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POLLUTION RESPONSE IN EMERGENCIES
MARINE IMPACT ASSESSMENT AND MONITORING

POST-INCIDENT MONITORING GUIDELINES

AN INTRODUCTION

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This document is aimed at providing an introduction to the background and content of the Premiam post incident monitoring guidelines. For any further detail, especially with respect to the operational tools, techniques and strategies, reference should be made to the comprehensive Guidelines document detailed below:

Law, R.J., Kirby, M.F., Moore, J., Barry, J., Sapp, M. and Balaam, J., 2011. PREMIAM – Pollution Response in Emergencies Marine Impact Assessment and Monitoring: Post-incident monitoring guidelines. Science Series Technical Report. Cefas, Lowestoft, 146: 164pp.

A copy can be obtained by downloading from the Premiam website at www.cefas.defra.gov.uk/premiam

PREMIAM PARTNERS

The Premiam guidelines are produced as part of the Premiam initiative. Premiam represents an ongoing collaboration supported by all key government stakeholders across the United Kingdom.

INTRODUCTION

Spillages of oil and chemicals into the marine environment can be high-profile events which may also give rise to significant environmental and/or public health impacts. Although there is evidence that the number of oil spills has decreased in recent decades as a result of improved practices and prevention, there are still occasional large, high-profile incidents (Deepwater Horizon, Hebei Spirit and Tasman Spirit, for example). Also, small spills, which can nevertheless have significant local impacts, and "near-miss" potential spills occur on an almost daily basis.

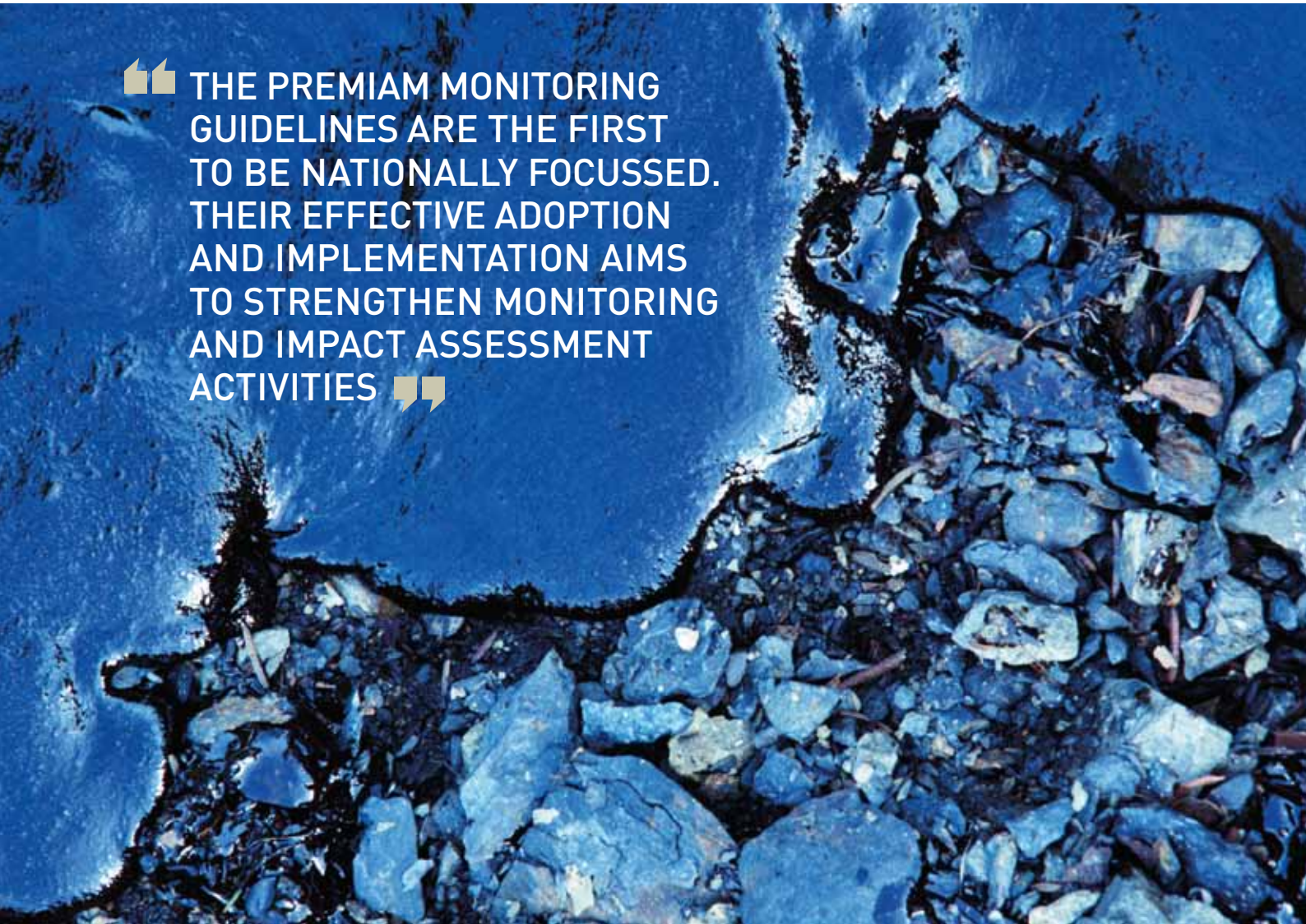
It is against this background that the UK authorities (and those of other countries) require the development and maintenance of an effective spill response and clean-up capability, including the ability to initiate and conduct scientifically robust post-incident environmental monitoring and impact assessment. The Premiam (Pollution Response in Emergencies: Marine Impact Assessment and Monitoring) initiative is a collaboration of all key UK government stakeholders aimed at the provision of effective post-incident monitoring processes. This is facilitated by clear monitoring guidelines to ensure that:

