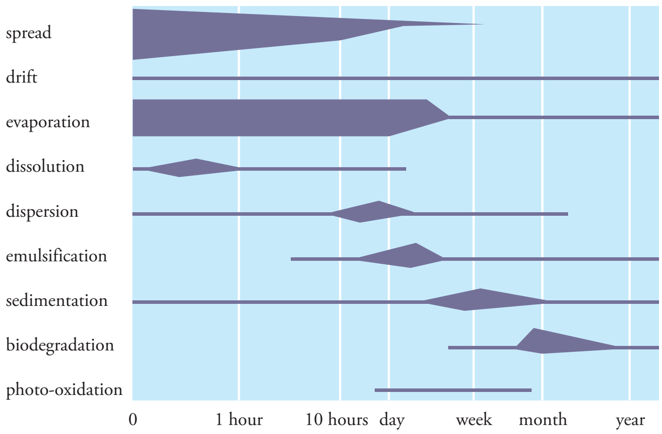
Oil spill computer models have been developed that can provide valuable support to both contingency planners and pollution response teams.

Sensitivity mapping of the environment at risk

Making and updating sensitivity maps are key activities in the contingency planning process. Sensitivity maps provide spill responders with essential information by showing the location of different coastal resources and indicating environmentally sensitive areas.

Strategy development

Viable response strategies should be developed. These may have to be adaptable to different locations, under different conditions and at different times of the year. They must be established in consultation with the relevant authorities and stakeholders.



A spill of typical medium crude oil onto water will follow a certain pattern. The line length denotes the duration of each stage; line thickness denotes the most critical phase of each stage.

Planning for response options to minimize damage

Ecological, recreational and commercial concerns should be carefully balanced and the consequences of applying or not applying a particular strategy should be understood by all parties.

Equipment and supplies

The assessment of risk, data collection and response strategies already described are the cornerstones for determination of equipment requirements.

Recovered oil and debris management

Processing and final disposal of oil and oily debris in an acceptable manner requires planning. Care must be taken not to create another environmental problem.

Oil wastes in temporary storage near a shoreline.

Management, training, exercises and plan review

In order to react quickly to an oil spill, response staff should be assigned specific roles and responsibilities. It is also vital that staff with an identified response role are given effective training.

Spill simulations are an excellent way to exercise and train personnel in their emergency roles and to test plans and procedures. Contingency plans will require periodic review and maintenance.

The report also contains Appendices giving an example of a contingency plan, showing functional responsibilities in a response organization, and indicating titles for follow-up reading.

The full report is contained on the CD-ROM included at the end of this publication.

IMO/IPIECA REPORT SERIES
VOLUME ONE

SENSITIVITY MAPPING FOR OIL SPILL RESPONSE

Introduction

Sensitivity maps convey essential information to those responding to oil spills by identifying the sites of coastal resources and environmentally-sensitive areas. Making such maps involves assembling information on resources and deciding what guidelines for spill response should be included. Uses range from planning practical site-specific shore protection and clean-up to strategic planning for large remote areas.

User groups and their needs

Different types of map will be used at different stages during the response. The first requirement is for a strategic map covering a large area, showing the most important resources in all the possible directions that a slick may travel. When the direction of travel becomes clear, there is a need for intermediate-scale tactical maps. When oil is deposited on the shore, there is a need for detailed operational maps.

A cost-effective approach is to invest in intermediate scale tactical maps for the whole coastline, and detailed maps for high-risk areas. Maps should show information on sensitive resources (such as the locations of mangroves, fish farms and bird colonies) and on spill response and clean-up (such as areas where dispersants can be used, booming points, and shore access roads).

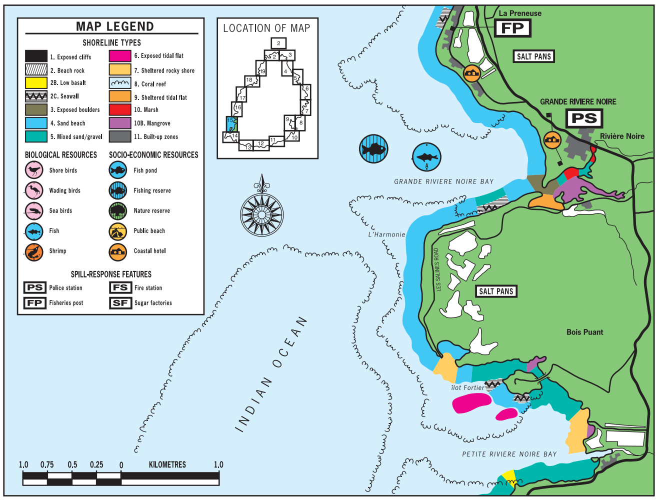
Map requirements

The publication lists the basic requirements for an understandable and easily useable map and the scales at which the different types of map should be prepared. Examples are shown of both the single map approach and the series approach. The advantages of different map formats and types of printing are discussed.

Information to be included on the maps

Shoreline types

Many maps classify shorelines using an environmental sensitivity index (ESI). This is convenient but gives only part of the picture because it does not take into account uses of the shore by wildlife and people. Alternatives are discussed.



An extract from the Coastal Sensitivity Atlas of Mauritius, *a large format atlas in which each map is accompanied by a page of descriptive text and information on specific resources. Note the inset location map.*

Sub-tidal habitats

Some habitats and species are particularly sensitive to oil spills. These should be identified on maps, and a list of the most common is included.

Wildlife and protected areas

Maps should show the areas of greatest sensitivity for wildlife species. Examples are given.

Fish, fishing activities, shellfish and aquaculture

Both commercial and subsistence fishing need to be considered, and the publication lists the features that need to be included.

Socio-economic features

These include boat facilities, industrial facilities, recreational resources, and sites of cultural, historical or scenic significance, on or close to the shore.

Oil spill response features

The types of response that can be included are listed, as are the means used to identify areas with different protection priorities.

Many maps characterize sites with an environmental sensitivity index (ESI). Recovery times are rapid on exposed headlands, classified ESI 1. ESI 5 beaches of mixed sand and coarser sediments have medium to high permeability to oil, and usually low biological productivity. The most vulnerable shores, ESI 10, include saltmarshes and mangroves. These often act as oil traps due to their extreme shelter.

Symbols

ESI ratings have been indicated using either symbols or colours. Symbols, or a combination of symbols and colour, are recommended. Examples of generalized symbols are reproduced.

Seasonal aspects

The sensitivity of many resources may vary seasonally, and seasonal information should therefore be included.

Obtaining and agreeing information

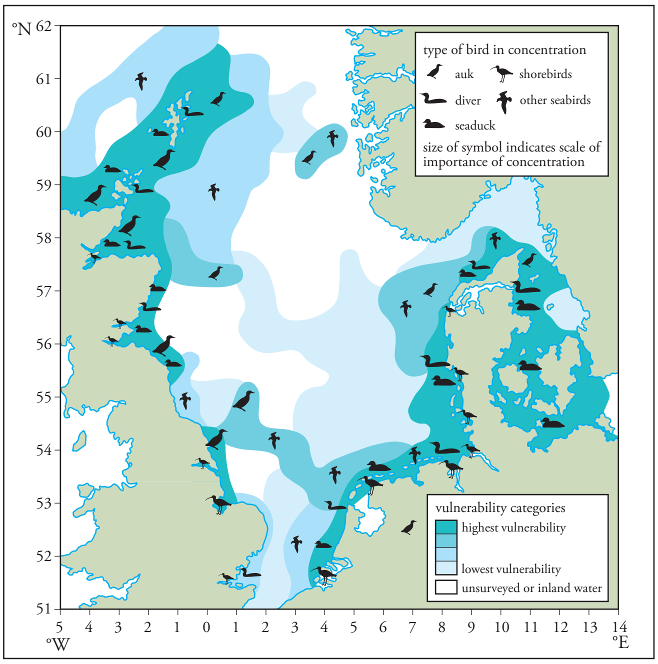
Some information can be obtained from existing maps, photographs, publications and environmental data banks. Inconsistencies can be reduced by simplifying the information and by filling gaps. For larger areas, aerial photographs or satellite images may be needed.

