SPILL IMPACT MITIGATION ASSESSMENT FRAMEWORK FOR OIL SPILL RESPONSE PLANNING IN THE ARCTIC ENVIRONMENT

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When there is risk for oil release into the marine environment, the priority for planners and responders is to protect human health and to minimize environmental impacts. The selection of appropriate response option(s) depends upon a wide range of information including data on the fate and behavior of oil and treated oil, the habitats and organisms that are potentially exposed, and the potential for effects and recovery following exposure. Spill Impact Management Assessment (SIMA; a refinement of Net Environmental Benefits Analysis, or NEBA, in the context of oil spill response) and similar comparative risk assessment (CRA) approaches provide responders a systematic method to compare and contrast the relative environmental benefits and consequences of different response alternatives. Government and industry stakeholders have used this approach increasingly in temperate and subtropical regions to establish environmental protection priorities and identify response strategies during planning that minimize impacts and maximize the potential for environmental recovery. Historically, the ability to conduct CRA-type assessments in the Arctic has been limited by insufficient information relevant to oil-spill response decision making. However, with an increased interest in shipping and oil and gas development in the Arctic, a sufficiently robust scientific and ecological information base is emerging in the Arctic that can support meaningful SIMA. Based on a summary of over 3,000 literature references on Arctic ecosystems and the fate and effects of oil and treated oil in the Arctic, we identify key input parameters supporting a SIMA evaluation of oil spill response in the

Arctic and introduce a web portal developed to facilitate access to the literature and key considerations supporting SIMA.

KEY WORDS: Oil spill response, Arctic, spill impact management assessment (SIMA); net environmental benefits analysis (NEBA), valued ecosystem components

I. INTRODUCTION

The changing Arctic environment may provide new opportunities for energy, shipping and other resource and economic development activities. Several emerging environmental, economic and social sensitivities pertaining to shipping activity, oil exploration and transport, as well as fishing and tourism in the region arise from increasing periods of open water in the Arctic (NRC 2014; Arctic Council 2009; 2015; Lloyds 2012; DNV-GL 2016). Accordingly, international organizations are working to formulate strategies to minimize the various risks that could be presented by these activities. For example, the International Maritime Organization (IMO) has adopted the International Code for Ships Operating in Polar Waters, which includes mandatory measures covering safety and pollution prevention for shipping, oil and gas and fishing in these waters (IMO 2014). Similarly, the Arctic Council provides international oversight and operating guidelines for shipping and oil and gas activities in the Arctic (Arctic Council 2009; 2015). In addition, the Arctic Oil Spill Response Technologies Joint Industry Program (ART-JIP) is nearing completion of a 5-year program, managed by the International Association of Oil & Gas Producers (IOGP), to undertake research that advances the state of science regarding Arctic oil spill response (IOGP 2016).

Oil spill response (OSR) planning and preparedness has been shown to be effective in the Arctic, particularly when rigorous planning and preparedness work has been undertaken to consider consequences and response options for likely and credible, worst case accidental oil releases. This effort is substantially improved in conjunction with the use of spill modelling and risk analysis tools to evaluate response alternatives and support response decision making. Spill modeling and risk analysis tools are most effective when the following are accounted for:

i. A range of potential OSR scenarios, from small vessel refuelling or operational releases to those scenarios considered to be "credible worst case" in terms of oil volumes, environmental sensitivities and weather conditions;
ii. The need to support smaller scale logistical decisions made within a larger response scenario;
iii. Variable physical conditions, including the presence or absence of specialized environmental compartments (e.g. sea ice, polynyas and open water) that can affect the choice of the most environmentally beneficial spill response options and their effectiveness;
iv. Highly variable populations of aquatic life that may or may not be present in the different compartments, with aggregations of particularly sensitive species occupying some compartments; and,
v. Variable recovery times for Arctic species, particularly for aggregations of species that may be threatened or endangered.