- Key stakeholders, including government and the general public, are provided with early and accurate evidence of the potential hazards and risks posed by the incident.
- There is an appropriate and effective means of investigating both short-term and longer-term impacts.
- Better co-ordination will result in a more effective use of resources and the ability to conduct integrated assessments.
- Information is gathered relating to the effectiveness of spill response and clean-up activities (including the use of dispersants) and that this provides a direct input into evolving response strategies.

Under the UK National Contingency Plan (NCP), if a marine pollution incident is expected to have a significant environmental and/or human health impact, arrangements should be made to begin to monitor and assess the long-term, as well as the short- and medium-term, environmental impacts. In addition to providing operational advice to the response centres, the Environment Group (EG) established during the incident will provide key advice/direction regarding environmental resources that are under threat and the nature of monitoring that should take place to enable an assessment of the environmental impact of the incident. A further role of the Standing Environment Groups (SEGs), between incidents, is to record data concerning the pre-existing baseline conditions within their area, for use as reference points during an incident. For certain incidents (either in terms of their scale or their potential to cause substantial environmental damage), impact assessment projects and monitoring or survey studies may need to be commissioned. The guidelines and procedures to facilitate the design, conduct and co-ordination of these activities have been put in place by the Premiam initiative and include the formation of a PMCC (Premiam Monitoring Co-ordination Cell) where necessary. Where an incident has the potential to impact coastal and inland communities, established public health arrangements will be initiated which may involve the setting up of gold and silver command and STAC (Science and Technical Advice Cell) structures. Where such incidents pose a significant risk of airborne pollution, the STAC may additionally trigger an AQC (air quality cell) operated by the Environment Agency.

The appropriate government department or devolved administration responsible for environmental issues for the waters in which the incident occurs (Defra for England, for example) takes the lead in the commissioning of such work, which should be linked with any existing monitoring and assessment activities. The NCP suggests establishing an Environmental Impact Assessment Group at an early stage, transferring responsibilities from the EG so as to allow them to focus on providing advice to the response cells. This group would also be charged with obtaining funding for the impact assessment (including any impacts on public health) and long-term monitoring programmes. The NCP does not, however, go into further detail regarding the co-ordination of such a group or its specific monitoring activities, and that is the role of the Premiam guidelines and other processes implemented as part of the project.

There were, therefore, some important preparedness and capability gaps with respect to establishing and conducting an effective post-incident monitoring programme. In particular, there were no established expert guidelines in the UK for post-incident monitoring and impact assessment, nor was there a fully co-ordinated mechanism for overseeing the practical aspects of any programme (e.g. survey design, sampling, analysis and interpretation). The Premiam project was established to help address these issues. Although other, more locally based, documents exist (such as that developed previously for Wales), the Premiam monitoring guidelines are the first to be nationally focussed.



The effective adoption and implementation of the Premiam Guidance and associated management practices aims to strengthen monitoring and impact assessment activities in terms of:

- Speed – providing a faster response in order to gain early impact information and baseline data for areas under threat.
- Cost effectiveness.
- Identification and availability of the expertise needed for an effective monitoring programme.
- Use of best practice and the ability to learn from studies of earlier incidents.
- Improved co-ordination and integration.

