Natural Resource Damage Assessment & Restoration (NRDA&R)

United Nations Environment Programme **(UNEP) Manual**

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I. Introduction

NRDA&R background - In the event of a significant pollution incident such as an oil spill, noxious chemical spill, or other hazardous substance spill into the environment (freshwater, coastal, marine, or terrestrial), governments have several important obligations in the exercise of their sovereign trust responsibilities. The overarching government responsibility is to protect the welfare of its citizens and the environment to the extent possible. Response objectives include the prevention of further release of a pollutant (e.g. offloading the remaining oil from a grounded tanker, securing a vessel from further damage, etc.); containment and recovery ("cleanup"), protection of sensitive habitats and resources, and the protection of health and welfare of citizens. There are several excellent manuals from IMO and ITOPF that address these issues in detail (see publications online at www.itopf.com; www.imo.org; etc.).

In addition to the emergency response, containment, and clean-up efforts, governments also have an obligation to assess the environmental injury caused by the pollution incident and to assist in the recovery of the injured environment. [Note: A distinct but important component of a government's obligation in responding to environmental disasters is assessing the damage to human societies – often referred to as *socio-economic injury*. A detailed discussion of socio-economic injury assessment is beyond the scope of this manual.]

In small-scale pollution events, the natural resource damage assessment may be unnecessary or, at most, limited and qualitative. In the event of a large-scale pollution incident with the potential to cause substantial environmental damage, a government should assess injury with a methodical, comprehensive and quantitative scientific investigation covering all components of the potentially injured ecosystem - this is called *a Natural Resource Damage Assessment*, or *NRDA* program. In addition, a government also has a responsibility to assist, to the extent practicable, the recovery of an ecosystem injured by pollution - this is called *Restoration*. The purpose of this manual is to provide an overview of both of these inter-related processes. As such, the primary target audience for this manual will be government agencies with responsibility for managing and protecting natural resources in member states. These are the institutions whose obligations include the prevention and response to environmental disasters (such as hazardous spills), assessment of environmental injury, and environmental restoration. They would include, for instance, state and provincial governmental agencies such as Ministries of Environment, Fisheries, Wildlife, Science, and so on.

There are four primary purposes for a government to conduct an NRDA program subsequent to a significant pollution incident, as follow:

1. to determine the extent and severity of ecological injury

2. to inform citizens, particularly those in the affected area, in a transparent and accurate manner, of the extent of environmental injury

3. to provide detailed information upon which to base financial claims against the Responsible Party

4. to develop and implement a Restoration program

The comprehensive assessment of injury to natural resources held in trust by a sovereign government requires consideration of immediate (acute) injury and mortality, sub-lethal (chronic) injury, long-term injury, and ecosystem-wide / cumulative effects. In general, all components of the potentially affected ecosystem should be assessed for their response to the pollution event, including coastal habitat, air and water, sediments, plants, plankton, fish, shellfish (and other invertebrates), mammals, birds, and other sensitive species and habitats. Every attempt should be made to mobilize a comprehensive NRDA program as described in this manual. If however it is not practical for a government to mobilize a comprehensive program, then a government should at least conduct what studies it can. The point here is that some damage assessment studies, even if limited, are better than no studies at all.

International Regime for Pollution Compensation - Overview

It is beyond the scope of this manual to discuss issues of legal liability and pollution compensation in detail, as these are discussed in several other documents (see IPIECA / ITOPF, 2004; ITOPF, 2004; www.iopcfund.org; www.itopf.com; etc.). But as the international oil spill compensation regime provides the framework within which damage claims are to be assessed, presented, and paid, a brief overview is presented here as background.

Under the conventions adopted within the International Maritime Organization (IMO), there exists a three-tiered regime to provide compensation for "persistent" (crude) oil pollution in the majority of maritime nations:

1. 1992 Civil Liability Convention (CLC), [1992 International Convention on Civil Liability for Oil Pollution Damage] providing strict spill liability limits up to approximately $131 million (US) to be paid by a shipowner and/or its insurer (P&I Club);

2. 1992 Fund Convention, [1992 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, or IOPC Fund] a fund providing up to approximately $296 million (US) to cover claims over and above a shipowner's CLC liability limits; and

3. 2003 Supplementary Fund, a newly established fund providing up to approximately $1,115 million (US) to cover claims over and above those covered under the CLC and the 1992 Fund.

Thus, if damage claims in member states exceed the CLC liability limits (tier I), then the 1992 Fund (tier II) is available to cover the additional amounts, and if claims exceed the amount available through the 1992 Fund, then the 2003 Supplementary Fund (tier III) is available. In the U.S., the spill liability regime set forth by the Oil Pollution Act of 1990 (OPA 90) is substantially different than that of the international regime, and as it is specific to U.S. waters and does not apply to other maritime nations, it is not discussed here.

Beyond the conventions covering oil pollution discussed above, two other conventions have been adopted to cover damage from other pollutants, but are awaiting sufficient ratification to enter into force:

1. HNS Convention, - the Hazardous and Noxious Substances (HNS) convention was adopted in 1996 to cover damage from ships carrying "hazardous and noxious substances" - chemicals, petroleum products, LNG, LPG, hazardous bulk solids, etc. Like the 1992 CLC and 1992 Fund conventions, the HNS convention provides a two-tiered structure to cover damage - the first tier is strict liability for a shipowner / insurer up to about $136 million (US), and the second tier is the "HNS Fund" to cover additional amounts up to about $340 million (US).

2. Bunker Spills Convention - adopted in 2001 to cover damage from heavy bunker (fuel) spills from non-tank ships.

Under the three-tiered oil pollution conventions (CLC, IOPC Fund, and the Supplementary Fund), any person, business, or government in a nation which is party to the conventions who suffers damage from an oil pollution incident is entitled to claim compensation from the ship owner, its insurer (e.g. a P&I Club), and/or the Funds.

Pollution damage is defined by the Conventions as:

> *the loss or damage caused outside the ship by contamination resulting from the escape or discharge from the ship, wherever such escape or discharge may occur, provided that compensation for impairment of the environment other than loss of profit from such impairment shall be limited to costs of reasonable measures of reinstatement actually undertaken or to be undertaken.*

Claims covered by the Conventions include 'reasonable preventive measures' to minimize pollution damage, property damage, costs of clean-up operations at sea and on shore, disposal of collected material, economic losses by fishermen or those engaged in mariculture, economic losses in the tourism sector, costs of studies, and environmental damage. Claimants can be anyone who suffers pollution damage, including private individuals, partnerships, businesses, private organizations or public bodies, including states and local authorities. To receive compensation, claimants must provide sufficient documentation to support the estimation of loss or damage suffered.

The two distinct but often overlapping categories of claims are as follow:

1. financial losses - individuals, fishermen, fish processors, tourism businesses, and governments (local, provincial, and/or national) may incur financial (economic) losses that should be documented and presented for compensation. This can include lost revenue caused by the pollution incident, loss of earning capacity, property damage, increased costs of services, government costs incurred in responding to the event, and so on.

2. environmental / natural resource damage - beyond direct financial loss, a government has the responsibility to assess injuries to the natural resources within its jurisdiction and is entitled to collect damages as specified under national laws and international conventions to which they are a party. This is one of the rationales for conducting a NRDA program. For practical purposes, damage documentation and substantiation in large pollution events often becomes the responsibility of government. In many instances, results from a government NRDA program will provide information useful in the support of private claims in addition to government claims for financial and environmental losses.

Thus under the conventions, a government has the opportunity / responsibility to receive compensation for both environmental injury as well as financial losses. For environmental, or "natural resource", damage claims, the international Conventions also recognize that in certain instances it is possible to enhance natural recovery, and thus costs of "reasonable reinstatement measures" are covered. For purposes of this manual, this process is termed *Restoration*, and is used in a broad sense. Following a pollution event which causes significant environmental injury, the development and implementation of a Restoration program is a fundamental trust responsibility of all governments. The government *Restoration* program is based upon the findings of the *Natural Resource Damage Assessment*, and costs of conducting the NRDA&R program are generally considered to be an admissible claim. Restoration is discussed in some detail in section IV below.

II. Pre-Spill NRDA Planning

An important government responsibility in providing for the welfare of its citizens is to assess and mitigate risks and injury to its marine and coastal environment. In this regard, it is important to anticipate locations and scenarios for potential disasters, and implement prevention and response plans. Detailed guidance for emergency preparedness is provided by other UNEP/IMO publications such as: *APELL (Awareness and Preparedness for Emergencies at Local Level) for Port Areas.* 1996; *TransAPELL: Guidance for Dangerous Goods Transport Emergency Planning in a Local Community*; and *Hazard Identification and Evaluation In A Local Community,* Technical Report No. 12 (see references).

