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**A whitepaper submission**

**Title:** Environmental damage: changing perceptions and future outlook

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**Abstract**

Over the last fifty years, increased global awareness of environmental issues has led to growing recognition of environmental stewardship as an essential component of economic development. This cultural shift was reflected in the 1992 revisions of the international oil pollution compensation Conventions, which incorporated direct provisions related to the reinstatement of environmental damage under the 'polluter pays' principle. In the United States, the 1990 Oil Pollution Act sought to achieve similar aims.

Since the adoption of these regimes, ITOPF has observed an increase in the proportion of spills following which environmental monitoring is conducted. In addition, during this period, the tools and methods with which changes in the environment can be detected and measured have evolved significantly. From ecosystemic function through to physiological responses to stressors at a sub-cellular level and at every scale in between, the science and technology to detect and measure these changes is now widely available.

With these tools at our disposal, several fundamental questions arise in respect of how we approach environmental monitoring. Focusing on accidental oil spills from ships, this paper will explore how perceptions of environmental damage have changed and explore shifts in the scope of environmental monitoring projects over recent decades.

This paper will seek to establish whether these trends have ultimately improved our understanding of environmental damage, recovery and the need for reinstatement measures – the over-riding objectives of any post-spill monitoring effort. Looking to the future, suggestions will be made on how the spill response community can build on past experience to ensure post-spill monitoring continues to focus on these principal aims.

**Introduction**

2018 marks ITOPF's fifty year anniversary. The organisation was established in the wake of the TORREY CANYON incident off the British coast, which resulted in a spill of 119,000 tonnes of crude oil and represented the first major oil spill from a new class of supertankers. The unprecedented magnitude

of the spill highlighted significant organisational and technical deficiencies in preparedness for such incidents. The event prompted intergovernmental organisations, national authorities and the shipping industry to urgently revise oil spill contingency measures and compensation provisions to mitigate the environmental and economic effects of future spills.

The reaction to the TORREY CANYON incident and its consequences reflected a wider and growing international realisation of the negative impacts human activities can have on the environment and the importance of sustainable resource use and environmental stewardship. Today, these concepts are an integral component of sustainable development, under which the precautionary approach and the polluter pays principle are well-established and widely applied.

Decades of concerted effort from industry and governments resulting in numerous international agreements and standards which sought to prevent, prepare for and reduce the environmental and economic impacts of maritime incidents have led to a dramatic decline in the frequency of oil spills (Figure 1). This increased emphasis on environmental protection was encapsulated in the 1992 revision of the international Conventions addressing liability and compensation for ship-source oil pollution, the Civil Liability 1969[1] and Fund 1971[2] Conventions, which incorporated explicit provisions addressing environmental damage.

The international maritime community that were a party to these Conventions undertook a wider review of the international regime in the early 2000's, leading to the adoption of the 2003 Supplementary Fund Protocol, including provisions for environmental damage already established under the Civil Liability and Fund Conventions. The publication of the IOPC's supporting Claims Manual sought consistency in the system's interpretation and application by clarifying the core principles enshrined within the Conventions.