Comparative risk assessment (CRA) models have been used for comparing and ranking the environmental consequences of different OSR management alternatives (e.g., French-McCay et al. 2017; DNV-GL 2014). As applied to OSR, Spill Impact Mitigation Analysis (SIMA) is an evaluation of the relative risks associated with different OSR alternatives compared to a "no intervention alternative" in the context of oil spill response. SIMA is the next evolution of net environmental benefits analysis (NEBA), a conceptual methodology developed to support decision making during environmental emergency response. SIMA focuses on the consequences of oil spills and OSR on environmental compartments (ECs) and ecological attributes during a spill event .

It is generally acknowledged by U.S. and other national environmental agencies that OSR plans provide critical guidance during spills events to operators and responders. SIMA and similar CRA tools can be used during OSR plan development to simulate spill events and predict outcomes such that best practices and OSR strategies most likely to contain and mitigate spill impacts are identified and made available. These tools are most useful in preparing for and conducting “Tabletop Spill Exercise Drills,” wherein planners and responders work together to simulate an event, evaluate options predicated on particular environmental and seasonal conditions, and practice using appropriate emergency response techniques (see, for example, TRP 2011).

In the Arctic environment, SIMA and similar CRA methods for OSR assessment can provide oil spill planners and responders with a systematic approach to weighing the complex array of underlying environmental data needed to make OSR decisions, including oceanographic, chemical, and biological information on the fate of hydrocarbons and OSR residuals in the Arctic; ecosystems and key food web components; toxicity of oil and OSR residuals; and, the potential for Arctic ecosystems to recover after a spill event. Broad recognition of these data needs prompted marked investments in scientific research applicable to SIMA in the Arctic, including programs led by the Arctic Council, various oil and gas industry joint industry programs (JIPs), and dedicated polar research programs conducted by research institutions in 15 countries (Lloyds 2012).

In this paper, we summarize the results of a five-year IOGP research program aimed at compiling the growing body of scientific information on oil behaviour in cold climates and Arctic ecology. We describe an information portal on the Internet developed as part of this work to organize the key environmental information within a framework consistent with SIMA and other CRA approaches for evaluating OSR alternatives. The information portal is intended to support quantitative advances in the NEBA process that have evolved in different decision-making frameworks similar to SIMA (API/IPIECA/IOGP 2016); these approaches, advocated by different organizations and regulatory agencies, for OSR planning and preparedness are briefly reviewed. Lastly, we describe the framework for conducting a SIMA in the context of the information portal by linking the current Arctic research data to the important environmental and ecological attributes pertaining to exposure, impact, and recovery of different ECs and valued ecological receptors in the Arctic.

II. DEVELOPMENT OF AN ARCTIC OSR INFORMATION PORTAL

An Arctic SIMA analysis requires understanding of expected oil fate and exposures in cold climate conditions, such as can be achieved through oil spill trajectory modelling. It also requires determination of the resources at risk and their ecological effects and recovery, much of which can be achieved through review of relevant literature and environmental data. For nearly 40 years, researchers have published numerous studies regarding the fate and effects of oil in the Arctic, including peer-reviewed literature, technical reports, government studies and professional symposia. Additionally, data exist in a number of different languages, as research has been conducted throughout the North American, European, and Russian Arctic.

The ART-JIP (Artic Response Technology) program has developed a web portal to organize information as a companion to SIMA. The portal facilitates access to the increasing body of scientific literature relevant to understanding the behaviour of oil in the Arctic environment and its consequences on the polar environment. The informational portal is found on the internet at http://neba.arcticresponsetechnology.org/. The fully searchable report and literature database enables rapid access to a wide scientific knowledge base relevant to work aimed at minimizing the environmental impacts of an oil spill event. The portal compiles technical and scientific reports identified by an international consortium of Arctic and oil spill research scientists describing field studies and research pertinent to each of four primary OSR alternatives - monitored natural recovery, mechanical recovery, surface dispersant application and *in situ* burning (ISB).