Part of the government contingency plan for oil spills and other pollution events should include pre-spill NRDA planning. The following elements should be considered / included:

1. Identification of environments-at-risk from pollution events - in the context of spill prevention and response planning efforts, it is necessary for governments to systematically identify waterways / environments within their jurisdiction that are at significant risk of a major pollution event. This "comprehensive risk assessment" should identify potential causes, sources, locations, size and types of hazardous substances that may be spilled, and potential flow characteristics and trajectories. This risk assessment should include a systematic analysis of vessel traffic patterns, types of vessels and cargoes, and identify traffic convergences and navigational characteristics that may increase the risk of large spill events. From this analysis, it should become apparent where an increased risk of a significant pollution event lies and thus where government preventive action should focus. High-risk areas may include approaches to oil ports and terminals, high-traffic areas offshore, and traffic crossings - e.g., areas with risk of groundings and collisions. This risk assessment should identify cross-border environments that may be affected in neighboring countries. The risk assessment should include a chemical analysis of cargoes / pollutants most likely to be spilled - specific types of crude oil, petroleum products, chemicals, etc. These analyses should include physical properties (such as specific gravity, viscosity / pour point, solubility, volatility / distillation characteristics, etc.), a complete chemical characterization, and toxicity analyses.

2. Baseline environmental studies - based on the comprehensive risk assessment and the identification of areas of potential risk from pollution events, it is important for the government to commission baseline studies of the potentially affected ecosystem from which comparative analyses of damage can be conducted if a significant pollution event occurs. It is possible to conduct a credible post-spill environmental damage assessment without pre-spill baseline information, using control sites that were not contaminated for comparative studies. However, pre-spill baseline information makes the post-spill assessment task much easier and more defensible. Essentially, the better an ecosystem is known before a pollution event, the easier it will be to assess damage afterward. Thus, as high-risk waterways and other environments are identified, baseline ecological information should be collected in the ecosystem at-risk.

Like the NRDA program (outlined in Section III below), baseline studies should cover the full spectrum of ecosystem components that may be damaged by a spill - primary producers, zooplankton, benthic invertebrates, forage fishes, larger fishes, birds, mammals, etc. There are two primary categories of pre-spill baseline information that should be collected:

a) background levels of contaminants - information on background hydrocarbon and other contaminant levels in water and sediment, as well as background contaminant levels in biological tissues (e.g., in indicator species such as fish, shellfish, mammals, birds, and other species of concern). Particular attention should be devoted to background levels of specific potential pollutants identified in the risk assessment.

b) general ecological characterization of the region - the basic ecology of the environment-at-risk, including the distribution and abundance of dominant species in the region, their seasonal and geographic variability, and information on the physical environment. This ecological characterization should measure specific population parameters for selected indicator species, including distribution and abundance, reproductive success, feeding habits, migratory behavior, growth rates and body condition, incidence of diseases, etc. Important natural and human-induced influences in the ecosystem should be monitored and understood.

It is advisable to continue a long-term baseline environmental study effort in order to enable the detection of long-term changes and cycles in the ecosystem prior to disturbance by a spill event. Historical sources of baseline data can and should be incorporated into the pre-spill characterization of the at-risk-environment – such as pre-existing Environmental Impact Statements, Environmental Assessments, other government or academic studies, industry studies, etc. If it is not possible to conduct a comprehensive baseline ecological study in each environment-at-risk, then a government should try to collect as much information as possible. If it is impractical to conduct the general ecological characterization of an at-risk region, then at a minimum studies to determine background levels of potential pollutants in the system should be conducted. For instance, pre-spill studies to determine background levels of Polynulcear Aromatic Hydrocarbons (PAHs) in various indicator species in a coastal ecosystem will greatly improve damage assessments post-spill. Similarly, if it is impractical to conduct baseline studies in every environment-at-risk, then at least those judged to be at greatest risk should be investigated.

The basic concept of baseline studies in ecosystems at risk is to facilitate amore effective post-spill NRDA and Restoration program. In addition, this scientific information will also be useful in directing emergency response efforts to protect sensitive resources and habitats, as well as to assist a government's normal management of natural resources.

[Note: In addition to baseline environmental studies, it is also advisable for governments to collect baseline information on economic and social parameters in areas-at-risk so as to provide a basis for better assessing the impacts of subsequent pollution events and/or prepare claims for these injuries.]

3. Pollution Library / Database - it is advisable to establish a centralized pollution library to collect all pertinent scientific information with relevance to a potential pollution incident. The Pollution Library should become the central repository for all pre-spill baseline studies; information on physical, chemical, and toxicological properties of potential pollutants; and all other technical references and information resources that may be useful in the conduct of a NRDA&R program. It should be housed wherever it would be most accessible in the event that a NRDA&R program becomes necessary, such as at a

university, an oceanographic institute, a government agency, a pre-existing public library, etc. The library should endeavor to become a comprehensive collection of general and technical publications / resources, including on-line resources and databases.

4. NRDA Plan - it is recommended that governments (as part of the MOA) agree to jointly develop a pre-spill NRDA Plan to be implemented subsequent to a significant pollution event. This should delineate all aspects of how a NRDA program would be conducted in the event of a significant pollution event -- including what studies will be conducted immediately, which scientific entities (agencies, universities, private contractors) will conduct those studies, how they will be financed, data collection protocols, and other issues that may arise. This should identify the "who, what, when, where, and how" of the NRDA program. The Plan should include a statement as to the authority for asserting trusteeship for natural resources potentially injured, and should be of sufficient detail to provide guidance in mobilizing a comprehensive NRDA effort. It should include a set of Standard Operating Procedures (SOPs) to guide all NRDA studies (see SOP section below). The SOPs will include sampling methodologies, laboratory analyses, equipment calibration, etc. The NRDA Plan should specify procedures for determining the scale and scope of a NRDA program. It should also anticipate relationships with neighboring countries in the event of the cross-border spread of a pollution event from regions within its jurisdiction. Having a pre-approved NRDA plan will greatly expedite and enhance the effective conduct of the program if it becomes necessary.

5. Memorandum of Agreement (MOA) between government agencies - often a significant problem in the chaotic aftermath of a large spill is the relationship between the various government agencies with statutory authorities over the event - national, provincial, local. In addition to clearly delineating spill response authority before a significant pollution event occurs, it is recommended that government agencies establish a Memorandum of Agreement (MOA) outlining how they will cooperate to implement the NRDA Plan and Restoration program. The MOA should identify all potentially responsible agencies, a cooperative organizational structure (e.g. Trustee Council, etc.), roles of various agencies, fiscal matters, and so on. This would help considerably in the planning for a government response to a pollution event, as well as reduce confusion during such an event. The MOA should also anticipate potential options for government relationship with the Responsible Party, including the option of conducting a Cooperative Assessment Program. (see NRDA organization below).

6. NRDA Response Fund - one of the major impediments to mobilizing an effective NRDA program immediately after a pollution incident is that of funding. Often in pollution emergencies, governments have to reprogram existing funds from agency budgets, and this can take time and cause delays in conducting the damage assessment. Such delays can lead to the loss of valuable information resulting in a reduction in the government's ultimate claim. Some countries have established *national oil spill response funds* to enable them to respond more quickly to spill disasters, including the conduct of NRDA programs. Such revolving funds are normally secured through a federally mandated per barrel (or ton) surcharge on oil imports / shipments, and used principally to

pay for government spill prevention and response preparedness activities both before and during a spill. These funds are also generally available to implement a NRDA program in response to a spill, are generally capped at a particular level, and structured to be reimbursed from ultimate claims received by the government from the Responsible Party or the Funds. All nations at risk from pollution disasters should seriously consider the establishment of such a national fund available to, among other things, fund the immediate implementation of a comprehensive scientific damage assessment if the need arises. Such a fund could also provide support for the pre-spill baseline studies necessary for comparative post-spill analysis.

7. Pre-spill NRDA&R Training - it is recommended that governments sponsor / receive pre-spill training workshops regarding the conduct of a NRDA&R program. These could perhaps be sponsored/organized by UNEP through National Environmental Action Plans (NEAP). Such workshops would gather agency representatives who may be involved in a NRDA&R program, and help agencies prepare for such a contingency. This will include the identification of any gaps in government preparedness to mobilize an NRDA program quickly and effectively.

8. Legislative / statutory review - it is advisable for all nations to periodically review and, if necessary, up-date their national legislation and regulations with regard to spill prevention, response preparedness, liability, and NRDA&R. This should include a review of their status with regard to all relevant international conventions, as well as their national NRDA&R regulations. A government should be clear on what its rights and obligations are with respect to pollution damage, damage assessment, and Restoration.