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[1] International Convention on Civil Liability for Oil Pollution Damage 1969
[2] International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 1971
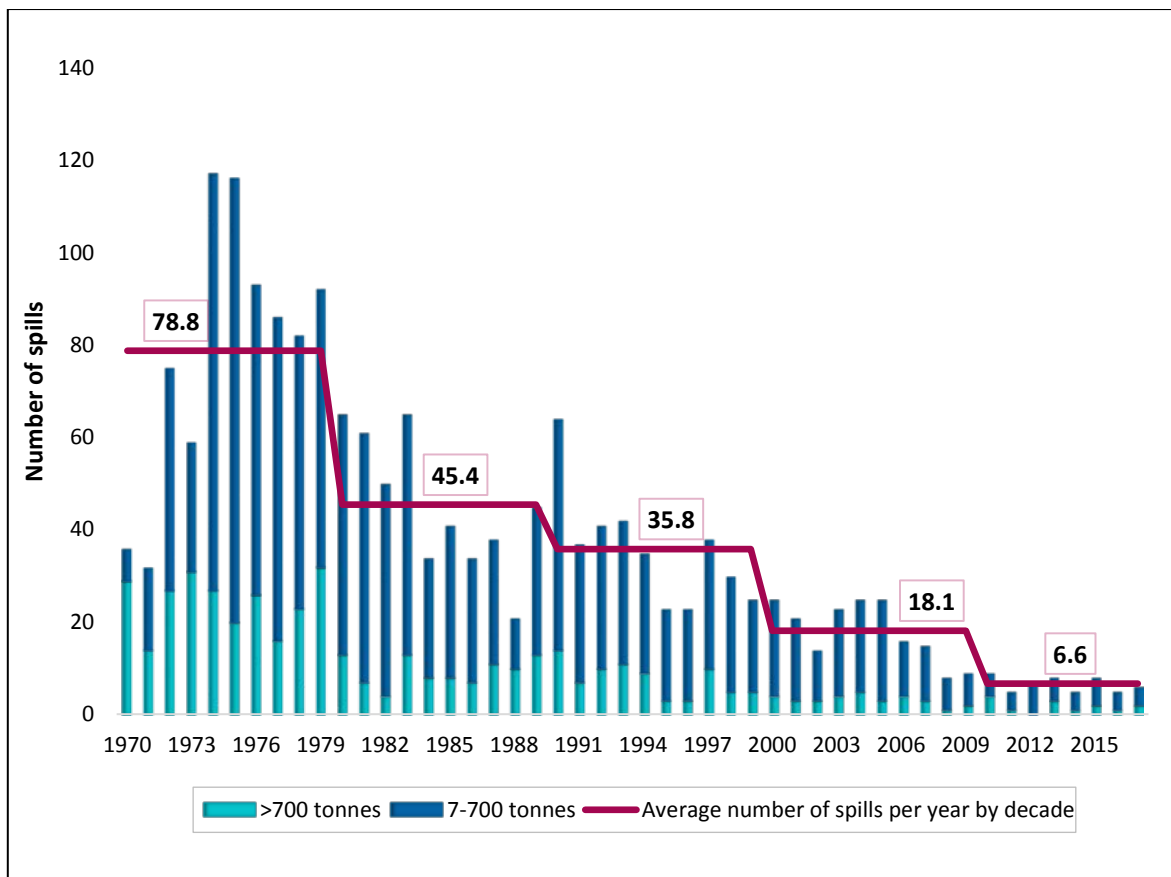
**Figure 1 Number of tanker spills by year > 7 tonnes (source: ITOPF database).**

Outside the scope of these Conventions, which solely address releases of persistent oil from tankers, the Bunker Convention 2001[3] provided a framework governing pollution damage arising from the release of bunker fuel from ships. The scope of compensation for environmental damage under the Bunker Convention is modelled on the definition of 'pollution damage' conceived under the CLC and Fund Conventions.

Under this definition, these IMO Conventions (hereafter referred to as 'the international compensation regime') provide compensation in relation to loss of profit resulting from impairment of the environment, and costs of reasonable measures of reinstatement, including post-incident studies. The Claims Manual clarifies that such reasonable reinstatement measures should be aimed at accelerating natural recovery of the damaged components of the environment, and may include measures taken at some distance from, but still within the general vicinity of, the damaged environmental component. In this sense, the international regime places great emphasis on measuring observable effects (via post-incident monitoring) and *in-situ* reinstatement. In cases where

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[3] International Convention on Civil Liability for Bunker Oil Pollution Damage 2001

in-situ treatments are not feasible, the Conventions call for geographic connectivity between adversely affected sites and those earmarked for reinstatement projects, thus ensuring efforts are focussed on remediating the actual effects of the spill. Based on the fundamental principle that most marine environments (especially in coastal areas) are resilient to adverse acute disturbances, such as oil spills, and are able to recover over time, the IMO Conventions do not address temporary 'losses' related to non-market human use or ecological services during the recovery period.

In the United States, provisions under the Oil Pollution Act 1990 (OPA '90) addressing environmental damage bear resemblance to the IMO regime, with some notable differences. Under OPA '90 restoration ranges from primary to compensatory, i.e. compensation is provided for actions taken to restore or accelerate recovery of impacted natural resources to an individual level (rather than population) as well as the public's lost use of natural resources during the period for which the environment is undergoing recovery. In this regard, natural resource trustees play an important role in assessing the extent of impact and restoration needed through a process called Natural Resource Damage Assessment (NRDA). The objective of NRDA is to return injured natural resources and services to baseline, prioritising restoration actions that provide the same type and value as those that have been lost.

In 2004, the Environmental Liability Directive (ELD) was adopted in order to establish a common framework for the prevention and remediation of environmental damage within EU Member States. Under the ELD, environmental damage is defined as damage to protected species and natural habitats, water damage and land damage, for which three types of remediation are provided: 1) Primary remediation, i.e. clean up and preventive measures, and remediation measures at the damaged site; 2) Complementary remediation, i.e. remediation measures at other sites and 3) Compensatory remediation, i.e. remediation to account for interim losses (akin to provisions under OPA '90) whilst primary and complementary remediation take effect. The ELD does not apply to ship-source spills covered by the IMO international compensation Conventions, where these are in force.