In addition to segregating published information according to different OSR alternatives, the research is segregated according to its relevance in four key parameters necessary for SIMA – ECs and valued ecological components (VECs); potential for exposure to oil in each

EC for different VECs; consequences of oil exposure to a VEC; and potential for a VEC to recover after exposure to oil. Scientific information relevant to a fifth consideration, resilience of the VEC to oil exposure (i.e., the ability to return to a stable state), is also identified; however, few research studies distinguish resilience from recovery when reporting on field work and the body of information useful to SIMA remains limited at present time. The information portal provides access to relevant studies for each of the OSR alternatives within each of the four SIMA parameter categories. As such, OSR planning and preparedness experts using SIMA for management and decision making purposes can access information important for comparing different OSR strategies and estimating the possible consequences to ECs and VECs, as well as the recovery potential for both, for different environmental conditions.

III. OIL SPILL RESPONSE PLANNING AND PREPAREDNESS IN THE ARCTIC

A growing volume of work on OSR strategies and different OSR technologies applicable to the Arctic environment has been published with the aim to support industry-wide best practices in the Arctic. This work has benefited from the numerous environmental impact assessments prepared jointly with governments as part of the permitting of project-specific oil and gas exploration activities. This work is generally represented by six different types of comparative assessment. The first is Net Environmental Benefits Analysis (NEBA), a risk-based alternatives analysis first applied in Prince William Sound, Alaska as part of the Exxon Valdez oil spill response (NOAA 1990). This approach was one of the first CRA tools for evaluating the potential cumulative consequences, both beneficial and harmful, associated with the use of different remediation technologies relative to a no-action alternative. NEBA has since been formalized for oil spill response by ASTM Method 2532-13 (ASTM 2013) and IPIECA (2015). NEBA has been used to support OSR planning in cold water environments (e.g., HDR 2015; Gardiner et al. 2015). NEBA often includes ecological, socioeconomic and human health considerations and has been used both as a stand-alone assessment of one or more OSR technologies and to support consensus-building among oil spill assessment experts.

A second CRA approach is Consensus Ecological Risk Assessment (CERA). The US Environmental Protection Agency (USEPA) and US Coast Guard (USCG) rely on CERA as the preferred approach to OSR planning in the US Arctic and in the Canadian Beaufort Sea (Aurand *et al*. 2000; Aurand and Essex 2012; BREA 2011). CERA focuses on ecological considerations, and rarely addresses social, cultural or economic issues. A unique aspect of this approach is reliance on the consensus of a broad panel of response planners and any potentially involved stakeholders to make decisions about receptors, exposure potential and the severity of the consequences of crude oil releases to the environment.

Outside the US and Canada, the Norwegian regulatory community has invested considerable effort in the development of CRA tools. Net Environmental Damage and Response Assessment (NEDRA) is similar to NEBA and is used in conjunction with the Oil Spill Contingency and Response (OSCAR) model system for comparative analysis of changes in environmental damages associated with the use of different OSR alternatives as compared to the absence of intervention (SINTEF 2015). A closely related fourth approach, also used in Norway, is Methodology for Environmental Risk Analysis (MIRA). MIRA is a quantitative decision support tool similar to NEDRA that was refined in 2014 to evaluate potential damages associated with spilled oil in the marginal ice zone (MIZ) (OLF 2007; DNV-GL 2014).

The evolution of CRA decision-support methods for OSR planning and preparedness continues concurrent with advancements in our scientific understanding of crude oil behaviour in the Arctic and its consequences on the polar environment. Following from CRA work conducted to examine the effectiveness of subsea dispersant use in deepwater in the northern Gulf of Mexico in 2016 (French-McCay et al. 2017), Spill Impact Mitigation

Assessment (SIMA) emerged as the next refinement of NEBA. Recognizing the disconnect between "environmental benefits" and evaluation of an oil spill, the NEBA paradigm has been refocused for the fundamental purpose of identifying and optimizing OSR approaches for mitigation of the ecological and environmental consequences of an oil spill. SIMA represents the merger of prior decision-support and comparative assessment tools by focusing on the trade-offs among different OSR approaches aimed at reducing the short-term and long-term adverse impacts to the environment, in terms of the ecological, socio-economic and human health consequences.