III. Natural Resource Damage Assessment (NRDA)

Deciding if a NRDA program is needed - The first step in government consideration of a NRDA program is deciding whether or not it is necessary to conduct such an assessment and if so, at what scale. The decision as to whether to conduct a NRDA program will depend primarily on:

1. the nature and toxicity of the pollutant,
2. the spill volume and expected trajectory
3. the sensitivity of the environment into which the spill occurred (including time of year, number of sensitive habitats and species present, commercial importance, etc.)

In this regard, government officials should immediately examine all resources at risk, the nature of their exposure, and consider all initial observations of injury. This should be done as soon as possible after an incident, preferably the day of the incident. From this officials should make a reasoned estimation of whether or not there exists the risk of significant environmental damage resulting from the incident and if such risk exists then an NRDA program should be initiated. It should be pointed out that in some cases, it may be politically advisable for a government to initiate a NRDA program even if it does not expect that significant risk exists, if only to demonstrate to its citizens that no significant damage occurred.

As a general guideline for crude oil spills, if a spill is less than 1 ton, an NRDA program may not be necessary; if a spill is from 1-10 tons, a NRDA program may be necessary; and if a spill is larger than 10 tons, a NRDA program will likely be necessary. Again, spill volume is only one determinant of a government's decision on this. If for instance one ton of a highly toxic chemical is spilled into a sensitive environment, then a government may need to conduct an environmental damage assessment. And it should be noted that initial spill volume estimates can often be inaccurate. The scale of a NRDA program should be commensurate to the scale of the pollution incident and the damage expected -- e.g., as spill volume and potential injury becomes greater, then so should the government's scientific response.

<u>NRDA</u> - Following a major pollution incident, the extent and severity of environmental damage should be determined by a methodical *Natural Resource Damage Assessment* (NRDA) program conducted by the government. The assessment of damages to natural resources requires consideration of immediate (acute) injury - both lethal and sub-lethal, long-term injury, and ecosystem-wide effects. All components of the potentially affected ecosystem should be assessed for their injury, including coastal habitat, air and water, sediments, fish, shellfish, plankton, marine mammals, terrestrial mammals, birds, plants, and others. In general, the damage assessment is carried out via three primary techniques - field surveys / observations, sample collection for contaminant and ecological analyses, and experiments conducted in the field and in laboratories. Estimates of acute mortality and lost productivity over time should be derived. Additionally, sub-lethal, chronic effects should be documented, including such things as digestive impairment, reproductive impacts, altered migratory behavior, physiological effects, cellular (cyto) toxicity, genetic effects / mutations, decreased growth rates, immune suppression and disease expression, and so on.

And in order to discriminate between the effects of the pollution incident from other long-term dynamics in the ecosystem, it is important that the damage assessment consider all potential sources of variability in an injured ecosystem - both natural and human-caused. These can include climate variability, normal population cycles, human harvests, other pollutants and ecological stressors in the ecosystem, and so on. As well, the studies should attempt to discriminate effects of the response / clean-up from the effects of the pollutant itself. Environmental effects of a response effort can include additional wildlife disturbance from vessels, aircraft, and cleanup workers; effects of chemical dispersants; effects of high-pressure / hot water washing of contaminated areas; effects of bioremediation and other beach treatments; damage to archaeological and cultural sites; etc.

<u>Standard operating procedures</u> - It is important to establish (preferably in the pre-spill NRDA Plan), a set of standard operating procedures (SOPs) for all NRDA studies. The SOPs should set forth procedures for study design, sample collection methods and management, data recording, sample analysis, and so on. These SOPs should be

developed along guidelines for internationally accepted best practices for scientific field studies (see for instance *Comprehensive Assessment of Injury to Coastal Habitats - Standard Operating Procedures*, 1990). And the SOPs should be used by all NRDA Principal Investigators (P.I.s) throughout the program. The NRDA SOPs should establish consistent standards for such issues as the following: selection of study sites, selection of un-damaged control sites; maintaining and protecting study sites; sample frequency; field and laboratory procedures for determining ecological parameters such as productivity, body condition, reproductive condition, growth and survivorship, etc.; analysis of microbial activity; determination of contaminant concentrations (e.g. hydrocarbon levels, etc.); experimental work; laboratory sorting and handling procedures; processing of tissue (histological) samples; chain-of-custody; data analysis; calibration of laboratory equipment; and so forth. To ensure maximum data quality and credibility of results, the SOPs should identify the kind of sampling equipment to be used, preparation of equipment, handling and storage procedures, etc., and each PI should be responsible for adherence to the established SOPs, and should report such in methods section of their final NRDA project reports.

Of particular concern in the context of scientific quality assurance are the laboratory analyses of contaminant (e.g. hydrocarbon) concentrations in water, air, sediment, and biological tissue samples collected. This sampling should conform to Standard Operating Procedures established for the quantitative analysis of contaminants including collection equipment and procedures, chain-of-custody, storage, laboratory preparation, analytical procedures, equipment calibration, etc. There are several existing references that provide guidance in such evaluations (e.g. *The Revised GESAMP Hazard Evaluation Procedure for Chemical Substances Carried by Ships*; GESAMP, 2002). Chemical "fingerprinting" procedures should be specifically identified, so that contamination post-spill can be identified to source as accurately as possible (see _________).. Again, it is advisable to sort this out before an emergency arises, rather than afterward. Agencies should conduct audits of laboratory procedures, and results should be independently verified by several laboratories. To the extent possible, this can be done in-country. But if the capability does not exist in-country, or if a government wishes to verify their results for quality assurance, then foreign laboratories can and should be used.

<u>Study design</u> -- The universe of potential NRDA study sites should be identified across the entire potential impact zone. To the extent possible, study sites should be the same as those used in pre-spill baseline studies for comparative reasons. Within the impact region, actual study sites should be selected randomly for each type of habitat to be assessed - this is called a "stratified random sampling design." In assessing oil spill damage to a coastal environment for instance, replicate study sites should include each coastal habitat type -- e.g. exposed rocky, sheltered rocky, fine textured sand beach, coarse textured beach, estuarine, mangrove, coral reef, etc. Each geographic region potentially impacted should be studied. Sites should also be selected with regard to the degree of contamination -- light, moderate, heavy. Vertical *transects* should be established in each habitat at each study site, usually perpendicular to the beach, from supratidal, to intertidal, to subtidal, with at least three transects per site. Transects should divide the habitat into intervals of equal length along a beach. Along each transect, 1-

meter square sample quadrats should be established for sampling. The sites should be sampled at regular time intervals (and various tidal levels, etc.). Information collected should be integrated into a Geographic Information System (GIS) database that allows extrapolation of effects on coastal habitat over the entire study / impact region. Photographs should be taken at each site, and accurately logged, and a map should be made of all study sites.

Similarly, standard study design protocols should be established for other potentially affected habitats - rivers, lakes, wetlands, offshore marine waters, etc. In wildlife damage assessment surveys, protocols should establish consistent procedures for vessel surveys, aircraft surveys, dive surveys, and beach surveys -- e.g. speed of travel, altitude, distance from shore, depth, swath scanned, weather conditions / visibility limits, time of day / tide, etc. For instance: 'fixed-wing aerial surveys shall be flown at an altitude of 100 meters, at a speed of 150 km/hr, and an area 200 meters on each side of the aircraft shall be scanned and all mammal and birds recorded'; and so on. Weather minimums should be established, below which surveys are suspended. To be comparative, all survey methods should be consistent across the region and life of the NRDA program as well as with pre-spill baseline studies. In addition, all other significant observations made during the conduct of field surveys, even if outside the established transects / quadrats, should be noted for later consideration. Extensive surveys should include more intensive sub-sampling for verification. Standard wildlife estimation techniques that are appropriate to the species and habitat should be employed - census, mark-recapture, aerial photogrametry density determinations, etc. Care should be taken in field surveys not to inadvertently herd uninjured wildlife into contaminated areas.

Sample management - For quality assurance, it is very important to collect, handle and manage samples correctly. And, as some pollution events carry criminal liability, a "chain-of-custody" protocol should be adopted to ensure sampling methodology will withstand legal scrutiny. Each sample should be tagged noting all pertinent information - sample number, location (site #), transect and/or quadrat, date, time, name of collector, type of sample. It is often advisable to assign at least two independent ways of identifying a sample -- e.g. unique sample number, and quadrat / site number. All such information should be recorded on a data sheet for each transect / study site as well. If necessary for chain-of-custody protocols, samples should be placed into containers and custody-sealed by the person who collected the sample, with the seal signed and dated. A chain-of-custody log should clearly identify who relinquishes and who receives the sealed samples.

Results Interpretation – damage should be inferred where the studies detect statistically significant differences between samples / observations of contaminated sites vs. control sites / baseline data. Inferring comprehensive damage results from data should be done realistically and credibly. If studies do not give conclusive evidence for precise estimates, then approximations should be made and specified as such.

The NRDA program can be conceptually organized into three phases, as described below.