With a view to meeting the requirements set out by the various legal regimes discussed above, extensive research in the fields of environmental management and marine biology has greatly improved our understanding of the impacts and responses of the environment to oil spills. Dramatic improvements in technology have enhanced our ability to detect and measure a plethora of parameters at higher resolutions, thus opening new options in post-incident assessment. In some cases, these advances have significantly altered the focus of damage assessment and, as a consequence, the perception of what constitutes damage.

This paper will provide a review of established protocols in damage assessment, the challenges typically faced and emerging trends. It explores post-incident monitoring protocols adopted internationally and how these seek to achieve the objective of evaluating damage, as a means of tracking and, where possible, accelerating the recovery of affected environmental components.

**A note on environmental valuation methods**

Experts have been debating how to value the environment for over fifties years. As will be explained in subsequent sections, historically valuation has been attempted in purely monetary terms, although more recently the focus has shifted to seek more holistic approaches to valuing the environment. Broadly speaking, the value of the natural environment has traditionally been categorised into use and non-use values. These categories can be further subdivided into direct, indirect, options, existence and bequest values. Direct and indirect values can more or less be quantified by market methods. Options, existence and bequest values utilise non-market methods. An ecosystem or particular environment that may have been impacted by an event such as a spill can be valued by monetary and non-monetary methods. The three main categories for methods to quantify or value environmental damage are market and non-market valuation methods and service-to-service scaling methods. This latter method estimates a proportion of a habitat or ecosystem service that has been lost or damaged and restoration aims to restore this component to pre impact conditions. Under the IMO regime, liability for damage to the environment relates to "actual costs undertaken or to be undertaken for reinstatement". In essence, this allows for service to service restoration methods to be applied. It also allows any market-use losses to be restored or compensated. Non-market valuation methods however, are not admissible under the IMO regime.

Traditional non-market valuation methods depend on either revealed preferences or stated preferences of a group of individuals (a group is asked to hypothetically value environmental services in monetary terms). Revealed preference methods include the travel cost, hedonic pricing and market price methods (what are the estimated values or ecosystem products or services which can be traded in commercial markets). Stated preference methods include contingent valuation (based on willingness to pay / accept) and stated choice method. The stated choice method uses a similar approach to contingent valuation but uses a person's trade-off choices instead of their willingness to pay. These methods are subject to large assumptions and resulting data are highly subjective. In theory, the same method could be applied to the same location and resource but the derived value could differ hugely. Results are highly dependent on asking questions rather than observing actual behaviour and so the demographics of selected respondents, and other influences, such as the time

of year, media coverage, public perception of an issue, etc. exert a large degree of influence on results. Over the years, this approach of assigning pecuniary values to the benefits provided by the natural environment has become increasingly discredited. Although still technically admissible under OPA '90, the approach is losing favour due to its variability making it difficult to defend from a legal perspective.

**Quantification of damage using abstract methods**

The need to assess the environmental effects of marine oil spills is influenced by a variety of factors, such as the conservation status of the affected habitats and species, the economic value of affected resources or the cultural, societal and political context within which a pollution event has occurred. As each of these factors change over time, the standards by which environmental damage is defined and the means by which it is measured are also subject to change. Historically, the use of abstract models to calculate environmental damage following spills reflected the widely-held belief that a spill inevitably resulted in long-term or irreversible damage. This assumption is implicit in models utilised internationally, such as the CETESB formula (Brazil) or Metodika (Russian Federation), both of which assign multipliers to a range of factors, including the volume of oil spilt and the general sensitivity of potentially impacted shorelines. More than 40 years of spill experience and research in marine ecology have demonstrated that the pathway to actual impact is, in reality, much more complex.

Broadly speaking, the severity of impact to the environment following a spill is dependent on the physical and chemical characteristics of the released oil, the ambient conditions following the spill and the vulnerability and sensitivity of the local environment. Each of these factors is influenced by a multitude of variables specific to a given spill incident. Since the interaction of these variables is virtually impossible to simulate, the generalisations and assumptions implicit in abstract models seeking to quantify environmental effects inevitably lead to a misrepresentation of the actual effects of a given spill.