The monitoring and impact assessment guidance is divided into two parts. Part 1 poses points to be considered, which are intended to aid the design and targeting of the monitoring programme, bearing in mind that there will be a large degree of incident and location specificity depending on the substance(s) involved in the incident and the habitats and resources at risk. Part 2 describes the tools that are available to realise the aims of the programme.

Much of the guideline document highlights the difficulty of obtaining absolute statistical proof that an impact has occurred, because the natural environment is so variable (both spatially and temporally), because the accidental nature of an oil or chemical spill does not allow for much experimental control and because suitable historical/baseline data are rarely available. The most useful and informative damage assessment studies have usually resulted from opportunistic situations, where very recent and good-quality baseline data happen to be available for an impacted resource; or where someone with appropriate expertise and technique is available and immediately begins studies on a sensitive resource. These situations are rare and most assessments have to work with inadequate baseline data.

The literature also suggests that useful insights on impacts have come more from good natural-history observation than detailed survey/monitoring analysis – recognising and correctly interpreting the signs and symptoms of unnatural effects and of the recovery process – even if proof was not achievable. The objectives of most damage assessments should aim to accumulate a weight of evidence using a range of methodologies, each of which will need to be tailored to the particular circumstances. Finally, it should be recognised that designing a monitoring programme is not a one-off event. Circumstances will change as an incident proceeds, particularly if it is protracted (as in the Deepwater Horizon subsea blow-out, for example) and the monitoring programme should evolve to meet changing aims. Logistics are also an important consideration.

- Expertise, equipment and capacity – many of the more technical studies will require specialist expertise and equipment and laboratory analysis of samples; large studies may stretch the availability of those resources.
- Tides and weather – survey timing will need to take account of tide times and weather.
- Access to sites – survey and sampling sites may be located in areas that are difficult to access or where access requires permission.
- Licences – some species are protected by law, and studies may require a licence from the relevant agency for any handling or collection.

DEFINING A MONITORING PROGRAMME

WHEN DO WE NEED TO MONITOR?

"When an incident is expected, or has the potential, to have a significant environmental impact."

This is related to the oil and/or chemical spilled, or that may be spilled, the quantity, the location and the resources at risk locally. It is a question that can be fairly readily assessed using inputs from modellers, chemists and ecotoxicologists from Cefas for England and Wales (or agencies such as the Agri-Food and Biosciences Institute or Marine Scotland Science in the devolved administrations of Northern Ireland and Scotland), backed up by natural resource information from the statutory nature conservation agencies (Natural England, Countryside Council for Wales, Scottish Natural Heritage and the Joint Nature Conservation Committee) and fisheries resource and activity information from the Marine Management Organisation or devolved administrations. It should consider physico-chemical properties (density, solubility, volatility, ability to bind to particles, persistence and reactivity), inherent toxicity to both wildlife (including aspects such as smothering and bioaccumulative capacity) and humans, and the likely movement of the material, whether as a coherent slick or not, in relation to the resources threatened. Initially, information on the actual severity of the incident may not be available. While worst-case scenarios rarely see a total loss of cargo and bunker fuel, this may be a good starting point for early modelling until more accurate information is available.

This process will also clarify the answers to the additional questions listed below, which will begin to focus the aims and extent of the monitoring programme.

- When species/habitats of nature conservation importance are likely to be impacted
- When commercial fish and shellfish stocks are likely to be impacted
- When contamination of the human foodchain is likely
- When an incident may have other human health implications

WHY DO WE MONITOR?

Possible aims might be:

- To assess the impact on species/habitats of nature conservation importance – for instance, in relation to the EU Birds and Habitats Directives
- To assess the impact on commercial stocks of fish and shellfish
- To assess the impact on the human food chain
- To inform fishery closure/re-opening
- To assess the efficacy of chosen response options
- To assess any impact on the local human population
- To provide public reassurance

However clear the direction of the monitoring programme is, there will also be a number of overlapping aspects to consider. Clouds of volatile chemicals close to centres of population with an onshore wind point towards impacts on the local human population, but may also impact species of nature conservation importance – fisheries and birds, for example. In major incidents, there will be considerable interest from the media and the public, who also need information to be provided in an appropriate manner. "Can I still eat fish?" is a perfectly legitimate question and should be answerable in a straightforward manner.

Finally, we have a statutory duty to do so. In transitional and coastal waters as defined by the Water Framework Directive (WFD) we have a statutory duty to ascertain the magnitude and impacts of accidental pollution to inform the establishment of a programme of measures for the achievement of the environmental objectives of WFD, and to identify specific measures necessary to remedy the effects. Also, under the Marine Strategy Framework Directive (MSFD), for waters at a greater distance from shore, we have an obligation to investigate the occurrence, origin and extent of significant acute pollution events and their impact on biota physically affected by this pollution, in order to assess the impact of the pollution events on Good Environmental Status within the affected region or sub-region.