NRDA Phase I - Rapid (short-term) Assessment (first 2 months)

This is the rapid assessment phase, and is useful not only in injury determination, but also in directing spill response efforts to protect sensitive habitats and other resources-at-risk. In addition to normal chemical and biological sampling methodologies, photographic documentation (both video and still photography) is very important in all NRDA projects.

Five high priority studies should be mobilized immediately and concurrently - the day of the incident if at all possible:

1. Spill trajectory analysis: it is important to delineate the entire geographic area that could be potentially impacted by a spill. Thus, using the most authoritative, pre-existing oceanographic information on water current patterns, together with observed wind / current patterns subsequent to the spill, a modeled spill map should be produced to delineate the *potentially impacted spill zone*. This trajectory analysis should include a record of the time, quantity, duration, and frequency of discharge of a pollutant. Discharge quantity should be estimated by at least two independent methodologies. The map of the potentially impacted spill zone will provide the NRDA study area for the subsequent assessments, and it is also useful in targeting spill response efforts. It should be kept in mind that spill dispersion will likely not behave in a strictly linear manner, as it responds to coastal gyres, eddies, convergences / divergences, and tidal forces to produce a more complex pattern of dispersion. Additionally, surface slicks often disperse differently than the dissolved component dispersed in the water column. The spatial distribution (aerial variation) of the pollutant across the impact zone should be assessed, as some dispersion patterns lead to high variability in pollutant concentrations across a broad impact zone. Spill trajectory needs to be modeled (estimated) using the best pre-spill information on current patterns in the region in combination with observed current, wind, tidal patterns post-spill. Spills can be tracked over time using aerial surveys, drift card and/or buoy deployment at the source, satellite imagery, IR / UV sensors, and so on. This defined impact zone should be used to establish sampling grids for the NRDA studies outlined below, and should be further refined based on the results of sampling of water, sediment, biota, and carcasses.

2. Water and air sampling – a comprehensive assessment of water surface, water-column, and air contamination should be initiated immediately to ascertain the distribution and dispersion of hydrocarbons / contaminants and their conversion products. Sampling should be organized along established Standard Operating Procedures, where transects are established and sampled across all potentially affected areas. For water samples, stations should be established along inshore - offshore transects, and at various water depths such as surface, 1 m, 5 m, 10 m, 50 m, 100 m, bottom). Uncontaminated control stations should be established for water and air sampling as well. Sampling stations should be consistent with stations sampled in pre-spill baseline studies, and maintained in future NRDA studies. Objectives are to determine the geographic and temporal distribution of surface, dissolved and particulate hydrocarbons / contaminants in the spill impact zone, including their concentrations, persistence, and chemical

composition. Water and air sampling should also include measurement of other relevant variables, such as temperature, salinity, dissolved oxygen, and so on. Attention should be paid to potential exposure of human populations through groundwater and atmospheric contamination.

3. Sediment sampling: a comprehensive study of spill contamination in intertidal, nearshore subtidal, and offshore bottom sediments should be conducted. This study should follow methodologies / transects for the water quality study above, and determine concentrations, persistence, and chemical composition of hydrocarbons / other contaminants in shoreline and seabed sediments. Sediment samples should be collected from the broad range of depths in the spill impact zone – beach, surf-zone, 1 m, 3 m, 10 m, 20 m, etc., and should be distributed spatially across the potentially impacted spill zone. With a representative sampling grid, a map of sediment contamination from the spill can be produced. Sediment samples should be sufficient to determine the depth distribution and concentrations of contaminants across the spill region, to perhaps 1 meter into the substrate. Studies should note sediment concentrations of pollutants sufficient to decrease microbial respiration, water holding capacity, carbon-flows, etc. Both sediment and water sampling programs should analytically "fingerprint" hydrocarbons / other contaminants to the source in order to distinguish them from other sources of contamination in the ecosystem. To facilitate this fingerprinting, a known sample of the pollutant should be collected and analyzed. A toxicity analysis of these initial contaminant levels in sediments and water should be conducted in Phases II and III of the NRDA.

4. Initial Biological monitoring: a biological monitoring program to detect hydrocarbons / other contaminants in indicator organisms should be deployed as soon as possible. This should include field sampling across the potentially impacted spill zone of tissues of at least three trophic levels: for instance, a bivalve species (as a bottom suspension feeder); a plankton species (as a water-column filter feeder), and a fish species (as a predator). The Initial Biological Monitoring study should assess the potential impact of a spill on the phytoplankton and zooplankton communities in the water column - including species distribution and abundance, body condition, evidence of contamination, etc. - as impacts in this component are likely to be most pronounced in the early stages of a pollution incident. The Phase I biological monitoring project could also include deployment of filter feeding bivalves in suspended cages downstream from the source to be sampled at regular time intervals for contamination.

5. Carcass survey and collection: a systematic effort should be initiated immediately to locate and collect carcasses of organisms in the spill impact zone in order to estimate the immediate (acute) mortality from the spill. This can be accomplished opportunistically in conjunction with the water and sediment sampling projects discussed above, as well as with dedicated efforts specifically searching for beach-cast and floating carcasses. Depending on the depositional characteristics of a particular environment, a beach should be searched at regular intervals so as to not miss carcasses that re-float. All carcasses located in the spill impact zone should be collected, labeled, frozen, and delivered to a central receiving point (wildlife agency, etc.) where they should be

identified, measured and weighed; necropsied by trained biologists, veterinarians, and/or pathologists to determine probable cause of death; and tissue samples should be collected to be analyzed for presence of hydrocarbons / contaminants. Care should be taken to discriminate carcasses killed by the pollution event from those that died from other causes. Some animals may die and become contaminated secondarily. A reference collection of all species collected should be maintained at least until government damage claims are resolved.

As most organisms killed by a marine pollution incident will likely sink at sea and not be recovered, a quantitative effort should be made to estimate the ratio of recovered carcasses to the total number of organisms killed. Other marine spill experiences have provided estimates at 1:20 or higher for this ratio. This estimate can be derived using tag mark-and-recovery methods (including radio transmitters) on floating objects used to simulate floating carcasses or a sub-sample of floating carcasses themselves. A radio transmitter on a carcass will generally cease to transmit when the carcass sinks, thus carcass sinking rates can be estimated using this method and extrapolated to estimate total acute mortality.

6. Sampling of animals captured for cleaning / treatment - an often overlooked source of valuable scientific information immediately post-spill is from live animals collected for cleaning and rehabilitation, generally birds and mammals. To the extent possible, while not interfering with the cleaning / treatment effort, these animals should be assessed for evidence of toxicity (blood samples, tissue samples, respiratory measurements, body condition, etc.). Such information can be useful in assessing sub-lethal injury, and/or modes of toxic impacts. Any animals that die while in treatment facilities should be thoroughly necropsied and added to the carcass database. A sub-sample of animals that are released from treatment facilities should be tagged (and/or fitted with radio transmitters) so that their fate can be monitored. This will provide an assessment of the effectiveness of treatment. In this regard, it is very important to maintain sterile conditions at treatment facilities so as to minimize the risk of disease transmission to treated animals and then on to wild populations upon release.

NRDA Phase II – Mid-term assessment - remainder of Year-1

All studies initiated in Phase I should be continued in the Phase II NRDA program as necessary. In addition, more in-depth investigations should be initiated. All such studies should establish study sites selected across the broad range of habitats in the potentially impacted spill zone, and sampled at regular intervals during the study period. All efforts should be made to keep study methodologies consistent and of high quality.

Phase II studies should include:

1. Habitat: a comprehensive study of the impact on specific ecological habitats of concern, such as coastal habitat, should be initiated. This could include, for instance, estimates of injury to mangrove ecosystems, coral reefs, salt marshes, beaches, lagoons,

river deltas, etc. Coastal habitats are known to be highly productive and vulnerable to spill impacts as a significant quantity of a spilled pollutant (oil, etc.) can strand in these areas. The study should establish several sites for regular analysis over the study period (as described in the "study design" section above) and document injury to resources dependent upon these coastal habitats.

2. Fish / Shellfish: a study/studies of the potential injury to various fish, crab, and shrimp populations in the region should be initiated. Indicator species that are either ecologically and/or economically important should be selected for study. Their distribution and abundance in the spill impact zone should be documented, and bile and tissue samples should be collected from a representative number of these selected indicator species for contaminant exposure, histopathology, and physiological analysis (including blood chemistry, enzyme markers, etc.). This can either be done be sub-sampling a percentage of the fish / shellfish catch in the region (if harvesting continues), and/or by field collection using conventional fish harvesting methodologies (trawls, gillnets, hook-and-line, traps, etc.). This sampling should be conducted at contaminated sites as well as uncontaminated (control) sites. Evidence of contamination in collected organisms should be noted, as well as other life history information - size, age, sex, stomach contents, reproductive condition, etc. It is also important that the fish / shellfish studies assess potential injury to egg, larval, and juvenile stages as well. Studies elsewhere have shown that various stage of fish and shellfish species can be affected by exposure to some contaminants in concentrations as low as a 1 part-per-billion (ppb). All closures of resource harvests / uses due to the pollution event should be recorded for valuation and inclusion in the government's claim.