While all spills alter the physical and chemical environment to varying degrees, ultimately, environmental impairment is measured on the basis of significant adverse effects on the ecology of an affected area. An organism's vulnerability, i.e. its likelihood of exposure to oil pollution, and its sensitivity to oil once exposed will depend on the physiological and behavioural characteristics unique to a given species. For example, sessile intertidal invertebrates such as mussels or barnacles are generally at greater risk of exposure than mobile fish species, which are known to exhibit avoidance behaviour to oil dispersed in water. Once exposed, the severity of the impact will depend on the organism's capacity to tolerate the chemical effects of oil within its tissues and/or cope with the physical effects of smothering. In some cases, the exposed organism may simply depurate its tissues

of oil without appreciable sub-lethal effects. In others, the effects of exposure may lead to mortality, which, depending on the number of individuals affected, may result in adverse population effects.

In this regard, it is important to recognise that populations of marine organisms naturally fluctuate, spatially and temporally, depending on the intrinsic characteristics of individual species and how they respond to their immediate physical, chemical and biological environment. Many marine species have evolved physiological, behavioural and life-history traits required to cope with unstable environmental conditions prevalent in marine habitats. Short-term disturbances such as storms or algal blooms routinely result in mass mortality events, from which populations are generally able to recover rapidly. This is primarily a consequence of reproductive strategies involving high energy investment in spawning, resulting in rapid recruitment from neighbouring areas once favourable conditions return. This capacity for rapid population recovery following natural disturbances is equally applicable to short-term anthropogenic disturbances such as oil spills. In the event of chronic exposure of populations to oil, or if the oil impacts populations of organisms with slower reproductive rates, such as marine mammals or seabirds, recovery will be protracted. In such cases the level of mortality of adults greatly influences the recovery period. The SAN JORGE spill off Uruguay in 1997 is one of very few oil spills following which significant impacts on mammals, in this case South American Fur Seals, was recorded. This spill of crude oil resulted in the death of several thousand fur seals pups on Isla de Lobos. The relatively small percentage of observed adult mortality, the fact that total mortality was within the range of background levels and that local fishermen participated in an annual cull of pups to mitigate depredation on their target species resulted in rapid recovery of the population.

The above discussion highlights the inherent complexity in quantifying any lasting environmental effects of oil spills. In this sense, the simplicity of abstract models relieve the burden of quantifying spill effects via empirical studies, providing a faster means of calculating monetary compensation to be levied from the polluter, appears attractive. On the other hand, since such models fail to quantify the extent of actual damage, compensation cannot be meaningfully utilised to repair the damage caused by the spill and are often directed towards unrelated activities.

The absence of scientific rigour implicit in abstract calculation and, most notably, its failure to recognise the fundamental concept of environmental recovery has increasingly led to widespread criticism, prompting a clear shift towards empirical measurement among national authorities. This has resulted in a growing number of countries incorporating requirements for post-spill impact assessment, through empirical studies, into national legislation (Reynolds, 2015).

As previously highlighted, internationally the texts of the CLC and Fund Conventions do not provide a clear definition of environmental damage following spills. In practice, this acknowledges the

uniqueness of each individual spill and allows flexibility dependent on the particular issues associated with each incident. However, provision for environmental damage is implicit in the scope of compensation available which is limited to 'costs of reasonable measures of reinstatement'. The IOPC Fund's claims manual supporting the international compensation regime clarifies that:

> "the aim of any reasonable measures of reinstatement should be to re-establish a biological community in which the organisms characteristic of that community at the time of the incident are present and are functioning normally" (2016 edition - para. 3.6.4.)

On this basis, the international compensation regime identifies population and community level impacts as the basic unit of measure for assessing environmental impairment, its recovery and the need for reinstatement. The Conventions therefore set the threshold of relevant environmental damage to a level that can be practically measured (population and community-level effects are easier to measure), with a strong emphasis on reinstatement via practical measures.

This focus on reinstatement clearly signifies a positive progression from abstract methods of quantification discussed above, most notably, because compensation can be directly channelled towards the damaged components to monitor and/or enhance natural recovery. However, as discussed above, the inherent complexity of natural systems and the multifaceted, unpredictable nature of oil spills make environmental assessment a challenging enterprise. The following section provides an overview of some of the challenges typically faced in the design and implementation of post-incident studies and reinstatement.