WHAT DO WE MONITOR?

- Important commercial species of fish and shellfish
- Oiled and rescued birds, or birds likely to be impacted by a spillage
- Species/habitats of nature conservation importance
- Seawater and sediments
- Air
- Public health impacts
- The general state of the marine ecosystem

This is dependent on the concerns identified above.

WHERE DO WE MONITOR?

- Impacted areas
- Unimpacted areas nearby, which may be impacted later
- Unimpacted areas nearby, likely to remain so, as reference sites

Use of fate and transport modelling to predict oil/chemical behaviour helps to identify sites likely and unlikely to be impacted later. During an oil incident response (and possibly also during a chemical incident response, depending on the nature of the chemical), Shoreline Cleanup Assessment Teams (SCATs) are often deployed to systematically survey and document affected areas to provide a rapid and accurate geographic picture of shoreline oiling conditions. This information is used to develop real-time decisions regarding shoreline treatment and clean up operations. Initially developed 20 years ago following the Nestucca and Exxon Valdez oil spills, the SCAT approach has been used on many occasions worldwide. A SCAT manual is available from the Maritime and Coastguard Agency.

Overall this information will also be of use in identifying impacted and unimpacted areas and the degree of contamination at specific locations, which will be of use when defining and interpreting the results of a monitoring programme. All impacted areas should be considered for monitoring. Hence the scale of the impact will drive the scale of the monitoring programme, as was the case, for example, for the Braer and Sea Empress oil spills. Also, the outcome of modelling studies will help to define areas outside the currently impacted area which may be affected later. These should also be incorporated into the monitoring plan. The limits to which oil or chemicals might be transported will define the maximum size of the impacted area for the incident – areas outside the impacted area that are similar to those inside (in relation to sediment characteristics, species of fish and shellfish present, etc.) can be utilised as reference areas if there is no or little background information available from the area before the incident. Comparisons between impacted sites and reference sites or background information allow the impacts of an incident to be inferred. Habitat-sensitivity mapping, conducted prior to an incident primarily to help guide a pollution response, can also provide information useful in the selection of sites to be monitored.

HOW FREQUENTLY DO WE MONITOR?

- Frequently enough to follow changes in status.
- Infrequently enough to keep within the funding constraints.
- Time-series measurements at multiple sites are very valuable in following the development of impacts resulting from an incident, and recovery.

Contamination and degree of impact can increase rapidly during the initial stages of an incident, as the oil or chemical spilled will be present in the environment at the highest concentrations. These will be reduced over time by dilution, evaporation, dissolution, beaching and a range of other processes. Typically, levels of contamination by, for example, polycyclic aromatic hydrocarbons (PAH) from oils, rise rapidly, peak, and decline over a longer period. Bioaccumulated chemicals can be expected to follow a similar profile. This means that the frequency of monitoring is likely to be more intensive initially and scaled back over time to allow monitoring to be cost effective. In all post-incident monitoring, there is a balance to be struck between the frequency of monitoring and the level of funding available with which to undertake it.

DESIGN PROCESS

The following points describe a logical process for designing a survey of a natural resource:

01 Identify the natural resources for which there is concern and carry out reconnaissance surveys to assess the spatial extent and level of exposure to oil or chemicals.

02 Define the aims and objectives of the study – first understand clearly what question(s) are to be answered. Examples of typical questions and their consequences are given in Appendix 3 of the main guidance document. Bear in mind that many objectives will not require detailed studies, particularly if there are severe visible impacts. For many objectives, the results of the reconnaissance survey may be adequate and more detailed study is likely to be expensive. Conversely, for the more subtle effects, consider the realistic possibility that detailed studies may still not yield statistical proof that an impact has occurred.

03 Define the geographic scope, time limits and the scale of the study. A balance is needed here between the desire to understand the full extent of the effects in space and time and the imperatives of budgets and deadlines. A focus on the worst affected areas and typical timescales of effects, with an associated but less intensive strategy for the wider area, may be appropriate.

04 Examine information from past studies of the resource in the affected area or elsewhere to evaluate whether the methodologies used are appropriate for application to oil spill impact assessment, whether a modified methodology would work or whether a new methodology needs to be devised. Evaluation of the pre-spill data from the affected area should also be made to assess its usefulness as a baseline.

05 With the above in mind, select suitable parameters/attributes for measurement – ensuring that they are suitable for detecting relevant change, that they are technically and logistically feasible within the timescale of the study, and that they will produce reliable and reproducible results.