The information to be included needs to be agreed with bodies such as fisheries departments, tourist boards and conservation groups. Maps need to be updated at intervals, and this may involve reassessment of priorities.

Geographic Information Systems

The use of Geographic Information Systems (GIS) is growing rapidly. One of their most valuable features is that they can be easily altered and updated. As GIS become more widely used, the possibilities of linking different GIS systems and data are increasing.

A fully utilized GIS can be much more than just a map—indeed the data shown on a map may simply represent the tip of an iceberg. Maps themselves can easily become cluttered and confusing but a well-designed GIS can help avoid this problem. The World Conservation Monitoring Centre (WCMC) Biodiversity Map Library is an example of a fully functional GIS operating at a small scale; other examples are described.



Methods of indicating seasonality. In Seabird Concentrations in the North Sea: an Atlas of Vulnerability to Surface Pollutants, *a different map is given for each month of the year. The map for April shows seabird distribution heavily influenced by the breeding season, with birds concentrated around coastal and island breeding areas.*

Conclusions

The publication concludes with a list of guidelines intended to promote harmonization in the production of sensitivity maps. These focus on clarity, the distinction between sensitive resource information and spill response and clean-up information, environmental sensitivity ranking, cost-effectiveness, the use of symbols, and the treatment of seasonality.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME TEN

CHOOSING SPILL RESPONSE OPTIONS TO MINIMIZE DAMAGE

Net Environmental Benefit Analysis

Introduction

After an oil spill, urgent decisions need to be made about how to minimize environmental and socio-economic impacts. The advantages and disadvantages of different responses need to be compared with each other and with natural clean-up. This process is called Net Environmental Benefit Analysis.

The process must take into account the circumstances of the spill, the practicalities of clean-up response, the relative impacts of oil and clean-up options, and some kind of judgement on the relative importance of social, economic and environmental factors. Decisions are best and most rapidly made if contingency planning has included reviews of environmental and socio-economic information, and consultations and agreements by appropriate organizations.

Aims of spill response

The aims are to minimize damage to environmental and socio-economic resources, and to reduce the time for recovery. This can involve:

- guiding or re-distributing the oil into less sensitive environmental components;
- removing oil from the area of concern and disposing of it responsibly.

Mangrove swamps, such as this one in Nigeria, are typically important both ecologically and socio-economically (e.g. for shellfish production). They are also vulnerable to damage by oil.

Initiation of a response, or a decision to stop cleaning and leave an area for natural clean-up, should be based on an evaluation made both before the spill (as part of the contingency planning process) and after it.

The evaluation process

Evaluation typically involves the following steps:

- Collect information on physical characteristics, ecology and human use of environmental and other resources of the area of interest.
- Review previous spill case histories and experimental results which are relevant to the area and to response methods which could be used.
- On the basis of previous experience, predict the likely environmental outcomes if the proposed response is used, and if the area is left for natural clean-up.
- Compare and weigh the advantages and disadvantages of possible responses with those of natural clean-up.

Each of these steps is considered in detail in the text.

Considerations and examples

Oil on the water

When a large spill occurs many miles offshore and it is not clear where the oil will move, a wide-ranging preliminary evaluation is an appropriate precaution, Rapid decision making is particularly important for nearshore situations, where there may be only a few hours available before the oil reaches the shore.

If sea conditions preclude containment and recovery, dispersant spraying may be the only possible option if there is to be any at-sea response.

Oil on the shore

If large volumes of mobile oil are present on the shore surface, a rapid response is necessary before the oil spreads. For some shores, ecological recovery times may be reduced by rapid action to remove smothering or particularly toxic oil. In contrast, more time can be given to decisions involving small amounts of weathered oil firmly stuck to the shore or retained beneath the surface.

For many spills which do not involve thick or particularly toxic oil deposits, moderate shore cleaning has little effect

After the Sea Empress *spill in southwest Wales it was important to clean this rocky shore quickly because there was free oil which might have moved elsewhere, the bay is an important area for tourists, and the shore is an area of outstanding ecological interest.*

on longer-term recovery rates of shore organisms. This is an important finding for shoreline response, because it raises key issues for decision making about clean-up.

The text discusses these issues in detail, dealing in turn with severity of oiling, whether there are interacting systems (wildlife species or nearshore ecosystems) which might be damaged if the shore is not cleaned, and socio-economic issues such as the importance of protecting amenity beaches, marinas and fisheries.

This beach near Madras, India, is an example of an area which is so important for amenity and tourism that restoration of human use after oil pollution would take precedence over ecological considerations (such as protecting any crabs that survived the oil).

Conclusions

Some damage caused by specific response options may be justifiable if the response has been chosen for the greatest environmental and socio-economic benefit overall.

- Groundwork for evaluation of response options is best done before a spill as part of contingency planning.
- The advantages and disadvantages of different responses should be weighed up and compared both with each other and with the advantages and disadvantages of natural clean-up.
- Response options need to be reviewed when a spill occurs, and such a review should be an ongoing process in cases of lengthy clean-up operations.
- Offshore and nearshore dispersant spraying can lead to an outcome of least environmental harm.
- For onshore evaluation, it is necessary to consider both the shore in itself, and systems which interact with the shore.
- In many cases of oiling there is no long-term ecological justification for clean-up.
- For extremely oiled shores, moderate clean-up can facilitate ecological recovery, but aggressive clean-up may delay it.
- In most cases of shore oiling where moderate clean-up is considered likely to reduce the damage to socio-economic resources, wildlife or near-shore habitats, this will not make a significant difference to the shore ecological recovery times.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME TWELVE

GUIDELINES FOR OIL SPILL WASTE MINIMIZATION AND MANAGEMENT

This report explains the waste generation implications of different oil spill clean-up techniques and describes best practice options for oiled waste management, which in many countries is strictly regulated.

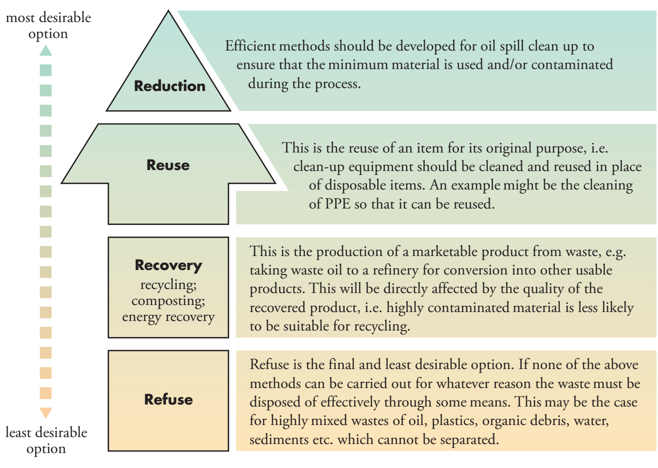
The importance of waste management

There is a constant risk of oil spills in almost every environment worldwide. If a spill occurs at sea, the action of currents, winds and tides will often result in the spilt oil impacting a shoreline. This has many implications but one of the most difficult problems to deal with is the quantity of waste generated in a very short period. Historical data show that oil spills impacting the shoreline can, in extreme cases, produce up to 30 times more waste than the volume of oil originally spilt. Although there may be different reasons for the amount of waste generated, it is also evident that a significant number of smaller spills have created large amounts of waste. The management of all waste in any spill should be regarded as a high priority.