3. Birds: a study/studies on potential impact on birds in the region should be conducted, including the general distribution and abundance of birds compared with pre-spill conditions and/or uncontaminated control study sites. It may not be possible to study all bird species potentially affected by the event, and thus indicator species should be selected for more intensive monitoring. Surveys should be developed along established Standard Operating Procedures, and be consistent with pre-spill baseline surveys. Evidence of obvious contamination or altered behavior in live birds should be noted. Using information from collected bird carcasses together with survey results, an estimate of bird mortality should be derived. The bird surveys should continue over several seasons, in order to determine population trends.

The bird studies should also document any effects on reproduction - nesting success, hatching success, fledging, etc. Post-spill bird reproduction results should be compared to baseline information and to uninjured control populations / sites. Consistent observational techniques using Standard Operating Procedures should be employed for all counts at nesting colonies throughout the life of the study. Aerial photo-documentation can be useful in estimating abundance at nesting colonies, but these observations should be ground-truthed for accuracy. Non-viable eggs should be collected and preserved for laboratory analysis of contamination. Some bird species can be considered for radio-tagging to estimate survival rates, causes of mortality, distribution with respect to contaminated areas, etc.

4. Mammals: a survey of marine (and other) mammals, using aerial and vessel surveys should be conducted. This should include whales, dolphins and porpoises, seals and sea lions, otters, and/or other mammals known to occur in the impacted environment. Of particular interest should be threatened and endangered species. Results from these surveys should be compared to the distribution and abundance expected from baseline studies, and/or in other uncontaminated regions used as a control. Particular emphasis should be placed on surveying areas of known aggregations of mammals. Evidence of contamination and behavioral anomalies in mammals should be noted. The presence of juveniles (whale calves, seal pups, etc.) should be noted, along with reproductive timing. Also, opportunistic sightings of mammals (from fishing vessels, recreational vessels, cargo vessels, etc.) can be used to augment survey data. Photographic documentation should be kept. As it is generally not acceptable to collect (lethally take) mammals for damage assessment purposes, evidence of exposure to contamination will often have to be derived from collected carcasses. Standard body measurements from mammal carcasses should be taken and used to construct models of survivorship. In some cases, live-capture of certain mammal species may be used to collect blood, fat, and other tissue samples for histopathological, toxicological, and DNA analyses. Before release, live-captured mammals can be fitted with tags and/or radio transmitters to track subsequent movements, derive estimates of survivorship, etc.

5. Other Species of Concern: a monitoring program for other species of concern, (e.g. sea turtles, threatened & endangered species, etc.) should be initiated. For instance, sea turtle studies should document nesting distribution, behavior, and success . Any obvious evidence of oiling should be noted on incoming females, and all non-viable eggs should be collected (after hatchlings have left the nest) to be analyzed for histopathology and contaminant analyses. The out-migration of hatchlings should be monitored in relation to what is found to be the spill zone, and sub-lethal effects should be investigated, including skin lesions, tumors, morphological deformities, etc.

6. Bottom (benthic) Organisms: in addition to the commercially valuable shellfish study above, a monitoring program for bottom-dwelling invertebrates should be conducted. This should include, for instance, invertebrates in bottom sediments (in-fauna), and those on top of the seabed (epi-fauna). This study should provide an assessment of contaminant concentrations in tissues, histopathologies, physiological effects, effects on growth rates, reproduction, etc., and it should compare abundance and productivity indices for organisms in contaminated areas to those in uncontaminated "control" sites.

7. Fate and Toxicity of the Pollutant: based on studies of Phase I and II, a mass-balance of the spilled pollutant should be developed in order to estimate the amount that evaporated, deposited in offshore and onshore sediments, dissolved in the water column, emulsified, percolated into ground sediments, biologically degraded, etc. The toxicity of the spilled substance to various organisms should be determined with a thorough literature review in combination with laboratory analysis. Laboratory experiments, in

which organisms (such as fish and shellfish) are exposed to controlled concentrations of the pollutant, can be used to supplement field studies.

<u>NRDA Phase III</u> – Long-term assessment - Year 2 and beyond, as necessary

If on the basis of the results of NRDA Phases I and II it is deemed necessary, a NRDA Phase III program should be continued after Year-1. The impacts of some pollution events may have a relatively short duration, while others have been known to persist for decades. Therefor, after the completion of these initial (Phase I) and mid-term (Phase II) studies, all investigators should assemble in a public symposium to report their results, propose additional long-term (Phase III) studies as necessary, and to begin developing a restoration plan. Long-term studies should continue investigating ecosystem components where injury is detected or suspected. Some ecological injury may not manifest for sometime after a significant pollution event, and thus a long-term monitoring program should be considered.

The NRDA Phase III program will generally subscribe to more traditional scientific program management (see NRDA Management below). A broad request for proposals (RFP) should be issued to all potential scientific organizations in the region – government, academia, NGOs. Project proposals should be developed by Principal Investigators (P.I.s), with detailed objectives, methodologies, and reasonable budgets. These should be submitted to the Chair of the government intra-agency coordinating committee (Trustee Council), peer-reviewed, and funded (or not) on the advice of a peer-review committee. The governments should be able to negotiate and adjust project budgets as they deem necessary.

Generally, after the settlement of government claims, the NRDA Phase III program will transition into a Recovery Monitoring and Restoration Science program during the Restoration phase (see Restoration section below).

The four primary objectives of this long-term research program are:

1. to monitor ecological recovery of the injured ecosystem;
2. to monitor the effectiveness of the Restoration program;
3. further refine the Restoration program through an adaptive management process; and
4. develop better information with which to manage the ecosystem sustainably.

A schedule of monitoring frequency should be developed for each injured species / resource, as some may not need to be monitored annually. A list of Injured Species / Resources should be developed and maintained by government agencies. This list should identify all significant resources that have been injured by the pollution event, including all species and resource services (commercial fishing, recreation, subsistence, etc.). The list should identify the extent of the injury and categorize the injured species / resource status as either *Recovered*, *Not Recovering*, *Recovering* (but not yet recovered), or

Recovery Unkown. An annual update of this list should be continued until all such injuries have been listed as *Recovered*, and the list should be available to the general public.

NRDA Phase III / Recovery Monitoring studies should include ecological modeling of the ecosystem effects of the incident based on all previous NRDA results. This should include an assessment of the cumulative, synergistic effects of the spill in conjunction with other ecological stressors, either natural or human-induced, in the region. This long-term ecological monitoring should investigate the potential for delayed population effects and their secondary (indirect, cascading) effects. This should include an understanding of the persistence of the pollutant in the ecosystem, and its effects on population recovery. Also, the long-term studies should investigate the potential effects of differential recovery rates, where one population may recover more quickly than another, thus affecting ecological balance in the system through altered predator-prey dynamics and/or habitat. These studies should look at human-caused (anthropogenic) processes, other than the pollution event itself, that may be limiting the recovery of the ecosystem – direct harvests, incidental take, coastal development, logging, other disturbances. And they should look at all factors that create ecological community structure and productivity: physical factors / climate, prey availability, predation, competition, alteration of community structure, changes in behavior, recruitment processes, reproduction, disease, etc.

A separate category of post-settlement research that should be considered as well is science to support more effective management of an ecosystem (as discussed below in the Restoration section).

Socioeconomic Injury

A distinct category of interest for governments and citizens in the aftermath of significant pollution events is the effect on social, psychological, health, and economic parameters in the impacted region. Sociological measures can include stress indices and chronic disorders in local citizens, human health effects, substance abuse, anger and uncertainty about the future, and so on. Economic effects can include disruption of commercial activities, displacement of workforce, wage inflation, loss of income, etc. A significant pollution event can result in economic impacts such as reduced fishery production, price effects on commercial fisheries, damage to recreation, loss of subsistence harvests, and loss of intrinsic values of injured resources, and so on.

Some of these social and economic injuries may be admissible as claims, and others may not. Regardless, it is within a government's trust authority to document all damage from significant pollution events as fully as possible. To the extent allowable in the existing compensation regime, this socioeconomic injury assessment should be used to support both private and government claims. This socioeconomic injury assessment is generally conducted separately from a NRDA program, which is intended to focus on injury to the environment rather than injury to humans.