06 Select or design an appropriate method to obtain the necessary data, including preparation of detailed protocols to ensure quality and consistency, to agreed standards.

07 Analyse existing pre-incident data from the site or from similar resources to understand the potential levels of natural variability (temporal fluctuations and spatial patchiness).

08 Decide on the level of accuracy that is appropriate. A specialist in the resource, possibly with the aid of a statistician, will be able to interpret the available information on natural variability and advise on the consequences of under- or over-sampling. This will be particularly important if it is expected that the results of the study could be challenged in a legal or scientific forum.

09 Decide on a basic impact assessment strategy – i.e. whether to compare post-incident and pre-incident data, impacted and reference sites, follow recovery at sites impacted during the incident, or a combination of two or more strategies.

10 Consider the likely data analytical requirements – it is often advisable to get guidance on appropriate statistical methods and computer software packages before collecting data.

11 Decide how many impacted sites and reference sites to survey and/or sample, how many replicate samples/ records to take at each site and how frequently to carry out survey/sampling; taking into account financial constraints and the need for statistical rigour (see Point 8 above).

12 Decide or estimate the duration of the study – you may wish to monitor until levels return to a pre-defined baseline, but this may take a much longer or shorter time than you predict. Periodic interim evaluations of the data will help to refine the monitoring programme so as to keep its focus.

13 Define procedures for tracking samples/data and other chain-of-custody requirements. Confirm availability of sufficient specialist expertise and laboratory analysis capacity (particularly for large studies) (e.g. via the Premiam network, www.cefas.defra.gov.uk/premiam.aspx).

14 Prepare relevant health and safety risk assessments, organise logistics and plan work schedule generic assessments and procedures may already be in place in the relevant agencies. The SEG should be aware of these ahead of time, and the EG should be prepared to adapt them to meet the specific circumstances of the incident.

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18 Initiate survey.

It must be recognised that survey design is, to a large degree, an iterative process, as the monitoring programme must continue to meet current needs. Biological and chemical sampling and surveys are typically carried out by different personnel, to different protocols, and often by different organisations (due to their very different academic disciplines). Unfortunately, this may result in a lack of co-ordination between the collection of biological and chemical data, with consequent difficulties for comparison and correlation. Coordination is important to ensure that the data can be integrated and assessed together at a later date.

TOOLS FOR IMPLEMENTING A MONITORING PROGRAMME

As marine pollution incidents can involve a wide range of oils and chemicals, locations and local resources likely to be impacted, it is not possible to define a "one size fits all" programme which will cover all eventualities. Such a programme would of necessity, in any case, be very expensive, and it is likely that a more focussed approach could meet the aims of the monitoring programme whilst also being more cost-effective. The topic of when to cease monitoring is also discussed in the main guidance.

Initially, guidance is given on selection of sites for survey and sampling, sampling strategies and methods, chain of custody considerations and transport and storage. Chemical analytical methods are covered in general terms, but with such a wide range of chemicals transported by sea, the vast majority of which are not the subject of routine marine monitoring, it is impossible to provide full details. Availability of GC-MS and LC-MS analytical techniques should provide sufficient flexibility for methods to be developed for most compounds. Chemical fingerprinting techniques, particularly for oil, are covered in detail in an appendix to the main guidance, as many are not familiar with this branch of analytical chemistry.

There is a detailed section which provides specific guidance for the study of biological resources in eight broad habitats and eight groups of mobile species. These are terrestrial maritime habitats, saltmarshes, seagrass beds, intertidal sediments, rocky shores, lagoons, subtidal sediments and subtidal rock; and plankton, fish, seabirds, inshore waterbirds, wetland birds, seals, otters and cetaceans, respectively.

Ecotoxicology in post-incident monitoring is covered next, in water, sediments and biota (using biological effects techniques in order to determine exposure and impact of hazardous chemicals and/or oils). This includes a list of recommended techniques for use in post-incident monitoring programmes. Integration of chemical and biological effects monitoring, as currently being developed within OSPAR, is also briefly covered.

Taint-testing, collection and/or rehabilitation of affected birds is also described briefly, as are quality control considerations which need to be borne in mind. Another part of the Premiam project has been to establish a database of service providers able to assist with monitoring programmes, whether by provision of vessels, sampling (including collection of fish), analytical chemistry, ecotoxicology or predictive modelling, and the minimum expected requirements are listed in the guidance.

The compensation regimes and environmental damage regulations are also discussed briefly, and there is an extensive bibliography with 291 cited references to literature which has supported the development of the guidelines.

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