The SIMA process is comprised of four steps consistent with IPIECA (2015), as summarized in **Table 1**.

1. Compile and evaluate data to identify an exposure scenario and potential response options, and to understand the potential impacts of that spill scenario.
2. Predict the oil fate outcomes for the given scenario, determine effective and feasible response options.
3. Balance trade-offs by weighing a range of ecological risks resulting from each feasible response option. This includes consideration of the following technical information:
    a. Identification of resources at risk, which may include both human and ecological receptors;
    b. Determination of exposure concentrations based on the fate and transport characteristics of the released oil and/or the residues of treated oil;
    c. Estimation of changes to one or more valued ecosystem components (VECs) based on the sensitivity of the VEC based on either predicted (i.e., modelled) or measured exposure concentrations, and the potential for the VEC to recover.
    d. Evaluation, required in some countries, of the socio-economic benefits and costs resulting from each response option; and,
4. Select the best response option or set of options for a particular oil spill event scenario, based on the results of the comparative analysis that will optimize the removal or isolation of spilled oil in the environment with minimal disruption of the ecosystem.

Table 1. Four Steps of the SIMA Process (IPIECA 2015)

The latter two steps are dependent upon an array of technical information regarding the study area, the nature of the release event (from Steps 1 and 2), and the ECs (habitats) and valued ecosystem components (VECs; resources at risk) that are potentially exposed, including their potential for effects and recovery (see **Figure 1**). In order for spill responders to conduct each of these fundamental assessment steps, they must be able to access large amounts of technical information in a variety of scientific and engineering disciplines.

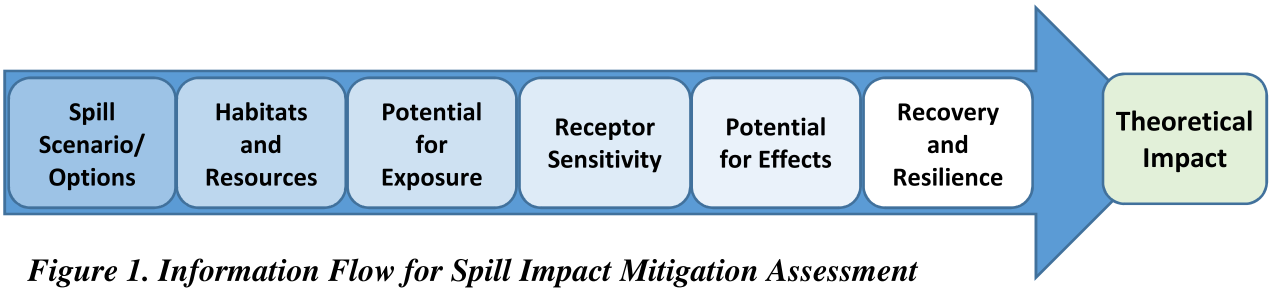

Figure 1. Information Flow for Spill Impact Mitigation Assessment

IV. KEY CONSIDERATIONS FOR EVALUATION OF OSR ALTERNATIVES

A. Definition of ECs and VECs

Arctic ecosystems are characterized by diverse and temporally variable food webs and wildlife that may be present in large aggregations within different habitats. The ECs defined within a SIMA analysis are those habitats where Arctic resources may be at risk of exposure to oil and OSR residues. In some cases, the ECs considered in the Arctic are similar to those in temperate and sub-arctic regions (e.g. sea surface and open-water pelagic zones). The Arctic, however, also includes habitats defined by sea ice. The sea ice represents a varied habitat defined by stage of development (e.g., multi-year ice, annual (first-year) ice, and new ice) and concentration (e.g. open drift ice, pack ice, fast ice, etc.) or polynyas. When oil and ice interact, some fraction of the oil between the floes may move with the sea ice, which does not necessarily follow the ocean currents (Drozdowski et al. 2011). In general, the effect of ice on oil movement is negligible at up to 30% of ice coverage. For ice coverage between 30% and 80%, movement is influenced partially by wind and current. For ice coverage above 80%, the oil is assumed to be trapped under the ice and move with it (Khelifa 2010).