Waste management considerations

The waste hierarchy

A useful model when dealing with a waste stream originating from any source is the 'waste hierarchy'. This concept uses principles of waste reduction, reuse and recycling to minimize the amount of waste produced, thus reducing environmental and economic costs and ensuring that legislative requirements are met. It provides a tool for structuring a waste management strategy and can be used as a model for all operations.



The 'waste hierarchy' provides a tool for structuring an efficient waste management strategy. (Modified from Williams 2000)

Segregation

In the event of a spill and the subsequent clean-up operation, oil and oiled debris collected becomes a waste that should be segregated, stored, treated, recycled or disposed of. Assuming segregated disposal routes are available, an important process in the first stages of an oil spill response is to classify and segregate waste streams at source. Waste should be channelled into separate storage dependent upon type, taking into consideration the most suitable containment for that material.

Minimization

Minimization is a method of reducing the amount of waste entering the waste stream. This is essential to reduce the amount of waste for final disposal, thus limiting environmental and economic impacts.

Secondary contamination

Secondary contamination is the spread of oil via people, transport and equipment to otherwise unpolluted areas. This should be avoided to control the overall impact of the spill, and can be achieved in a number of ways.

Health and safety

All hydrocarbons potentially pose some degree of health risk and it is therefore essential that a health and safety plan is drawn up before any activity commences. Risks from physical hazards, e.g. storage pits, should not be overlooked. Each stage of the management process should be assessed to establish any potential health and safety risks together with appropriate mitigating methods.

Waste generated by different oil recovery methods

The nature of the environments in which spills occur and the clean-up techniques used all determine the waste type and quantity generated. The key is to ensure that each waste type is segregated at source and the amount of waste kept to a minimum. This will facilitate recycling as well as the environmental and economic efficiency of disposal. Examples are given of the types of waste generated by different recovery methods.

Examples of temporary storage on the shoreline and at sea (clockwise from top left): portable tanks; barrels; sacks; inflatable barges; in-built vessel tanks; lined pits.

On-site/near-site temporary storage

Location of the storage site should be carefully planned and should, ideally, be above high-water, spring tide and storm wave limits to avoid being washed away. In regions subjected to extreme heat certain storage containers, especially plastic bags, should be protected from prolonged exposure to direct sunlight as this can cause breakdown of their material. Storage containers should be labelled with the contents, quantities and relevant hazard labels before transportation, and relevant documentation passed to the driver or waste manager. In some countries this is enforced by legislation. The appropriateness of different storage methods is discussed in the report for a variety of spill situations.

Intermediate/long-term storage and transfer

It is essential that all long-term storage sites be set up as soon as possible after a spill in order to facilitate efficient transfer of waste from the spill site. Storage sites should be strategically placed at locations which are suitable for the storage of contaminated waste. Effective management of these sites is also important in order to ensure that the waste is correctly handled, stored and prepared for final disposal.

If possible waste transfer, storage and disposal issues should be addressed at the contingency planning stage when different authorities can discuss the situation rationally without the pressure of an emergency situation. It is also essential that contingency plans be kept up to date with organizational or legislative changes.

Treatment, recycling and final disposal of oiled waste

The objective of any oil spill clean-up operation is ultimately to treat, recycle or dispose of the oily waste in the most efficient and environmentally sound manner. The disposal option chosen will depend upon the amount and type of oil and contaminated debris, the location of the spill, environmental and legal considerations and the likely costs involved: the merits of various options are explored in the report.

Beach washing involves the cleaning of pebbles and cobbles.

Conclusions

An oil spill inevitably leads to numerous difficult decisions having to be made with regard to the supply of resources, prioritizing of resources, best practice clean-up techniques, and the safety of those involved, to name just a few. The issue of waste management can be one of the most significant aspects, in terms of both the operational impact, and the environmental and financial burdens. For successful management of these problems it is essential that the issues are well understood in advance so that they can be planned for, and ultimately mitigated. This should be possible through the use of the best practice techniques which are described in greater detail in the report and the implementation of an effective contingency plan that includes waste management.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME THIRTEEN

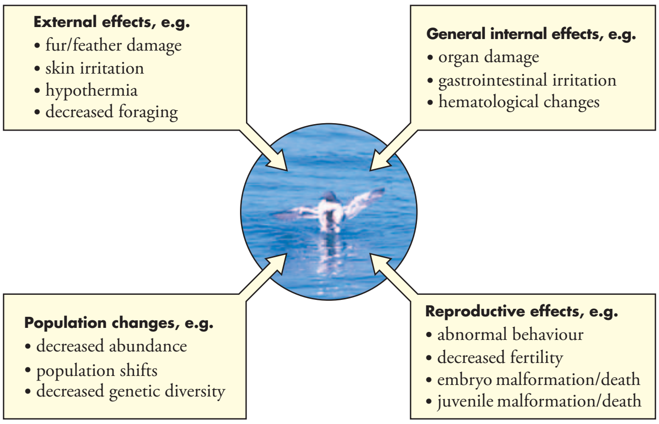
A GUIDE TO OILED WILDLIFE RESPONSE PLANNING

This Guide provides an overview of the different components of oiled wildlife response. It focuses on critical planning issues and response options and is intended as a reference guide for oil spill managers, government officials and industry representatives who may be called upon to make important decisions regarding the fate of wildlife in the immediate aftermath of an oil spill.

Animals suffering from oil exposure or contamination need prompt and appropriate treatment, ranging from rehabilitation to euthanasia. Dead animals can reveal important information and need to be collected in a systematic way to allow for a proper impact assessment. Wildlife mortality can mobilize a myriad of groups and individuals, some of whom will assist while others will hinder rehabilitation efforts through protest. The media will tend to pay disproportionate attention to the wildlife problem in an oil spill incident. If a wildlife problem does occur as a consequence of the oil spill incident, adequate assessment of environmental impacts and the success of oiled wildlife rehabilitation will depend on a comprehensive wildlife response plan.

What are the key features of an effective oiled wildlife response?

1. Responders working safely.
2. Joint primary aims of the response to mitigate the impacts on wildlife welfare and conservation values threatened or impacted by the oil spill event.
3. Systematic objective data collection to facilitate impact studies where legislative and compensation regimes mandate such assessments.
4. Responsible utilization of resources, and auditable documentation of costs.
5. Cooperative and collaborative inclusion of wildlife and environmental stakeholders in planning and operations.
6. Utilization of widely accepted protocols and practices.
7. Minimization of the environmental impact of the wildlife response activities.
8. Adherence to legal permitting requirements for wildlife interactions, including capture, holding, marking and release of wildlife.
9. Wildlife response integrated into wider oil spill response effort.



The effects of oil on animals and their populations

Effects of oil on wildlife

When oil spills occur, there is likely to be an immediate impact on the environment and on the wildlife present. Birds may be perceived by the media as the highest priority for response attention, but other groups of animals, including invertebrates, fish, reptiles and mammals, can also be affected. The likely adverse affects on these groups are described.

Resources at risk

Any wildlife response plan should include an assessment of the species that occur within its geographic limits and the resources at risk that may need protection in the event of a spill. This information is important in the pre-spill planning process, in real-time spill planning, and in the initiation of the wildlife response and its ongoing efforts. If fully integrated with the wider oil spill response plan it could identify whether the protection of various resources would require the use of, for example, protective booming, specialized hazing stockpiles, capture or rehabilitation equipment, or coating of shorelines with sorbents etc. All of this information should be presented in a user-friendly format that responders can access readily to determine the important areas and species to protect.

Objectives of oiled wildlife response

Human safety must always be considered first. If a wildlife response cannot be done safely, it should not be attempted. Risk assessment conducted during the pre-spill planning process can help to identify unacceptable risks and offer removal or mitigation actions to reach acceptable levels of risk.