**Post-incident monitoring studies: moving beyond abstract methods**

The methods used to establish environmental impacts resulting from ship-sourced oil spills vary from country to country and sometimes, case by case. In the absence of protocols to evaluate damage following discrete and unforeseen pollution events, it is common for those wishing to undertake an assessment to draw on existing protocols used for other purposes. Traditional Environmental Impact Assessment (EIA) is widely used as a tool to evaluate the environmental effects of proposed projects to promote environmental protection and aid decision-making. While EIA practitioners are able to fully examine and mitigate adverse environmental effects by quantifying pre-existing environmental conditions prior to a planned development, post-spill studies rarely have the benefit of relevant baseline data for comparison. Methodologies rooted in classical experimental design, requiring rigorous controls and sufficient statistical power to detect change are, therefore, very seldom possible. Where baseline data are available, they frequently consist of a collage of different studies

employing an array of methodologies covering spatial and temporal intervals that typically do not align with those of interest following a spill. In ITOPF's recent spill experience, regulations mandating that areas vulnerable to pollution such as ports or oil terminals undergo continual monitoring, and can generate usable reference data in the event of a spill. Generally, these provisions focus on water quality in relation to human health and broader resource management, with the study parameters usually consisting of those intended to monitor contaminants in sediment and biota, rather than detailed ecological data. When such standards are applied following a spill, it is common for studies to consist of sampling and analysis of not only oil concentrations, but a wide array of water quality parameters unrelated to oil pollution, such as pH, salinity, coliforms and heavy metals. Whilst the need for adherence to national and regional standards, such as those provided by the EU's Water Framework Directive[4] is recognised, transferring the use of such protocols in their entirety (i.e. including aforementioned parameters unrelated to oil spills) and without flexibility to the context of an oil pollution incident, could lead to misinterpretation of results and the misplaced conclusion that a spill has impaired the normal environmental functioning of the area under observation.

In areas of special scientific or conservation value, such as Ramsar sites or marine protected areas, relevant ecological studies may have been undertaken by conservation agencies, universities or research institutes, which can serve as a baseline for post-incident studies. A more common scenario however is for suitable reference sites of comparable character to be chosen, to establish a baseline in general terms. In cases where neither reliable baseline data nor suitable reference sites exist, monitoring of conspicuous biological effects in relation to diminishing hydrocarbon concentrations, as a means of tracking recovery, may also be appropriate.

In the event of a shipping casualty where no spill has yet occurred, ephemeral data collection (including both chemical and biological sampling) in areas that have the potential to be impacted by the spill, may be undertaken. The primary drawback of this approach is that these data merely represent a 'snapshot' of conditions that do not reflect background population fluctuations. As a result, establishing a viable link between an incident and its environmental effects, independent of background variation, may be challenging (Hook, 2016).


**Scope and design of post-incident monitoring studies.**

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[4] The WFD, adopted in 2000 was an aim to harmonise and unify the patchwork of legislation governing all aspects of water quality throughout Europe at the time: http://ec.europa.eu/environment/water/water-framework/index_en.html.

Many countries have adopted sector-specific monitoring guidelines and the EIA process is well-integrated. However, in the case of oil spills, few countries have adopted oil spill specific environmental monitoring guidance. A notable exception is the UK which has developed and adopted under its national contingency plan (NCP), specific post-incident monitoring guidelines. The PREMIAM guidelines[5] were developed to enable a standardised and coordinated approach to post spill monitoring, whilst allowing flexibility to enable each project to be case specific and scaled up or down dependent on the scale of the incident and sensitive resources at risk.

The first consideration is deciding whether it is actually necessary to conduct an assessment. Not all spills will have the potential to cause significant damage, and it is important to acknowledge this. The PREMIAM guidelines advise that monitoring should be considered when contaminants have the potential to enter the human food chain or pose other risks to human health and/or if species and habitats of conservation or commercial significance are likely to be adversely affected.

Whilst the pressure and timeframes for post-incident studies may be significantly greater than for under traditional EIA for planned developments, initial scoping is an essential component of setting realistic aims for the study.

Environmental concerns often underlie the need for clean-up measures following oil spills and, as such, effective response measures are actually part of the restoration of a site. A considered scoping phase enables early communication to be established between various stakeholders who may have information or be able to provide assistance in meeting the objectives of the monitoring study, including those integrated within the response structure.

A considered scoping phase also allows proper consideration to be given to the experimental design of the study. Establishing the link or causality between a specific environmental stressor and impairment of an ecological system is a well acknowledged and considerable scientific challenge (Marshall-Adams, 2003). The difficulty lies primarily in the intrinsic natural variability of marine environments, or the existence of other anthropogenic stressors, which obscure the true effects of a given spill. As a result of these factors, causality cannot be determined with absolute certainty, but a 'weight of evidence approach' employing a combination of appropriate methodologies to meet several "causal criteria" or rules is a widely accepted approach (Law *et al*., 2011; Suter & Cormier 2013).