In cases where the oil is trapped under large ice floes, the oil is generally contained and follows the ice (Singsaas et al. 1994; Buist et al. 2009). The presence of ice can also shelter the oil from wind and wave action, subsequently slowing down spreading and weathering of the oil (DNV-GL 2014). Oil under an ice sheet or pack ice will be completely encapsulated within 18 to 72 hours, depending on the time of year (Dickins 1981, Buist 1983). Once in the ice, oil may migrate up through brine channels to the more highly saline surface ice. Recent research compiled in the IOGP-ART information portal also describes the effectiveness of oil spill countermeasures in the presence of ice, including mechanical recovery, dispersants, and ISB (Faksness et al. 2011, 2012).

Ecological receptors, or VECs, are species or groups of species that represent the resources at risk targeted for protection in the context of deploying different OSR actions. VECs may be isolated to one EC; however, it is more common for most Arctic species to inhabit, forage and/or spawn in several aquatic, shoreline and inland ECs and habitats. A SIMA-based analysis can be performed by combining the taxa groups present in the affected area into defined VEC groupings, except in instances where one key species or specific community is central to evaluating the level of concern. In such cases, the analysis may be customized to include species that are important to specific regions. Generally, VECs include taxa with all or some of the following characteristics:

- Taxa that are important to the function of Arctic food webs;
- Taxa that are representative of pelagic, benthic, and sea-ice realms;
- Taxa that are relatively abundant;
- Taxa that are threatened or endangered; and,
- Taxa that may have cultural or commercial importance.

The set of VECs representative of the pan-Arctic environment and included in the ART-JIP information portal are listed in **Table 2**. The distribution of biological communities in the Arctic is highly variable because of the seasonal movement of both resident and migratory species. A critical component guiding OSR decision making is identifying the presence of threatened and endangered species and areas with aggregations of species (e.g. among ice floes, in coastal lagoons, or on selected beaches). An understanding of the regional and pan-Arctic distribution of species, which is summarized in the ART-JIP information portal, can inform the definition of the study areas, as well as the compartments and VECs included in the SIMA.

B. Potential for VEC Exposure

In SIMA analysis the potential for VECs within each EC to be exposed to oil can typically be estimated using oil spill trajectory modeling. The ART-JIP information portal contains a supplemental information on oil fate and transport under different OSR alternatives to ensure that all considerations are made within the modeling framework. Notably, the portal contains documentation of oil fate in ice conditions and provides the literature basis for addressing exposures to OSR residues, such as ISB residues and dispersants. Such literature may be necessary for supporting the oil spill model design and for identifying mechanisms of exposure (such as surface fouling or droplet ingestion) that may be of importance to specific VECs.

C. Consequences of Exposure to VECs

The ART-JIP information portal summarizes currently available ecotoxicity studies involving Arctic organisms exposed to different types of crude oil under specific conditions for a given amount of time. Such studies provide information on both the concentration of oil needed to elicit a negative biological effect and the relative toxicity of different OSR options.

While there are some examples of field toxicity studies (e.g. Cross et al. 1987, Neff et al. 1987), most toxicity studies performed on Arctic fish, invertebrate and algal species are laboratory studies under controlled conditions. Acute toxicity studies with Arctic species have been conducted with physically and chemically dispersed oil, in-situ burn residues with a variety of different types of oil, as well as pure PAH compounds (e.g. 2,4 methylnaphthalene). Test exposures have included continuous and “spiked” exposures.

Continuous exposures are applicable to environmental scenarios where the VECs are likely to be exposed to oil and oil spill residues for a prolonged period, whereas spiked exposures simulate a declining concentration, where there is an initial pulse of oil or treated oil and then the concentration declines quickly to near background levels. Longer duration, chronic tests have been conducted with both Arctic fish and invertebrates and often evaluate sub-lethal endpoints. A summary of acute and chronic studies is presented in the IOGP-ART literature portal.