The most important objective of any response to oil pollution is to minimize environmental impacts. This can be accomplished by:
- preventing oil reaching critical habitats by using protective booming and/or other response technologies;
- reducing the oiling of wildlife by preventing animals from entering the impacted environment; and
- if practical, the initiation of pre-emptive capture and removal of animals at risk.

If animals are oiled and the necessary resources are available, rehabilitation can be effective in minimizing the impact.

Response activities

The following mix of activities may be considered the main components of a good oiled wildlife response and are described more fully in the guide:
- incident assessment and monitoring;
- preventing wildlife from getting oiled;
- record keeping, evaluation, reporting;
- dealing with dead casualties; and
- dealing with live casualties.

Operational aspects

When live animals are involved, time is a pressing factor. There is also the matter of public attention, which can be exacerbated by media interest. A number of operational aspects that need careful planning are summarized below and discussed in this volume of the report series:
- mobilization;
- coordinating wildlife response;
- moving from incident response to project management;
- management of animal care;
- geographical organization of facilities;
- planning;
- management of volunteers;
- minimizing waste and secondary pollution—waste management;
- international management;
- wildlife operations and the media; anf
- demobilization.

Health and safety

The first priority of an incident response, before consideration is given to oiled wildlife response activities, must be the health and safety of the people involved.

The cleaning of a bird requires experienced washers—the plumage can easily be damaged.

Working with animals

Wild animals are not used to being handled. Their natural response to human interference is aggression, as a means of protection, which can be prompted by sudden movements, capture and noise—in fact by anything that they might perceive as a 'disturbance'. Beaks, claws, wings, etc. are all potential weapons and can cause severe damage to those handling the wildlife. Cuts, scratches, etc. should be treated immediately because these can be a source of infection.

Zoonoses

These are diseases which can be transmitted from vertebrate animals to man, and include bacteria, viruses, fungi and parasites. For marine mammals, the two most important are salmonellosis and other bacterial infections due to direct contact, including bites.

Protective clothing

As a minimum, staff should be equipped with personal protective equipment (PPE) as follows:
- Field team: oil impermeable coveralls, rubber boots, hard hats, nitrile gloves;
- Working with animals: oil impermeable coveralls, nitrile gloves, safety glasses;
- Washing animals: waterproof clothing, nitrile gloves, safety glass.

Response planning

The structure, prescriptions and approaches of any operational contingency plan will typically reflect specific cultural traditions and philosophies on how emergencies are best dealt with. It is therefore not possible for this guide to present a 'blueprint' of a plan that can simply be copied and used in any local setting, although a suggested structure for contingency planning is included, and some key components described more fully. Detail is also given on key issues in the planning process: plan ownership; selecting responsible officers and personnel; the tiered response concept; funding and compensation. Training, exercises and regular review of the oiled wildlife response plan is essential.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME FIVE

DISPERSANTS AND THEIR ROLE IN OIL SPILL RESPONSE

Dispersants are one option for reducing damage from oil spills. By breaking up slicks, they can lessen effects from oil coating and smothering, reducing biological damage. However, dispersants are not a panacea. This report considers when they should be used, and when they should not, and how the dispersant option relates to contingency planning.

Dispersants and how they work

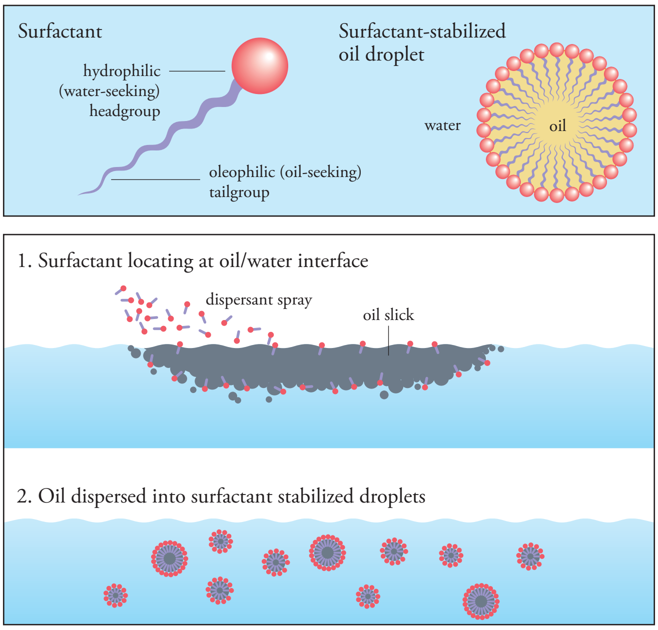
It is common knowledge that oil and water do not mix easily. Spilled oil floats on the sea surface in calm conditions. The mixing action of the waves can cause oil and water to combine in two ways:

Natural dispersion
Waves break up the oil slick, forming oil droplets that become suspended in the water. The majority of these oil droplets will float back to the surface; but a small proportion of tiny droplets with neutral buoyancy will remain dispersed in the water almost indefinitely.

Water-in-oil emulsification
The mixing action of waves can cause water droplets to be incorporated into the oil, forming a water-in-oil emulsion which has a much higher viscosity than the oil from which it is formed. This emulsion is often referred to as 'chocolate mousse' and can increase in volume by up to four times that of the spilled oil.

Dispersants alter the balance between natural dispersion and emulsification, pushing the balance strongly towards dispersion and away from emulsification. By applying dispersant onto the spilled oil, it is possible to inhibit emulsion formation while promoting oil dispersion.

Dispersants—the active ingredients
Dispersants promote the formation of numerous tiny oil droplets, and delay the reformation of slicks because they contain surfactants with hydrophilic heads which associate with water molecules, and oleophilic tails which associate with oil (see diagram). Oil droplets are thus surrounded by surfactant molecules and stabilized. This helps promote rapid dilution by water movements.



Surfactants consist of two parts; a water-seeking hydrophilic headgroup and an oil-seeking oleophilic tailgroup. This allows them to stabilize oil droplets.

The formation of droplets increases the exposure of oil to bacteria and oxygen, favouring biodegradation. However, the distribution of oil into the water column is increased. How to weigh up these advantages and disadvantages is one of the main subjects of this report.

Advantages and disadvantages of dispersants

Dispersion of floating oil into the water column provides a number of advantages, including:

- reducing risk of contamination of marine habitats and wildlife;
- assisting with biodegradation of the oil by increasing exposure to naturally-occurring bacteria and oxygen;
- reducing the amount of surface oil susceptible to drifting with the wind;
- rapid treatment of large areas through application of dispersant from aircraft compared to alternative response methods;
- dispersed oil droplets can become associated with suspended sediment, producing a neutrally buoyant 'aggregate' which is distributed naturally over large areas at very low concentrations.

The main potential disadvantage of dispersion of oil is the localized and temporary increase in oil in water concentration which could effect marine life in the immediate vicinity of the spill.

Subsequent sections of this report consider the importance of weighing up the advantages and disadvantages of dispersant application.

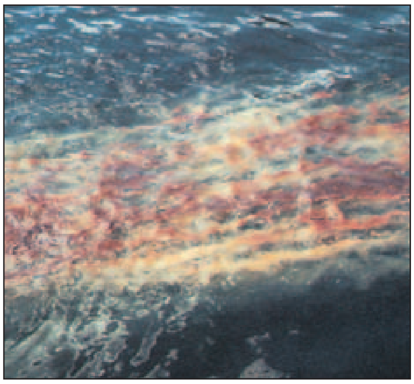
Types of dispersants available

This section of the report looks at the types, effectiveness and means of application of dispersants developed over the years.

Low toxicity dispersants, known as 'Type 1 dispersants' (UK classification) were developed at the beginning of the 1970s. Still available today, they are of relatively low effectiveness and need to be used at very high treatment rates.