Depending on the individual circumstances of a pollution incident, this may include sampling of hydrocarbon concentrations in environmental media (i.e. water and sediment), alongside samples

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[5] https://www.cefas.co.uk/premiam.aspx?RedirectMessage=true

taken from the pollution source, for comparison via forensic techniques such as Gas Chromatography Mass Spectrometry (GC-MS). Ecotoxicological analysis of biota may also be reasonably undertaken in situations where commercially-exploited species are at high risk or where there are concerns of long-term exposure resulting in adverse population effects. It is important to note, however, that population and/or community impacts should not automatically be inferred from ecotoxicological data, but rather such data should be used with the support of suitably tailored population studies, where these are deemed feasible.

In recent years, ITOPF has noted a tendency towards altering the scope of damage to scales beyond those widely regarded as relevant in terms of ecosystem services. Several cases in the US, and more recently elsewhere, identify a trend towards examining individual-level effects (which is warranted under OPA '90 but not under the international compensation regime), in place of population and community-level impacts, as the basis for damage assessment. This shift in the perception of what constitutes damage is driven by a number of factors. Fundamentally, the will to 'put things right' and, to a certain extent, the underlying misconception that any oil released to the environment inevitably leads to damage and, as such, should be compensated. Advances in science and technology, which provide the tools for detection of a range of sub-cellular, cellular and physiological effects are another contributing factor to this shift. Reframing the scope of relevant damage to individual-level effects bypasses the difficulties associated with establishing causality between a given spill and population/community-level effects. Although this certainty may satisfy a number of stakeholders, pursuing such studies without of confirmation of wider ecological effects does little to further our understanding of the effects of spills on ecosystems.

**Restoration/ reinstatement**

Reinstatement[6] of damaged environmental components, whether through a combination of human intervention and natural recovery or solely by natural processes, is the central objective of the damage assessment process. As such, the natural progression from post-incident monitoring studies is to utilise data gathered during the assessment phase to consider whether reinstatement through human intervention is necessary or feasible. The weight of evidence approach to designing a post-spill monitoring project enables detection of any changes to ecosystem or habitat functioning, which facilitates the design and implementation of appropriate reinstatement measures.

With the exception of effective clean-up measures, which are sometimes overlooked as a reinstatement measure, restoration measures targeted at actual damage is rare in the aftermath of spills. This is, in part, due to the fact that in many cases, post-incident studies reveal no discernible

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[6] Restoration and reinstatement are used synonymously throughout this paper.

impacts and/or the fact that natural recovery of populations occurs within a relatively short time period that precludes the need for further intervention.

In recent oil pollution incidents in the US there has been a shift in focus from primary restoration (i.e. the restoration of resources directly affected by a spill) towards the concept of 'off-site' compensatory restoration. At first glance, this notion of 'off-site' restoration to restore the ecological services impaired by a spill, bears some resemblance to the international compensation regime accept 'off-site' restoration of areas provided tangible spatial connectivity is maintained. However there are several fundamental differences between the two approaches. Compensatory restoration is based on the interim loss of ecological services as the injured component returns to baseline. The objective is therefore to estimate the ecological value of an injured component, with a view to establishing how much of an equivalent component must be created to compensate for the deficit in services. Of the methods used under this principle, Habitat Equivalency Analysis (HEA) is more commonly utilised than Resource Equivalency Analysis (REA), which examines more discrete metrics such as species abundance.

A key assumption intrinsic to HEA is that the value of resource services is assumed to be constant over time. This assumption is particularly problematic in dynamic coastal environments, where changes in the condition of environmental components are frequent.  It is impossible therefore to predict that during the period of lost services, habitats/resources on both sides of the equation will not have been altered in some other way through, for example, hurricane damage or other anthropogenic stressors. The choice of metric upon which the return to baseline is defined is another key challenge, which greatly affects the outcomes of restoration and timescales involved. By comparison, the international compensation regime, which focuses on the reinstatement of actual damage resulting from an incident and therefore is not subject to such uncertainties, is far less problematic. Notwithstanding that the regime is intended to be applicable to a wide range of circumstances, there are few examples of restoration projects implemented in the aftermath of oil spills governed by the international compensation regime. This is probably attributable to a number of causes. The issues and complexities highlighted above mean that the post-spill monitoring and assessment process can be slow and disjointed. For simplicity and to reduce time and associated administrative burdens, in many cases, regulatory authorities may opt to go against the international regime and apply a monetary fine based on formulae reliant on either subjective concepts or simplistic models, such as those described earlier. Another reason is that the discipline of restoration of aquatic systems is in its infancy. Given the complexity of marine ecosystems and our limited understanding of them, there are currently significant limits to which environmental damage can be artificially repaired / restored. As a final point,

natural recovery processes in the aftermath of most oil spills are often such that restoration measures would yield no tangible benefits, and could indeed interfere with recovery processes.