The biological effects of physical contact of oil with respiratory organs (i.e. lungs and gills) and the outer body of the organism should also be considered; this is especially important for birds and marine mammals. Disruption of the insulation properties of feathers and fur resulting from oil fouling can lead to hypothermia and the loss of buoyancy (Jenssen and Ekker 1991, Jenssen 1994, Williams and Davis 1995, Hurst and Ørisland 1982, Duerr et al. 2011). Additionally, some studies show that inhalation of volatile components can cause lung injury, especially for cetaceans due to deeper lung exchange and reduced capacity to filter air than humans (Schwacke et al. 2013, Green 1972, Irving et al. 1941).

Several general conclusions can be drawn on the relative toxicity of natural attenuation versus dispersants to Arctic fish, invertebrate and algal species. Dispersants increase oil concentrations in the water column in the short term, increasing acute toxicity. However, oil concentrations in the water column quickly decrease due to dilution, transport, and biodegradation over the long term, thereby decreasing chronic toxicity. Several studies have shown similar toxicity, based on measured hydrocarbon concentration, between mechanically and chemically-dispersed oil, and between water accommodated fraction and chemically-enhanced water accommodated fraction (Gardiner et al. 2013, Vevers et al. 2010, Frantzen et al. 2016, Hansen et al. 2012, Frantzen et al. 2015, Olsvik et al. 2012, Adams et al.

2014, Cross 1987). These observations may be dependent upon the type of dispersant used and the presence of sunlight (Aunaas et al. 1991, Barron et al. 2003).

Researchers have also conducted toxicity studies to evaluate the biological effects of ISB residues in the Arctic. Faksness et al. (2011; 2012) found no change in water column toxicity to the copepod *C. finmarchicus* after ISB use. Temperate studies found similar results for both invertebrates and fish (Daykin et al. 1994, Blenkinsopp et al. 1996, Gulec and Holdway 1999).

Studies comparing the response of Arctic versus temperate species to oil and dispersed oil have found animals in both environments to possess similar sensitivities (Camus et al. 2015, Olsen et al. 2011; Gardiner and Word 2015). One study by Hansen et al. (2011) showed some indication that Arctic species take a longer time after exposure to elicit effects, which may be tied to differences in temperature and lipid stores.

In a SIMA evaluation, toxicity thresholds derived from species sensitivity distributions are generally used to define the potential for effects related to petroleum hydrocarbons. Species sensitivity distributions are cumulative distributions of laboratory-derived toxicity endpoints (Figure 2) that can establish concentration thresholds that are assumed to be protective of a range of species (Bejarano et al. 2014).

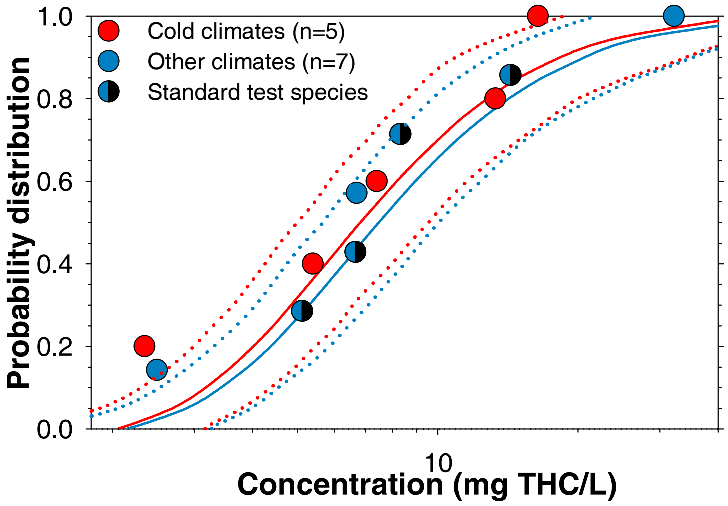

Figure 2: Relative sensitivity of cold water species vs. species from other climates (subtropical/temperate) to medium oils (WAF/CEWAF combined; Bejarano (2014).