More efficient dispersants were produced using a higher surfactant content. The higher viscosity of these dispersants made them difficult to apply using certain existing spraying mechanisms, but this was later overcome by substituting some of the solvent with seawater. Such water-dilutable dispersants became known as 'Type 2' (UK classification) dispersants.

Higher performance dispersants using blends of different surfactant types were developed in 1972 and improvements in formulations continued into the 1990s. Most modern dispersants can be sprayed from aircraft, and from boats and ships.



Dispersant-treated oil breaking up into clouds of droplets.

What dispersants can and cannot do

Dispersants function by enhancing the rate of natural dispersion caused by wave action. The results of field and laboratory tests are described. A table summarizes case histories of effective dispersant use.

When appropriate, and under most circumstances, dispersants can remove more oil than physical methods. However, dispersants do not always work well: dispersant spraying was ineffective on heavy fuel oil spilled from the *Vista Bella* (Caribbean, 1991).

Properties of spilled oil which affect dispersant effectiveness (e.g. viscosity, wax content, pour point, sea temperature) are discussed. The need to recognize the different types of dispersants and their characteristics is emphasized.

The potential for natural dispersion of light crude oil was spectacularly demonstrated when the Braer *grounded in severe weather on the Shetland Isles, Scotland, in January 1993, losing its entire 85,000-tonne cargo. Some 120 tonnes of dispersant was applied from aircraft, mainly to treat slicks that formed close to the wreck during periods of slightly calmer weather.*

Effectiveness and toxicity testing

Dispersant effectiveness is usually judged visually, although it is difficult to assess concentrations of dispersed oil in the water column through visual analysis alone. Laboratory analysis of water samples indicates that oil levels following

IPIECA REPORT SERIES VOLUME FIVE

DISPERSANTS AND THEIR ROLE IN OIL SPILL RESPONSE *(continued)*

dispersion are not high. UVF techniques have been used over the past ten years to confirm that dispersants are having a positive effect.

Laboratory procedures for testing toxicity are also useful but cannot be used to predict environmental effects. Studies have shown that toxicity concerns should be focused on the potential environmental effects of chemically-dispersed oil rather than on dispersants themselves.

To spray or not to spray

Weighing up the advantages and disadvantages of dispersant spraying is of primary importance in the decision-making process. The evidence from spill case histories and experiments is summarized.

Dispersed oil in the water column

Information on concentrations of oil below dispersant-treated slicks comes mainly from field experiments in open water. Measured oil concentrations range from <1 to >60 ppm. How damaging are such exposures to marine life? Information from the US National Research Council, and the Searsport, TROPICS and BIOS experiments is summarized. A case history is included on the Searsport experiment.

The Searsport experiment: the objective of this field experiment was to obtain quantitative information on the fate and effects of chemically dispersed and untreated oil in a nearshore area.
Below left: aerial view of chemically dispersed oil
Right: clam sampling

Field experiments on chemically dispersed and untreated oil

There is little comparative information for birds and mammals. Direct fouling of birds and fur-insulated mammals is disastrous for them, and it is assumed that dispersion of surface slicks must be beneficial because it reduces the risk of such fouling. However, use of dispersants as 'shampoos' increases the wettability of fur and feathers, which can lead to death by hypothermia. Spraying should be kept as far as possible from birds and mammals.

Economic considerations

Economic factors are important in deciding whether or not to spray dispersants—for example, beaches and marinas may need to be protected by dispersants but industries using saltwater intakes may be adversely affected by dispersants. Economic and biological considerations may coincide; for example, a mangrove swamp may be important both ecologically and economically and so require priority protection.

Dispersants and contingency planning

The 'window of opportunity' for dispersant spraying generally lasts for only two to three days, so it is essential that the dispersant option has pre-approval under certain conditions depending on water depths, currents, wave characteristics and mixing energy, and distance from sensitive resources. Named products have to be approved and stocked. There are also logistical requirements, such as approval in principle for aircraft to operate in certain areas. Details are provided on the pre-approval process.

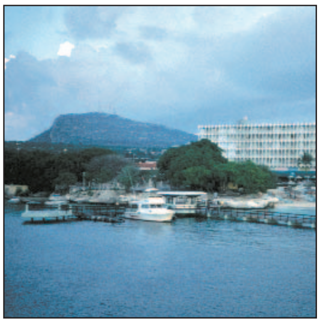
The pre-approval process involves:

- definition of oil types, scenarios and geographical locations where dispersants are a viable option from the logistical point of view;
- net environmental benefit analysis, i.e. consideration of the advantages and disadvantages of dispersant use compared with those of other response options;
- on the basis of the above, identification of locations and situations where dispersant use can or cannot be pre-approved—any restrictions should be indicated on sensitivity maps.

The dispersant option is then discussed in relation to a number of hypothetical scenarios:

- the open sea, slick moving rapidly towards a fishing ground and islands with important bird colonies;
- a large river;
- nearshore, slick moving through area of shallow water with coral reefs, towards a mangrove area;
- nearshore, slick moving through area of shallow water with coral reefs, towards a sandy shore;
- nearshore, slick moving towards industrial water intakes or harbours;
- nearshore, slick moving through area of shallow water with sub-tidal shellfish, towards tourist resort; and
- rocky shore, with sub-tidal seafood resources (e.g. lobsters) near the shore.

Dispersant application options are discussed, including boat-based systems, fixed wing aircraft-based systems (above), and helicopter-based systems.



Dispersant options are discussed in relation to a number of hypothetical scenarios: options are assessed for a range of open sea, inland and nearshore environments.

Application options

Ideal spraying systems deliver dispersant uniformly to the slick in a way which maximizes dispersant-oil mixing and minimizes wind drift. The various dispersant application systems—boat-based systems, aircraft-based systems and helicopter-based systems—are summarized.

Dispersant use on shorelines

The use of dispersants on shorelines requires careful consideration of the risks and benefits. The approaches to shoreline clean-up are discussed, and the report notes that specialized shoreline cleaning agents are now available which should be considered in preference to dispersants.

The full report is contained on the CD-ROM included at the end of this publication.

IMO/IPIECA REPORT SERIES
VOLUME TWO

GUIDE TO OIL SPILL EXERCISE PLANNING

This report is designed to guide those who are responsible for developing and managing oil spill response exercises. It is illustrated with eight case histories of exercises that have been held by industries in different parts of the world.

The Guide describes four categories of exercise and establishes an exercise planning process that involves four steps—designing, developing, conducting and reviewing.

Exercises provide many advantages. Response teams can practise their skills, work together closely and make complex decisions under stressful circumstances. Plans, equipment and systems can be tested and improved. And government and industry can demonstrate their commitment to managing the risk of oil spills.

It is essential that the roles of the different parties involved are properly reflected in exercises. Government representatives should be involved in industry-led exercises and industry representatives in government-led exercises. This enables all parties to explore and understand their separate roles and responsibilities. The final authority, however, almost always lies with government.

GUIDING PRINCIPLES

- Ensure that management from the top down supports the exercise activity.
- Set clear, realistic and measurable objectives for an exercise.
- The thrust of exercising is to improve—not to impress.
- Simpler, more frequent exercises lead to faster improvements initially.
- Do not tackle complex exercises until personnel are experienced and competent.
- Too many activities, locations and participants can overcomplicate an exercise.
- Evaluating the exercise successfully is as important as conducting it successfully.
- Planning and conducting a successful exercise is a significant accomplishment.