Therefore, the data to support effective restoration of habitats in the aftermath of oil spills are few. Examples from the spills ITOPF has attended are for the most part, limited to mangrove replantation projects or to projects undertaken to reinstate physical damage, such as that incurred during clean-up. Following the SAINT THOMAS AQUINAS incident in the Philippines, mangrove replantation was undertaken by the local environmental authorities with the assistance of local communities albeit without a structured plan, objectives, or associated monitoring and evaluation phase. Mangrove seedlings were planted at random in unsuitable locations and the species did not reflect the assemblage typical of the area. ITOPF has found that in cases where restoration has taken place in the aftermath of a spill, projects have often been undertaken on a unilateral basis at a local level. This can result in a lack of awareness as to the existence of these projects by the wider oil spill response community. Furthermore results are frequently unmonitored or not disseminated.

Geist & Hawkins (2016) acknowledge that it remains unlikely that universally applicable approaches to aquatic restoration that work equally well in different habitats or regions will ever be identified. Nonetheless, they do identify some emerging core principles, three of which could relate to post-spill reinstatement, namely: i) reduce as many impacts as possible and harness natural recovery processes; ii) focus on ecosystem engineers, keystone species and habitat forming and shaping species or assemblages and, iii) in open systems, rely on natural recovery as far as possible, perhaps 'nudging' nature by enhancing successional[7] processes.

By adhering to these core principles, there are a number of examples of successful approaches from the wider field of aquatic restoration that might be applicable under the right circumstances in post-spill restoration. These include:

- Mangrove, seagrass or saltmarsh replantation where post spill monitoring indicates significant mortality;
- Removal of ghost fishing gear (discarded fishing gear that continues to fish without catches ever being retrieved) where notable spill-related = fish mortality (adults, juveniles or larvae) has been observed. The resultant increase in stocks could buffer any potential effects of oil spills on stocks where large-scale mortalities of juveniles or larvae were attributed to oil. Removal of derelict fishing gear has also been proposed as a restoration measure for seabirds following the DWH spill in the Gulf of Mexico as derelict fishing gear is currently responsible

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[7] The processes by which a biological community evolves over time. In this context, the evolution of the biological community in the aftermath of small or major disturbances.

for considerable mortality across a number of species.

- Introduction of mussels or removal of invasive algae in certain closed systems (ports, harbours and estuaries) that are subject to eutrophication and where the effects of a spill (or subsequent clean-up measures) result in a significant further decline of water quality.

However at present, in most cases, poor planning, vaguely defined aims and a lack of monitoring of the results of the restoration projects means that there is little information to guide future oil spill specific restoration projects. Consideration of current trends in the wider discipline of coastal and aquatic restoration provide two lessons which are often not considered in the post-spill damage assessment and restoration process:

- According to CIEEM (Chartered Institute of Ecology and Environmental Management ), EIAs should consider not only the negative, but also the potential positive impacts of a process or activity. For example, with regards to oil spills, this might include the effects of fisheries closures to preserve commercial species or the conservation effects of reduced footfall in a particular area.
- The removal of contaminants is normally considered a key component/technique in restoration projects. For example, the restoration projects for Muskegon and White lakes in Michigan to remediate decades of chronic pollution from terrestrial run-off included the dredging of thousands of tonnes of contaminated sediment as key activities (Steinman & Ogdahl, 2013; EPA, 2014). However, in relation to oil spills, the clean-up phase is rarely regarded as a restoration activity. A reason for this is that environmental authorities responsible for the resources at risk are rarely involved or integrated in the initial phases of a response (which is likely to fall under the remit of a different entity) and therefore do not see a site at its worst, before all the bulk oil has been removed.

In the past, many restoration projects have been unsuccessful due to a focus on individual components of the ecosystem rather than a more holistic aim to restore ecosystem functioning (Friberg *et al.* 2016). The recognition of the importance of natural recovery processes and addressing ecosystemic functional processes rather than individual species or components is important in the context of spill-specific restoration considerations.