IV. NRDA Organization and Management

1. Government Organization - it is important that a cooperative intra-governmental coordinating structure be established early on in the process to manage the NRDA& R program. An effective model for managing a NRDA program is that used in the U.S.- the establishment of a Trustee Council - comprised of principal state (provincial) and federal (national) agencies with responsibility for managing injured resources. Usually there are many agencies with distinct and/or overlapping responsibilities for resources potentially injured by a pollution incident. Those with primary responsibility should be identified (in the pre-spill NRDA Plan), and the MOA should clearly identify cooperative agency responsibilities in the implementation of a NRDA&R program. The intra-governmental coordinating committee (or Trustee Council) should consist of one representative from each agency, an executive director and staff sufficient to manage the program. It should also include government attorneys to advise authorities regarding the potential legal implications of their actions. The NRDA coordinating group / Trustee Council should have clear budget authority (such as access to a national oil fund / NRDA fund) in order to expedite payments to Principal Investigators quickly, so as to not lose valuable time in mobilizing the studies. It should be kept in mind that the reasonable costs of studies are reimbursable under the compensation regimes, and thus a detailed accounting of all expenditures should be maintained by the governments. These costs can include all aspects of the NRDA&R program – developing a NRDA implementation plan, public participation costs, exposure confirmation costs, field studies, management, economic valuation costs, and so on. To the extent practicable, all work of the intra-governmental coordinating group / Trustee Council should be conducted in public. In general, provincial government agencies will be responsible for assessing damage to resources within their jurisdiction, and the federal (national) government agencies will be responsible for assessing damage to resources within their jurisdiction. If there are overlapping authorities, then a joint effort will likely be most effective.

2. NRDA Chief Scientist / Technical Advisors - it is also important for the intra-governmental coordinating committee / Trustee Council to appoint a Chief Scientist to manage the scientific program, and to have access to technical advisors, both domestic and foreign, to the extent deemed necessary. The Chief Scientist should have the overall responsibility of managing the NRDA studies -- solicit competitive proposals by issuing a Request for Proposals, or RFP, for Phase II and III studies; identify Principal Investigators (P.I.s) either from government, academia, or from the private sector for each study; establish a credible proposal review / approval process; monitor progress on studies; and provide recommendations to the Trustee Council (or government coordinating body) regarding funding decisions. In this process, the Trustee Council and/or the Chief Scientist should have the ability to contract with Technical Advisors to the extent necessary. It is recommended that potential Chief Scientist/s be identified in the pre-spill NRDA Plan. Each NRDA project should have a lead agency, a Principal Investigator, clearly defined objectives, statistically valid methodologies, and a reasonable budget. As part of their academic training, consideration should be given for

university students to become involved in the NRDA projects under the supervision of the Principal Investigator.

3. Public Information - an important responsibility of government in the chaotic aftermath of a large pollution incident is keeping the public well informed. A poorly informed public can quickly become a suspicious and angry public, particularly when their livelihoods may be at risk. Further, it is a fundamental tenet of democratic governance that the public, on whose behalf the government is acting, has an inalienable right-to-know the affairs of its government. Thus, it is incumbent upon any government to regularly report to the public factual, real-time information with which they may better understand the potential effects of the incident. The protocol for release of NRDA results to the public should be identified beforehand. Generally, results can be released in preliminary form if clearly identified as such; or after the completion of studies. This will require a delicate balance between the public's right-to-know, scientific integrity, and issues of legal and financial liability. Experience has shown that the public can become impatient with waiting for final study results, and thus there may be need to release preliminary results. The public involvement process can either be formalized by establishing a Public Advisory Group (PAG) of representatives of civil society groups / potentially affected sectors (fishing industry, tourism industry, environmental groups, etc.); or by regular (daily / weekly) release of printed bulletins, pollution / assessment reports; and/or Press Releases; holding regular press conferences; and so on.

4. Relationship between Government and Responsible Party - the post-spill relationship between a government/s and a potentially responsible party (RP) is often a source of considerable debate and tension. The potential options for government / RP relations should be identified in the pre-spill NRDA plan and MOA. There should be one primary point of contact between the two parties, and a procedure for determining how each party will interact with regard to the NRDA program. One potential option is establishing a RP/government partnership to conduct the NRDA program - this is called a *Cooperative Assessment Program*, or CAP (Young, 2000; and www.noaa.darp.gov). The advantages in joining together in a CAP can be cost-sharing (e.g. for vessel charters, aircraft charter, equipment, personnel, etc.); reducing unnecessary duplication of sampling effort; and coordination of sampling to ensure consistent interpretation of results. It is also possible that through a CAP, a Responsible Party may simply stipulate to a particular injury, thereby rendering certain NRDA studies unnecessary. Potential disadvantages in entering into a CAP could include industry influence in / co-option of the NRDA program, the public perception of a conflict-of-interest between the RP and government, requirements of covenants not to sue, etc. Clearly, as governments and Responsible Parties can become litigants against one-another, a cooperative assessment program can present formidable problems. A government's foremost responsibility is to advocate the interests of its citizens and environment, and thus must carefully consider whether a Cooperative Assessment Program with the polluter is in this interest.

Often, if a government does not have a NRDA Plan and Fund with which to execute the plan, the RP may offer to cooperate by providing financial, logistical, and scientific support to a NRDA program. This may or may not be in the government's best interest in pursuing its claim against the RP, and thus should be carefully deliberated by government. Financing is one of the principal rationales behind the pre-spill establishment of a NRDA Fund. However, in the event that a government does not have either a pre-approved NRDA plan or finances available, and it considers it inadvisable to enter into a Cooperative Assessment Program with the RP, then a government may opt to solicit interim financing from the RP with which to begin the NRDA program. An agreement to provide such interim financing would likely stipulate that the amount provided would be deducted / credited against the final claim for damages by the government against the Responsible Party.

5. NRDA Quality Assurance - it is important that any government damage assessment program adhere to rigorous, internationally recognized standards of quality assurance and control. This will include such issues as study design, sampling methodologies, sample analysis and interpretation. Quality Assurance will be a primary responsibility of the Chief Scientist and Technical Advisors, and should include an independent, credible Peer Review process to be established as early in the NRDA program as is possible. All NRDA study proposals and reports should be submitted to Peer Reviewers, and reviewers comments and recommendations (anonymous or otherwise) should be incorporated in funding decisions. The government may wish to establish a Scientific Advisory Committee to the NRDA process, chaired by the Chief Scientist, and including universities, agencies, NGOs, UN organizations, etc.

6. Claim Determination / Presentation - at some point in the NRDA process (perhaps after NRDA Phases I and II), the government coordinating committee or Trustee Council should assess all of the NRDA results available in order to estimate the total amount of environmental injury, expected recovery times, and the potential for a Restoration program to enhance recovery. From this, a government may then estimate monetary damages for environmental injury resulting from the pollution event. This must be done within the framework of the operative pollution compensation regime – national or international. For environmental injury, the costs of "reasonable reinstatement measures" provides the guidance for claim determination. These can include *direct costs* such as compensation of employees for the time and effort devoted to carrying out particular restoration actions, costs of materials used specifically for the purpose of the action, equipment, etc.; and *indirect costs* of Restoration that can be included in the government claim can include such things as overhead, office lease costs, etc.

If a government is confident it has sufficient information available with which to calculate monetary damages, it can then present the damage claim - which consists of response costs, financial losses, and natural resource damage - to the Responsible Party (as discussed in International Pollution Compensation Regime section above). This can be done through a "demand letter", and allowance for a reasonable time for the RP to acknowledge and respond (perhaps 60 days). The presentation of a government's claim generally initiates attempts to negotiate a settlement with the Responsible Party, or if settlement negotiations prove unsatisfactory, litigation to collect damages. In the event that there is still uncertainty with regard to unanticipated injury, a "Reopener for Unkown Injury" can be considered for inclusion in the damage settlement (as discussed above).

All government damage recoveries should be placed into a separate, interest bearing account in the federal treasury for use by government Trustees, without further appropriation, exclusively for Restoration.

V. <u>Restoration</u>

<u>Background and goals</u> - One of the primary purposes of conducting a *Natural Resource Damage Assessment* described above is to develop and implement an environmental *Restoration* program. Restoration is generally defined as any action that endeavors to restore to their pre-spill condition (or to the condition that would have existed had the pollution incident not occurred) any population injured, lost or injured as a result of the spill, or that replaces or substitutes for the injured resources, or that provides another positive environmental offset to the damage suffered. An ecosystem can be considered *recovered* when the populations of organisms are again present, healthy, productive, and at numbers and distributions that would have existed had the spill not occurred; there is a full complement of age classes; they are behaving normally; and people have the same opportunities for the use and enjoyment of natural resources as they would have had the spill not occurred.

Thus, the overall goal of a Restoration program is to return a damaged ecosystem to the same ecological state that would have existed had the pollution incident not occurred. In a relatively static ecosystem over a short recovery time, the goal will be to return the system to its pre-spill condition as much as possible. For a highly dynamic system over a longer recovery time, that objective will become more difficult to achieve.