D. Potential for Recovery/Resilience

Resilience and the potential for recovery of the species or group of species after exposures associated with an oil spill is an important consideration of a SIMA-based analysis. The Arctic marine and coastal areas have notable aggregations of ecological resources with long recovery times (e.g. walruses) and locations where an entire population of a given species may occupy a confined area (e.g. Kasigluk Lagoon, Alaska). For some species, their high biological densities in one or more Arctic aquatic compartments can provide considerable resilience (e.g. copepods), allowing populations to recover from either sudden natural changes or human-caused environmental stresses such as an oil spill.

For the purposes of SIMA, recovery is the estimated length of time that it takes for a VEC to recover to the ‘natural’ range of conditions prior to exposure to oil and OSR actions. The speed of recovery after exposure is related to biological characteristics of the affected species or populations. There are two general mechanisms influencing population recovery: 1) recruitment and import of individuals from unaffected areas, and 2) the reproductive success of affected populations. In the first case, organisms that are widely distributed in the Arctic and occupy multiple compartments may recover rapidly after oil exposure. The second mechanism relies on the intrinsic ability for a species to repopulate after exposure. The biological attributes that contribute to resilience of a species include sensitivity of species to the types of disturbance, population age structures, age to fecundity, progeny produced per year, natural mortality rates and propensity of the species to congregate in high abundance.

In addition to species or population recovery, the potential for the EC to recover is another important consideration. EC recovery is the time expected for oil concentrations within the EC to return to levels that are below one or more effects thresholds; an oil fate model may capture this factor as a duration of exposure, in which case the EC recovery time does not need to be separately evaluated. In general, Arctic ECs considered to have low resilience are cobble beaches, estuaries and lagoons.

V. CONCLUSIONS

SIMA is a relatively new method for comparative risk assessment that follows closely the traditional approach for oil spill planning and preparedness and represents a refinement of what heretofore has been referred to as NEBA. SIMA focuses on the trade-offs among different OSR approaches with the aim of avoiding, eliminating and/or mitigating the ecological and environmental consequences of an oil spill. The ART-JIP information portal was developed to facilitate access to the scientific and technical literature relevant to the pan-Arctic environment and useful in a SIMA-based analysis. The information portal captures a large and ever-increasing body of research and is structured to capture information describing four key parameters used in SIMA decision-making: ECs and VECs; potential for exposure to oil in each EC for different VECs; consequences of oil exposure to a VEC; and potential for a VEC to recover after exposure to oil. Further, the portal is organized to facilitate examination of the key parameters in the context of four OSR alternatives: monitored natural recovery, mechanical recovery, surface dispersant application, and ISB.

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Table 2. List of Arctic VEC Groups and Associated Environmental Compartments (ECs) Found in the IOGP-ART Information Portal

VEC Groups	ECs Where VECs are Exposed											
	Air	Sea Surface Layer	Sea Ice	Open Water Shallow (<10m)	Open Water Mid (>10m)	Deep Sea	Benthic	Nearshore <10m	Intertidal			
									Sand	Cobble	Lagoon	Rocky
Ice algae/phytoplankton		●	●	●	●							
Eelgrass											●	
Kelp											●	●
Pelagic invertebrates		●	●	●	●	●						
Eggs/Ichthyoplankton		●				●		●				
Polar/Arctic cod			●	●	●	●		●				
Planktivorous fish/Forage fish				●	●	●		●				
Piscivorous fish				●	●	●		●				
Cold-water coral						●	●					
Epifauna/Megafauna						●	●		●	●	●	●
Infauna						●	●		●	●	●	
Demersal fish						●	●	●				
Baleen whales	●	●		●	●	●						
Beluga whale	●	●	●	●	●	●						
Narwhal	●	●	●	●	●	●						
Orca	●	●		●	●							
Walrus	●	●	●	●	●				●	●	●	●
Seals	●	●	●	●	●				●	●	●	●
Polar Bear	●	●	●	●					●	●	●	●
Coastal benthic feeding birds	●	●							●		●	
Pelagic diving birds	●	●	●	●	●							
Coastal diving birds	●	●						●				
Pelagic surface feeding birds	●	●	●									
Coastal surface feeding birds	●	●	●					●				