**The way ahead/recommendations**

Over the last fifty years, the concepts of environmental management and EIA have become thoroughly ingrained both in our legal systems and in practice. Oil spills, by their nature, are generally unplanned and uncontrollable. This uncertainty means that every oil spill is unique and thus, the need for an

environmental damage assessment depends on the scale of the pollution, sensitivity and vulnerability of the affected natural resources, and general level of concern of authorities and the general public on a case-by-case basis (IMO 2009). Whilst the methods used to establish environmental impacts from ship-source oil spills may vary from country to country, and case to case, the need to remain flexible and iterative (accounting for new technologies and understanding) is key to post-spill monitoring and subsequent damage assessment. Nonetheless, based on discussions throughout this paper we make four recommendations to better harmonise the process between States that have adopted the International compensation regime:

1. **Recognise response and clean-up as part of the restoration process**

   Oil that persists in the marine environment has the greatest potential for long-term ecological impacts and, once removed, most populations and communities usually recover without further intervention (Moore, 2006). More generally, the removal of contaminants is a key principle of the reinstatement of degraded environments. It is unclear why, but in relation to oil spills the removal of oil through active clean-up operations is rarely considered to constitute restoration, despite these activities being frequently driven by environmental motivations. Post-spill studies should aim to account for the impact that response operations may have had in upon restoration of the ecosystem, habitat or species of concern to baseline (both positive and negative).

2. **Develop and adopt coordinated post-spill monitoring specific framework and guidelines, such as the UK PREMIAM guidelines**

   In the majority of cases that ITOPF has attended internationally, institutions rarely give due attention to scoping post-spill monitoring properly, leading to studies with vague or unrealistic objectives.

   This can often be attributed to the socio-political and time pressures following an incident, a lack of familiarity with environmental assessment outside of established protocols such as EIA, as well as the lack of post-specific guidelines or frameworks to guide this phase.

   We have acknowledged throughout this paper that post-incident monitoring studies differ from EIAs for planned projects in several ways, but their ultimate goal is the same. Activity or sector specific EIA guidelines have facilitated standardisation of EIA processes and integration within regulatory frameworks. Currently, processes for post-incident monitoring are not harmonised between States party to the international framework of compensation. Wider development and adoption of post-incident specific guidelines, similar to the UK PREMIAM guidelines that are nonetheless, in line with national capabilities could facilitate the assessment of potential

ecosystem impacts from oil spills and better inform the design of specific and measurable restoration measures should the assessment process find these to be necessary.

3. **Engender a collaborative approach between scientific institutions and the formal response structure.**

   In the US, the Environment Unit is a formalised cell within the overall response structure and is activated as part of the response, tasked to review and analyse existing environmental data. In the initial stages of a response, its aim is to aid planning and operations to reduce and mitigate adverse impacts where possible. Similarly, following the active phase of a response, the Environment Unit has responsibility for coordinating post-spill monitoring. In the UK, this function is .formalised under the NCP where the Standing Environment Group (EG) is comprised of a network of core experts throughout the UK. The Environment Group is convened in the immediate aftermath of an incident and provides advice to all levels of the response organisation, throughout the active response. During the post-spill monitoring phase, the EG remains active and provides advice following the PREMIAM guidelines.

   States should seek to appoint a standing panel of objective experts to advise on spill related environmental issues. By appointing people on a long term basis, they are able to build experience and understand the difference between general environmental management and the issues specific to oil spills. These groups should be formally incorporated into the response structure from the start (either remotely or physically, situation dependent).

4. **Shift focus to understanding restoration/reinstatement rather than quantifying damages.**

   Historically, there has been little exploration of the legal notion as to the nature of quantification of environmental damage and what constitutes environmental harm. This gap, coupled with the heavy focus on the polluter paying for damage caused by their activities, has resulted in academic research geared towards methodologies that quantify environmental damages in monetary terms. The ultimate purpose of environmental liability and stewardship frameworks is to safeguard the environment and its resources for the future. In ITOPF's experience from oil spills, the emphasis on the pecuniary quantification of damages detracts from this goal. Rather, research efforts would be best placed in seeking to understand the mechanisms associated with post-spill recovery and the relative impacts of relevant restoration projects. In other fields, recognition of the need to document the outcomes of aquatic restoration efforts better is growing. For example, the UK's Environment Agency maintains a

website that hosts case studies of river basin restoration projects from 31 countries across Europe[8] .

As evidenced by ITOPF's spill statistics, the shipping community has come a long way in fifty years in preventing, mitigating and remediating oil spills. Fifty years after the TORREY CANYON and after ITOPF was established in recognition of the need to take responsibility for our activities, society continues to adopt an increasingly zero tolerance approach to pollution events. New challenges emerge and it is important that technological advances and our greater understanding of impact dynamics are translated into practical means of meeting these challenges rather than focussing on simpler, faster, but abstract or theoretical approaches of quantifying perceived effects into pecuniary reimbursement. If money available to compensate environmental reinstatement is spent on arbitrary bases rather than invested in understanding recovery dynamics and the impact of restoration projects, we will never further our understanding on how to best protect the environment – the ultimate goal of the comprehensive international legal frameworks that have developed over the last 50 years.

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[8] https://restorerivers.eu/wiki/index.php?title=Main_Page

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