Exercise categories

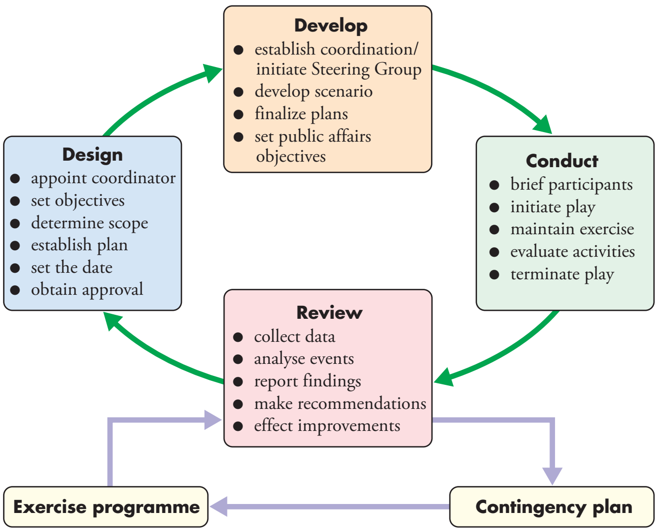
A well-coordinated programme of oil spill exercises includes activities of varying degrees of interaction and complexity. Four exercise categories are identified, lasting from about one hour up to about 14 hours:

- notification exercises;
- tabletop exercises;
- equipment deployment exercises; and
- incident management exercises.

Planning process

Exercise planning consists of four separate activities—design, develop, conduct and review—that collectively describe the process for creating and running realistic and successful exercises. The process cycle is illustrated in the figure below.

The exercise planning process



Design phase

The design phase is described in six activities:

- appoint Exercise Coordinator;
- set objectives;
- determine exercise scope;
- establish exercise plan;
- set the date; and
- obtain management approval.

Development phase

The development steps covered here are common and may be applied to exercises of different categories, scope and objectives:

- establish coordination/initiate Steering Group;
- develop scenario;
- finalize plans; and
- select public affairs objectives.

Building in realism: in this oil spill exercise, the application of dispersants is simulated using vegetable colouring as a substitute for the real thing.

Public affairs

In major oil spill incidents, handling the media and managing the crisis consumes much time. Exercise planners should take care to choose public affairs objectives that create realistic situations and provide public affairs personnel with practice of managing oil spill issues. Where exercise planners wish to test the capability of the response organization to handle the media, it is best to employ company personnel or outside consultants to simulate media interjections. When involving outsiders, special care should be taken to ensure the boundaries of the exercise are understood and maintained. The cooperation of the local community is essential. Relationships with the community, therefore, should be established at an early stage.

Conducting the exercise

The conduct of an exercise consists of briefing participants, initiating play, maintaining the exercise, evaluating activities and, finally, terminating play.

All participants require an exercise briefing, In the case of a notification exercise, when one of the objectives is to test team members' availability and response times, any briefing should be given a couple of weeks in advance but the exact time and day of the exercise should not be disclosed. Deciding how the exercise should be initiated is important for establishing realism and urgency. Clear responsibility for initiating play at a predetermined time and in a prescripted manner should be established. It is often worthwhile to check that lines of communication have been established at an early stage, rather than risk delays in starting the exercise.

The pace and direction of the exercise is set by the interjections that update information on the imagined incident. Evaluation should begin during the exercise and carry through until after completion. Orderly termination of exercise activities is critical to ensuring that play ends positively and tidily.

Review phase

Evaluation is critical to improving emergency and crisis response capabilities. This phase of an exercise consists of collecting and analysing data and reports, documenting the findings and making recommendations for improvements. Summaries of the findings and recommendations should be copied to exercise participants and to management, as feedback.

A schedule should be set for reporting and discussing the findings of an exercise to ensure details and opinions are not forgotten. A target of two to four weeks for completion of the process might be appropriate.

Once the reports have been discussed and conclusions drawn, recommendations for improvement can be made. Priority should be given to those options that can be implemented quickly and easily. It is perhaps appropriate that the Exercise Coordinator be made responsible for implementing and communicating the changes. Alternatively, the individual or group with overall responsibility for the contingency planning process should effect the changes.

Exercising contingency plans, however, is a reiterative process. Any adaptation of the plan will need further testing. The process continues by returning to the design phase to start the planning of another exercise.

The full report is contained on the CD-ROM included at the end of this publication.

IPIECA REPORT SERIES
VOLUME ELEVEN

OIL SPILL RESPONDER SAFETY GUIDE

Health and safety should be the cornerstone of all oil spill preparatory measures. The purpose of the report is to investigate the safety aspects of oil spills and their response, focusing on identifying the principal safety issues when an oil spill occurs, their degree of severity and the practical steps that can be taken to minimize the impact of the spill. It is recognized that safety is managed in many different ways around the world and no attempt is made to provide a 'blue-print' safety document.

Management control of spill safety

The safety of the general public and responders is assigned the highest priority during spill response operations. A response management system, with safety as its core element, should start from the top and penetrate to all levels within the organizations participating in response activities.

To ensure that safety takes its proper place during response operations special actions need to be taken. The management team should appoint an individual and, if necessary, a supporting team, with a responsibility for safety management. Responders can often become too involved in operations and not be able to take an overall view of the situation. The safety manager needs to be able to step back from the operation and consider wider issues.

The safety manager should be responsible for monitoring and maintaining awareness of active and developing situations, assessing hazardous and unsafe situations and developing measures to assure personnel safety. The following measures are described more fully in the report:

Briefing the response team prior to a day's operations

- site assessment;
- developing and implementing a Site Safety and Health Plan (SSHP);
- participating in planning meetings to identify health and safety concerns;
- correcting unsafe acts or conditions through the regular line of authority; and
- establishing first-aid stations and medical facilities in accordance with the SSHP.

Risk assessment

The first task that should be undertaken when preparing to conduct oil spill response operations is a comprehensive risk assessment and hazard analysis. When an oil spill occurs the management team will need to carry out a high-level risk assessment of the overall situation as soon as possible to ensure that oil spill responders or the wider population are not in danger. The initial approach should be to answer such questions as:

- Is there a potential gas cloud and therefore an explosion risk?
- Should people be evacuated or excluded?
- Is the environment safe for people?
- Will oil enter water systems that may affect people?

The risks posed by particular operations or locations should be assessed on a case by case basis; an example of a typical Site Safety Survey Form is given in the report. The risk assessment should be fully documented and filed.

Spilled product and response clean-up: chemical safety

Responses to oil spills inevitably put responders and chemicals together in the same environment. Potential exposure of personnel should be assessed, monitored and controlled if health effects are to be avoided. Each type of product, when spilled into the environment, will have its own set of chemical characteristics that will determine the most effective response strategy and, indeed, which strategies are safe to use. It should be borne in mind that the chemical characteristics of the spilled product will usually change over a period of time as a result of what is known as 'the weathering process', i.e. the action of the elements on the product and its reaction with the surroundings.

Oils, whether in the crude state or as refined products, represent a safety hazard. The main hazards that can arise are described in the report and result from the following properties:
- flammability;
- explosive vapours;
- toxicity;
- hydrogen sulphide;
- exclusion of oxygen; and
- the slippery nature of oil.

The working environment and safety during response operations

Oil spills can occur in practically any type of environment and under all climatic and meteorological conditions. This poses a number of challenges to responders and has an overriding influence on the response options available. Some aspects of the working environment (such as site layout, security, working shifts) may be controlled by the responders themselves. Others, including the weather and the terrain, must be given consideration and accommodated when response targets are set. In every working environment, safety must remain the top priority, and measures to control any risks put in place. A variety of spill site hazards are described in the report.

Providing safe access to the worksite is critical to reducing the risk of accidents.

Personal protective equipment selection and site facilities

PPE selection

Personal protective equipment (PPE) is essential for ensuring responders are able to work in a safe manner. The proper selection and use of PPE requires skill and experience. The following points should be taken into consideration when selecting the appropriate PPE:
- the expected working conditions and hazards;
- the activities to be performed;
- the person(s) being exposed; and
- the compatibility of the equipment—each piece of PPE should be capable of performing effectively without hindering the proper operation of other pieces.