To be considered for compensation under the international regime, Restoration measures must satisfy the following criteria:

- measures should be likely to accelerate significantly the natural process of recovery
- measures should seek to prevent further damage as a result of the incident
- measures should, as far as possible, not result in the degradation of other habitats or in adverse consequences for other natural or economic resources
- measures should be technically feasible
- costs of the measures should not be out of proportion to the extent and duration of the damage and the benefits likely to be achieved (that is, be cost-effective)

Based on the results of the NRDA program, potential options should be developed with which to restore, replace, or provide other environmental benefit to offset / mitigate the damage from the pollution event. The primary focus of a Restoration program is to assist in and enhance the full recovery of an injured ecosystem.

While not the purpose of this manual, it is important here to note that the current international compensation regime is somewhat more restrictive than that provided by United States law in determining what Restoration projects can be claimed for compensation. The two principal differences between the present U.S. and international liability regimes are that under U.S. law: 1. natural resource damages include the interim loss or diminution in value of injured resources from the time of injury until full recovery, and 2. Restoration is more broadly defined to include direct (primary) restoration, rehabilitation, replacement, the acquisition of the equivalent of the injured resources, and other actions to compensate for the interim losses of natural resources. In the U.S., natural resource damage calculations assign a monetary value to injured resources that are not normally bought and sold, and thus employ various non-market economic valuation methodologies - e.g. contingent valuation, unit value methodology, hedonic pricing, travel cost methodology, etc. - to estimate such values. In contrast to the U.S. regime, the current international regime specifically excludes claims for such natural resource injuries based upon an "abstract quantification of damage calculated in accordance with theoretical models", and provides compensation only for costs of "reasonable reinstatement measures actually undertaken or to be undertaken" as well as other financial losses. Thus, natural resource damage calculations and the ensuing Restoration programs they support are more extensive under U.S. law than the present international regime. It should be noted that both regimes have converged to some extent over time, and may continue to do so in the future as society increasingly demands that polluters bear the full social costs of accidents, over and above financial losses (Jones, 1999).

Nevertheless, it is important for governments everywhere to consider all possible methods for assisting the recovery of an ecosystem injured by a significant pollution event, whether or not such methods may be covered directly within the current compensation regime. Put another way, the Restoration program need not be limited to just those projects that are covered by the compensation regime. Often a government can solicit additional donor support or reprogram other funds in order to implement a comprehensive environmental Restoration program that goes beyond that covered by the international regime. Programs such as a National Environmental Action Plans (NEAP), International Financial Institutions, private philanthropic foundations, and so on may have interests which overlap with those of an environmental Restoration program after a pollution incident. Thus, a significant pollution incident can become a powerful catalyst for accomplishing a broad array of conservation and sustainability reforms in a region. In this way, compensation paid by a Responsible Party to a government can be leveraged into a more effective, comprehensive Restoration.

Except for the reimbursement of actual government expenses (including the costs of a NRDA program), it is generally accepted that governments should apply any and all monies recovered in pollution events toward the Restoration and recovery of the injured ecosystem. Indeed, these are two principal claims that are admissible in the international compensation regimes. To the extent allowable under national laws, any criminal damages (restitutionary payments, fines, etc.) should go to environmental Restoration as well.

Direct vs. Indirect Restoration - Under the general scientific approach to ecological restoration, there are two principal categories of activities:

Direct Restoration / Reinstatement – projects that aim to improve the rate of natural recovery through direct manipulation of the environment, e,g, replanting of mangroves or seaweed in injured areas, restocking injured fish populations, fish habitat improvement, removal of contaminated sediments, captive breeding programs to enhance wildlife populations, etc; and

Indirect Restoration – projects that protect natural recovery processes, e.g. redirecting hunting and fishing effort away from injured populations to aid recovery, reducing human disturbance around sensitive habitat areas, enhancing sustainable fishery management regimes, increased enforcement of laws and regulations, protected areas designation, reduction of pollution, acquisition of habitat, etc.

Direct Restoration of impacted populations and environments is often difficult, particularly in aquatic ecosystems, but any opportunity to do such should be explored and implemented as appropriate. Beyond such direct restoration opportunities as may be available, often the greatest Restoration opportunity in significant pollution events is from *Indirect Restoration* - the implementation of other environmental protections and enhancements as offsets and mitigation. The general concept with Indirect Restoration is to provide a *net environmental benefit* to the impacted ecosystem.

If for instance a coastal environment in which a pollution incident occurs was already significantly degraded prior to the spill, then an effective Restoration program must take these pre-existing sources of degradation into account. In this case, reducing the chronic, point-source input of pollutants into a degraded coastal area would offer broad ecological and economic benefit, and perhaps be a cost-effective option for Restoration. Additional Indirect Restoration options include the designation and management of protected areas, implementing Coastal Zone Management Plans, habitat protection, acquisition of resources equivalent to those injured, and/or other efforts that enhance the sustainability of the coastal environment.

In general, all Restoration projects should contribute to a healthy, productive, and biologically diverse ecosystem. The Restoration program should assess what limitations may exist to the sustainability of the injured ecosystem and develop options to mitigate such limitations. Restoration decisions should take into account the extent to which natural recovery is occurring, the priority of the resource both ecologically and economically, and the technical feasibility of the option. The Restoration program should be subjected to independent scientific review (as the NRDA program), government acceptance, and be responsive to the concerns and ideas of citizens.

Restoration Plan - Using results of the Phase I and II NRDA program, all Principal Investigators and the public should begin a Restoration planning effort as soon as possible (perhaps as part of the NRDA&R symposium at the end of Year-1). This is essentially the "who, what, when, where, and why" of Restoration. The planning process should include the following elements:

1. Identify and evaluate potential Restoration options to address each injured natural resource(with a public symposium, scoping meetings, literature review, technical workshops, feasibility studies, etc.)

2. Produce a Draft Restoration Plan, broadly circulated for review and comment

3. Present damage claims to Responsible Party to support the Restoration plan

4. Approve and Implement Final Restoration Plan after considering all comments of public, agencies, scientists, and Responsible Party.

The Restoration planning process generally requires broader input than the scientific input necessary for the NRDA program. The Restoration Plan should provide a reasonable balance between costs and potential benefits, be appropriately scaled, holistic and comprehensive, and employ an ecosystem approach. As such, the plan must take into account all ecological stressors in an injured ecosystem, not just those caused directly by the pollution incident. The Restoration Plan should monitor natural recovery, and seek to minimize further disturbance from human activity. And the Plan should be flexible and responsive to address new injuries as they are detected. In this regard, a government may consider incorporating a "Reopener for Unkown Injury" into any settlement of its natural resource damage claims, that would allow it to receive additional compensation (perhaps 10%-20% of the final settlement) from the Responsible Party if unanticipated environmental injuries are discovered post-settlement.

The Restoration Plan should identify a process for public participation in the Restoration program - public testimony at meetings of the government Trustee Council, a Public Advisory Group, etc. While most Restoration activities will be located in the immediate impact zone, a comprehensive Restoration program can include limited activities outside an impact area if such activities are deemed to be of potential assistance in recovery (e.g. in habitat elsewhere used seasonally by injured migratory species, etc.). In general, a Restoration program should not support what would be considered 'normal agency duties', unless the lack of support to those normal agency duties is identified by the Restoration planning process as a significant impediment to ecological recovery and sustainability. And the Plan should ensure that any Restoration actions will comply with all existing federal and provincial laws and regulations.

The Restoration Plan should be the principal document providing long-term guidance for restoring resources and services, and it may or may not list specific restoration projects. If the plan is general in scope, then it should be implemented through annual work plans that describe in detail the projects to be supported for Restoration. The development of annual work plans should be competitive and subjected to thorough scientific review and deliberation by government authorities. Using the NRDA results, the Restoration Plan should identify each injured resource and resource service (human uses of natural resources), and then establish *recovery objectives* and *strategies* for each. These recovery objectives should state a clear, measurable, and achievable endpoint specific to each injured resource. An example might be: "populations of species 'x' will have recovered when they are again healthy and productive, exist at pre-spill abundances and distribution, and have pre-spill age / sex ratios." In other injured resources, the best that can be hoped for may be "population stability or increase." Restoration strategies to reach these specific objectives will provide the guidance for solicitation of project proposals.

Government Trustees of the Restoration program should publish an annual report of their program (available to the public), including a status of injured species / resources which categorizes all resources in one of four categories as follow: *not-recovering, recovering, recovered,* or *recovery-unkown,* The status of injured species / resources list should be updated as new information becomes available. The annual report should also update the public on all Restoration projects and activities. Additional methods of disseminating information on the NRDA&R program to the public should be employed as appropriate - web site, regular public meetings with opportunity for public comment, etc.