Safety and welfare facilities on site

Potable water, non-potable water, toilets and personal hygiene facilities should be readily available. Details of the location of hygiene facilities should be contained on the Site Safety Map.

Decontamination is best performed in a specific sequence, described in the report, to reduce levels of contamination on personnel, PPE, equipment or transport until no contaminant remains. Facilities should be established to deal with the waste from cleaning stations so it can be disposed of in an approved manner in order to prevent secondary pollution.

Management of volunteers

Volunteers will frequently offer their services to assist, either as part of the clean-up team or to assist with wildlife rescue. Volunteers are often inexperienced and untrained in spill response activity, so this resource can be both an asset and a liability if their use is not controlled and insufficient care is given to safety and welfare. For this reason, safe use of volunteers needs careful thought and planning.

If volunteers are used in a response activity, it should be in such a way that their safety is assured. A specific training programme should be provided, identifying the risk and hazards and how to avoid injury. Volunteers should also be provided with appropriate PPE and integrated in to the overall command structure to ensure that they have the benefit of safety information briefings.

Conclusions

The clean-up of spilled oil is important, but not as important as ensuring the safety of those who are involved with, or may be affected by, the spill. The health and safety of the public and the responders is a critical aspect of a successful operation. The problem is not a particularly complex one, but one that requires management, planning and common sense to minimize the risk of accidents.

The full report is contained on the CD-ROM included at the end of this publication.

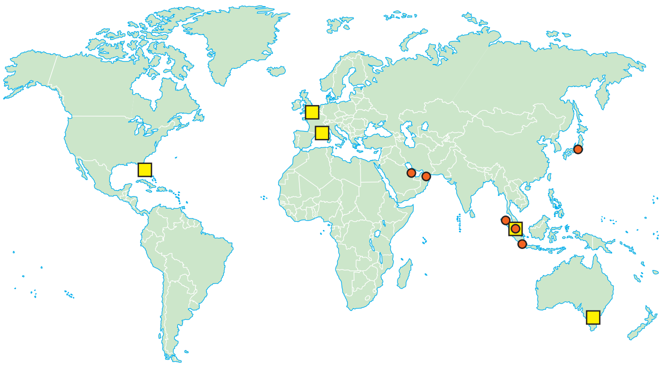
A JOINT IPIECA / ITOPF BRIEFING PAPER

INTERNATIONAL OIL INDUSTRY SPILL RESPONSE RESOURCES: TIER 3 CENTRES

This publication describes the features and operational characteristics of the oil industry's spill response Tier 3 Centres. These Centres (see map and caption) have been established over the years by the oil industry at a number of strategic sites. They reduce the need to establish national stockpiles.

Most offer specialized equipment and expertise to their member companies and, conditionally, to other users such as governments and tanker owners. Their use requires good planning, and logistic support such as transport, boats and recovered oil storage facilities. Some users have unrealistic expectations of Tier 3 Centres with the result that some spill response efforts have been compromised.

All Centres maintain a stock of equipment at a single location, and a capability for rapid aerial transportation. Some have a core of trained operators and provide training. In addition, the Petroleum Association of Japan (PAJ) has resources distributed along tanker routes between the Middle East and Japan.



internationally available oil industry spill response resources

Petroleum Association of Japan stockpiles (note: six distinct stockpiles are located in Japan)

Features of the Centres

Location

The Centres have been located according to the needs of the participating member companies. Except for OSRL, whose equipment can be used anywhere, the Centres are designed to respond within designated geographic areas. All or much of the equipment is ready for rapid air transport. PAJ on the other hand has opted for setting up smaller stockpiles in the vicinity of high risk areas.

Response capability

Total capability is difficult to quantify and depends on factors such as type of oil, weather and sea conditions and the organization of the response operation.

Equipment

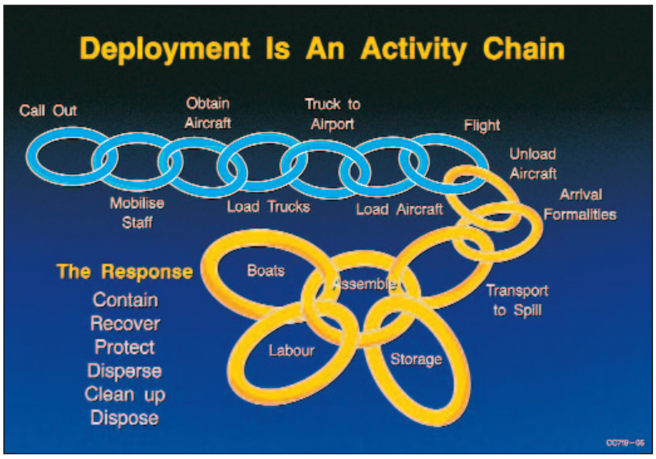
Most Centres have resources for offshore, nearshore and onshore responses. The aerial application of dispersants is a primary response tool for most Centres, and some have high-capacity application equipment. PAJ does not have a dispersant response capability. CCC also maintains fire-resistant booms for the *in-situ* burning of floating oil. Only OSRL has sufficient manpower to operate most of its equipment at an oil spill. PAJ stockpiles do not have dedicated personnel to deploy their equipment.

Response equipment stored in a warehouse and packaged for immediate transportation.

Access

Access is preferentially given to companies that provide funds. Third parties such as governments and ship owners generally have access but a response is not guaranteed. Third parties are charged a higher rate than members and methods of charging are described. PAJ is unique in offering its equipment to third parties free of charge.

Response teams need to be adequately prepared for a potential oil spill; above, a team receives practical training in equipment deployment.



Effective deployment of Tier 3 resources is an activity chain, parts of which (shown in yellow) are beyond the control of the Tier 3 Centres.

Making best use of the centres

Large spills require much equipment and expertise to be mobilized. A full evaluation of the situation must be carried out by the user in conjunction with the Centre to ensure that only appropriate materials are mobilized and that the necessary support is available locally. Full cooperation from government authorities, such as customs and immigration, must also be obtained.

Staff from the Centre work under the direction of the requesting organization. They can provide tactical advice but do not manage the overall response or provide command and control elements. It is not the responsibility of the Centres to gain approval for the use of particular equipment or strategies nor to arrange for the disposal of recovered oil.

Conclusions

Tier 3 Centres can play an important role, provided the necessary groundwork has been done in advance of a spill within the receiving country. Government agencies should be responsible for ensuring that the necessary pre-spill preparations have been made.

Appendices

The features, capabilities and contact details of the Centres are described in three appendices.

The full report is contained on the CD-ROM included at the end of this publication.

A JOINT IPIECA/ITOPF BRIEFING PAPER

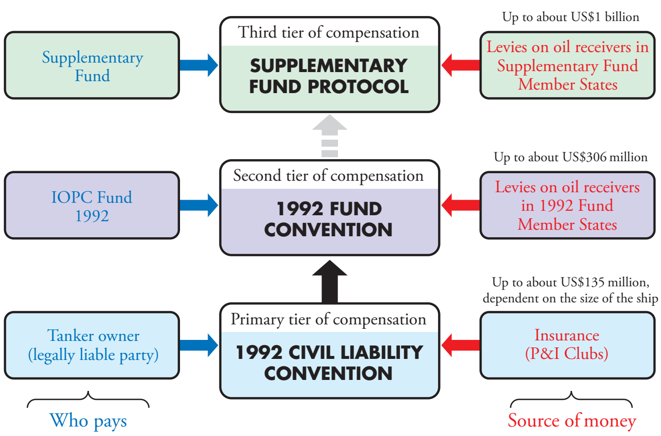
A GUIDE TO OIL SPILL COMPENSATION

The purpose of this Guide is to provide a summary of the 1992 Civil Liability Convention and the 1992 Fund Convention, and to provide a basis on which tanker owners, oil companies and other interested parties can promote their ratification by all coastal States.

Introduction

The *Torrey Canyon* incident in 1967 stimulated the development of two voluntary agreements and two international Conventions regarding compensation to those who incur clean-up costs or suffer pollution damage as a result of oil spills from a tanker. The voluntary agreements were terminated on 20 February 1997. The Conventions were the 1969 International Convention on Civil Liability for Oil Pollution Damage ('1969 CLC') and the 1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage ('1971 Fund Convention'). In 1992 this 'old' regime was amended by two Protocols which increased the compensation limits and broadened the scope of the original Conventions. The amended Conventions are known as the 1992 Civil Liability Convention ('1992 CLC') and the 1992 Fund Convention. This Guide deals primarily with the 'new' 1992 regime and also introduces the International Supplementary Fund for Compensation for Oil Pollution Damage, 2003 ('Supplementary Fund') for which a Protocol was adopted at the IMO in May 2003.

More than 100 countries have ratified one or other of the Conventions and compensation of many hundreds of millions of US dollars has been paid.



The three-tier system of compensation established by the international Conventions: the owner of the tanker that caused the spill is legally liable for the payment of compensation under the first tier; oil receivers in Fund-Member States contribute to the second and third tiers once the tanker owner's applicable limit of liability has been exceeded.

Fundamental features of the compensation Conventions

A two-tier system of compensation is established by the international Conventions, with the owner of the tanker that caused the spill being legally liable for the payment of compensation under the first tier, and with oil receivers contributing once the tanker owner's limit of liability has been exceeded (see box overleaf). A third tier is introduced by the 'Supplementary Fund'.

First layer of compensation—the tanker owner and his P&I Club

The text describes the scope of application, the concept of strict liability, limitation of liability, who can be held liable, compulsory insurance and the Protection and Indemnity Associations (P&I Clubs—mutual, non-profit making associations which insure their shipowner members against various third party liabilities, including oil pollution).

Second and third layers of compensation—the 1992 Fund and Supplementary Fund

The text discusses the administration of the International Oil Pollution Compensation Fund 1992 ('1992 Fund'), when it pays, the contributors to the 1992 Fund, and how claims are approved and settled. Basic details of the Supplementary Fund are also provided.

Working together

The final part of this section deals with how to address a claim, the relations between the P&I Clubs and the 1992 Fund, submissions to joint claims offices that these two bodies may set up in special cases, and the role of technical experts. These experts are often members of technical staff from the International Tanker Owners Pollution Federation (ITOPF).

Compensation limits

The amounts of compensation available under the 1992 CLC and 1992 Fund Convention are illustrated in the box and detailed in the text. What happens if the approved claims might exceed the compensation available is described.

Maximum amounts of compensation available (US$ million) for various sizes of tanker

Gross 1992 tonnage	*1992 Fund CLC*	*Convention*
5,000	6	284
25,000	24	284
50,000	40	284
100,000	84	284
140,000	126	284

Scope of compensation—admissible claims

For a claim to be admissible it must fall within the definition of pollution damage or preventive measures in the 1992 CLC and 1992 Fund Convention. Claims in respect of pollution damage can fall under:

- preventive measures (including clean-up);
- damage to property;
- economic losses; and
- reinstatement/restoration of impaired environments.

Each of these categories is considered in turn, including a discussion of how 'reasonable' clean-up measures are interpreted for the purpose of the Conventions.

Record keeping

The speed with which claims are settled depends largely upon how long it takes claimants to provide the P&I Club and the 1992 Fund with the information they require in a format that permits easy analysis. It is vital that all those involved keep records of what was done, when, where and why in order to support claims for the recovery of the money spent in clean-up. The text describes how these records should be kept and what they should contain.

Claims presentation

The text discusses who is entitled to compensation, the period in which a claim must be made, how the claim should be presented. Information on how to obtain further guidance on these issues is included.

Compensation in states not Party to the Convention

Some States which have not ratified the international compensation Conventions have their own domestic legislation for compensating those affected by oil spills from tankers within their territory. In other countries that have not acceded to the Conventions, reliance has to be placed on broader laws developed for other purposes. The text discusses the problems this can cause and urges ratification of the Conventions.

Conclusions

The Conventions provide a straightforward mechanism whereby the costs of clean-up measures and pollution damage can be recovered on a strict liability ('no fault') basis from the individual tanker owner and P&I Club involved in an incident and from the 1992 Fund. So long as the clean-up measures taken in response to an incident and the associated costs are 'reasonable' in the particular circumstances, and the claims for compensation are well presented and supported by relevant documentation and evidence, few difficulties should be encountered. The compensation available (approximately US$284 million) should be adequate in most cases.

The Guide concludes with a section providing answers to commonly asked questions relating to compensation mechanisms for oil pollution damage.

The full report is contained on the CD-ROM included at the end of this publication.

LIST OF TITLES IN THE IPIECA OIL SPILL REPORT SERIES

IPIECA reports

Volume number	Title	First published
1	Guidelines on biological impacts of oil pollution	1991
2	A guide to contingency planning for oil spills on water	1991 (2nd edition 2000)
3	Biological impacts of oil pollution: coral reefs	1992
4	Biological impacts of oil pollution: mangroves	1993
5	Dispersants and their role in oil spill response	1993 (2nd edition 2001)
6	Biological impacts of oil pollution: saltmarshes	1994
7	Biological impacts of oil pollution: rocky shores	1995
8	Biological impacts of oil pollution: fisheries	1997
9	Biological impacts of oil pollution: sedimentary shores	1999
10	Choosing spill response options to minimize damage: net environmental benefit analysis	2000
11	Oil spill responder safety guide	2002
12	Guidelines for oil spill waste minimization and management	2004
13	A guide to oiled wildlife response planning	2004

Reports published jointly with IMO

Volume number	Title	First published
1	Sensitivity mapping for oil spill response	1996
2	Guide to oil spill exercise planning	1996

Reports published jointly with ITOPF

Title	First published
The use of international oil industry spill response resources: Tier 3 centres	1999
Oil spill compensation: a guide to the international conventions on liability and compensation for oil pollution damage	2000

IPIECA'S ROLE AND MEMBERSHIP

The International Petroleum Industry Environmental Conservation Association (IPIECA) is comprised of oil and gas companies and associations from around the world. Founded in 1974 following the establishment of the United Nations Environment Programme (UNEP), IPIECA provides one of the industry's principal channels of communication with the United Nations. IPIECA is the single global association representing both the upstream and downstream oil and gas industry on key global environmental and social issues including: oil spill preparedness and response; global climate change; health; fuel quality; biodiversity; social responsibility and sustainability reporting.

Company Members

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Association Members

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Canadian Association of Petroleum Producers (CAPP)
Canadian Petroleum Products Institute (CPPI)
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European Petroleum Industry Association (EUROPIA)
Institut Français du Pétrole (IFP)
International Association of Oil & Gas Producers (OGP)
Petroleum Association of Japan (PAJ)
Regional Association of Oil and Natural Gas Companies in Latin America and the Caribbean (ARPEL)
Regional Clean Sea Organisation (RECSO)
South African Petroleum Industry Association (SAPIA)
World Petroleum Congress (WPC)

IPIECA Oil Spill Preparedness and Response

Report Series on CD-ROM

The attached CD-ROM includes the complete IPIECA Oil Spill Preparedness and Response Report Series, published between 1990 and 2005, in PDF format†. Each report in the series is included in full, in English, French, Spanish and Russian.* Some reports are also included in Italian, Chinese and Japanese.

The publication *Action Against Oil Pollution,* which was published jointly by key international stakeholders in 2005, is also included. *Action Against Oil Pollution* contains links to related topics and more detailed information, including other files on the CD-ROM and resources on the Internet.**

* Russian translations for Volumes 3 and 4 are not included

† Requires Acrobat Reader™ **Web browser and Internet connection required