<u>Potential Restoration Options</u> - Without presupposing what sorts of Restoration options should be selected in specific pollution events, some examples include the following:

<u>*Direct Restoration*</u>*:*

Protection, rehabilitation, and replanting of plants in affected areas - reseeding mangroves in areas impacted by a spill, etc.

Restocking of fisheries through aquaculture and enhancement techniques to supply additional food resources for natural predators and additional resources for fishermen.

Additional cleanup of contaminated sites in the ecosystem, using bioremediation, mechanical removal, etc., of contaminants not otherwise removed during the spill response, and whose presence may impair the recovery of injured resources.

Enhancing bird nesting success, via predator deterrence, artificial nest sites, etc.

<u>*Indirect Restoration*</u>*:*

Improved / intensified management of harvested fish and shellfish populations to prevent overfishing: existing fisheries could be restricted or redirected to other areas / stocks to enhance injured fish populations and the predators dependent upon them. Various restrictive management tools could be considered, including more restrictive catch limits, additional gear restrictions, time / area closures to fishing, fish size restrictions, fleet capacity reduction (vessel buyback) etc.

Intensified management and protection of sensitive species such as sea turtles, birds, marine mammals, etc. -- reducing human disturbance of sensitive habitats for priority species by restricting human access to sensitive habitats, implementing measures to reduce the incidental take of such species in fish nets, expanded buffers around sensitive habitats, etc.

Increased enforcement of fish & wildlife and environmental laws and regulations – the provision of funds for additional enforcement officers, vessels, aircraft, etc, to reduce illegal harvests, apprehend violators, increase awareness of fish and wildlife protection laws, etc.

Reduce or eliminate introduced species from the ecosystem, e.g. removal of rats through trapping, establishing ballast water treatment systems, invasive species management programs, etc.

Pollution abatement- develop an initiative to reduce or eliminate point-source pollution into a spill impacted region. This should include a comprehensive analysis of point-source effluent discharge (e.g. from steel mills, power plants, textile mills, refineries, sewage outfalls, fishing vessels, large ships, port facilities, etc.) in the region, as well as non point-source inputs. On the basis of the comprehensive analysis and mapping of all pollutant inputs into the ecosystem, a detailed plan for the reduction of such deleterious inputs should be prepared with a necessary budget, timetables, and measurable outcomes. This project would be large, and thus may need funds outside the framework of the compensation conventions. It should be contracted to a credible environmental engineering firm, with a proven track record on such large pollution abatement projects, and would likely take many years to fully implement.

Implementing sustainable management initiatives - in many cases, nations have already developed plans to enhance the sustainability of ecosystems, but have yet to implement these plans due to inadequate funding and/or governance structures. For instance, many nations have developed National Programmes of Action under the Global Programme of Action to Protect the Marine Environment from Land Based Activities. Such plans identify problems and sources of degradation, establish priorities, set management objectives for priority problems, and identify strategies to address priority problems. Other plans include Integrated Coastal Zone Management (ICZM) plans, and so on. Many of these national and regional management plans have yet to be implemented, and they provide an excellent general framework for the development of a long-term Restoration project that would enhance the recovery and sustainability of an environment injured by a pollution event. A significant pollution event can become a catalyst for the implementation of such plans in the context of Restoration.

Habitat protection - protecting ecological habitat from other sources of degradation can be an extremely useful Restoration tool. Additional protections can be enacted for habitats injured by the pollution incident, or those uninjured but threatened by other injury, such as logging, mining, industrial development, etc. In nations with significant private or corporate ownership of resources, these resources or resource harvesting rights (logging rights, mineral rights, etc.) can be purchased and protected by a government in the context of a comprehensive Restoration program - coastal forests, wetlands, beaches, etc. Such publicly acquired protections are intended to assist overall recovery by minimizing further injury to habitats already injured, and/or to preventing additional injury within the general ecosystem. Such protections may protect water quality and reduce disturbance in particularly sensitive areas.

Designation of Protected Areas - on lands and waters already in public / government ownership, to be managed accordingly. This can include the designation of new marine protected areas, wildlife refuges / sanctuaries, no-take reserves, parks, etc., and/or the improvement of management in protected areas already in existence.

Debris cleanup and control – plastic and other persistent and harmful debris in an ecosystem should be cleaned up to the extent practicable. Such debris is well known to effect many organisms, including birds, fish, mammals, and sea turtles. Also, a program to eliminate or reduce this source of degradation should be implemented – improved solid waste management, better collection facilities, an education program, etc.

Economic alternatives for local fishermen – if fishery resources are injured or contaminated by a pollution event, it may be possible to develop alternative resources which fishermen can harvest. For instance, if an offshore fishery is dominated by foreign vessels, a program to award a portion of the offshore fishery catch / quota to domestic fishermen could gradually phase out foreign fishing and contribute to the development and sustainability of a nation's domestic fishery. Also, a fishery observer program for offshore foreign fisheries could be implemented (or expanded if it already exists) to provide additional enforcement of fishery regulations as well as to train coastal fishermen in offshore fishing technologies.

Develop tourism / recreational alternatives - to substitute for the loss in tourism and recreational opportunities – development of new parks and other tourist amenities along the beaches, etc.

Provide alternative energy resources - substitution of bio-gas generators, charcoal, imported fuel, compressed paper logs, solar voltaics, etc., for local residents who currently harvest local resources for energy (e.g. mangroves, forests, etc.).
Initiate a feasibility study for the use of alternative energy to reduce reliance on polluting fuels such as oil and coal

Develop an environmental education program for children and adults to increase awareness of the importance of conservation and sustainable management, with particular emphasis on the injured ecosystem. This can include consideration for the construction of additional educational facilities and/or expanded funding for existing facilities / programs. It can also include specific educational objectives such as how boaters can reduce disturbance of sensitive species (marine mammals, sea turtles, seabirds, etc.).

Recovery Monitoring and Restoration Science - to the extent that effective management actions in an ecosystem are limited by lack of information, research is a legitimate exercise of the Restoration process. It is critical that such research projects be targeted

specifically to gather information necessary for more effective management, and then applied in the improvement of management. An example of such research may be to better understand environmental pressures on fish populations so that harvest levels can be regulated more effectively. In addition to this sort of management research, there is also a need to monitor recovery and the effects of the restoration program (as discussed in NRDA Phase III section above). Government's should carefully consider the scale of their research and monitoring program post-settlement. In this regard, it is important to recognize that research and monitoring do not contribute to environmental recovery *per se*, but rather through the management *application* of research results.

VI **<u>Conclusions</u>**

It is a generally accepted tenet of environmental stewardship that in the event of a significant pollution incident, a government has an obligation to assess environmental injury and assist in the recovery of the injured environment to the extent practicable. International law provides governments the right to claim damages from a Responsible Party, and to use such damages to conduct an environmental Restoration program. To derive its claim against a Responsible Party, a methodical Natural Resource Damage Assessment (NRDA) science program should be implemented to assess damage to all components of an affected ecosystem, and Restoration alternatives should be developed.

Prior to a pollution event, a government is advised to, among other things, identify environments-at-risk from a significant pollution event, conduct baseline environmental studies to determine background contamination and understand the ecology of the regions-at-risk, develop a NRDA Plan, enter into a Memorandum of Agreement (MOA) between agencies stipulating how they will cooperate to conduct an NRDA&R program if necessary, and conduct pre-spill NRDA training exercises.

A NRDA program can be organized in three sequential phases: Phase I - Rapid Assessment (the first 2 months); Phase II - a more comprehensive mid-term assessment (remainder of year-1); and Phase III - long-term studies to monitor injuries, natural recovery, and the Restoration program. NRDA projects should address all components of an injured ecosystem - contamination to sediment and water, contamination to living organisms, population effects, cumulative ecosystem effects, and so on. The assessment should include short-term acute effects (mortality, etc.), as well as sub-lethal, chronic effects.

With results of the Phase I and II NRDA program, governments should develop and implement a comprehensive Restoration program that seeks to return an injured environment to its pre-spill condition, or to the expected condition had the spill not occurred. In consultation with scientists and other members of civil society, a government should develop a Restoration Plan to guide the funding of specific projects to assist in the recovery of the injured environment. Projects can include Direct Restoration - activities to enhance natural recovery; and/or Indirect Restoration - other activities to contribute to and protect the natural recovery process. As it is difficult to directly Restore an injured ecosystem, Indirect Restoration is often the most useful means for a government to aid in environmental recovery. This includes the protection of an injured ecosystem from additional injury.

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EVOS Trustee Council (U.S.)	www.oilspill.state.ak.us
IOPC Fund	www.iopcfund.org
ITOPF	www.itopf.com
IMO	www.imo.org
UNEP	www.unep.org
Dept. of Interior (U.S.)	www.restoration.doi.gov/

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