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An Analysis of Change in Policy Context Regarding COREXIT Dispersant Use Following the Deepwater Horizon Oil Spill

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AN ANALYSIS OF CHANGE IN POLICY CONTEXT REGARDING COREXIT DISPERSANT USE FOLLOWING THE DEEPWATER HORIZON OIL SPILL

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ABSTRACT

On April 20, 2010, an explosion on the offshore drilling platform Deepwater Horizon located in the Gulf of Mexico resulted in the largest oil spill in U.S. history. The subsequent use of massive amounts of chemical dispersants near the Gulf floor, an untested method, led to great controversy regarding the regulation, use, and toxicity of dispersants of the COREXIT family of products, as well as of dispersants in general.

This study compares dispersant (COREXIT brand products in particular) regulation and use in the United States, Norway and the United Kingdom; the latter two countries are among the largest oil producers in the European Union. This study also applies Kingdon's conceptual model of public policy development as a convergence of three independent "streams" in an attempt to gauge the outlook for increased regulation in the United States regarding COREXIT dispersants based on patterns of federal research funding, possible policy tool options, the existence of political will, and the perspective of the dispersant industry. The study found that with the exception of toxicity testing and approval mechanisms, the United States, Norway and the United Kingdom differ little in dispersant regulation and use. When research funding was examined, it was found that while initial funding levels increased, this may not be sustainable in the long term and therefore not a reliable indicator of the likelihood of policy change in the U.S.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

As oil exploration and production extend farther out into deeper offshore waters, the likelihood of accidents and spills will increase. The toxic nature of oil necessitates the remediation of spills using techniques and tools that will have the least impact on the environment. Dispersants, chemical agents that break up oil in water, are perhaps the most controversial of the tools employed in oil spill cleanup, yet are considered by many experts to perform a valuable function (Fiocco, 1999).   The Deeepwater Horizon spill in the Gulf of Mexico in 2010, in which unprecedented amounts of dispersants were used, brought these chemicals to the forefront of scientific and public debate. This research examines dispersant use policy in the United States, and Norway and the United Kingdom, two leading European oil producers, and the likelihood of future changes in U.S. regulations.

Among various conceptual models to explain the processes involved in formulating new public policy, John Kingdon's "multiple streams" framework best lends itself to an investigation of the current state of dispersant-use policy in the United States. In contrast to linear models of public policy formation, where laws and policies are seen as the product of a series of sequential steps, the Kingdon framework describes three categories of activity that must be developing concurrently for new laws and public policies to be enacted. Unlike a linear model, the Kingdon framework does not consider decision makers as solitary individuals faced with clear-cut choices when making policy and accounts for participation of individuals/groups outside the government elites (Porter, 1995).   In the Kingdon framework, the independent forces (streams) that lead to policy formation are seen to be in a state of flux.   Only when these streams converge on a common point, a policy "window", is it possible for policy to be inacted (Guldbrandsson, 2009). The streams are labeled "problem", "politics", and "policy" (Kingdon, 1984).

The lack of comparative analyses of the United States, Norway and the UK (two leading European oil producers) regarding dispersant-use policy as well as an analysis of U.S. policy using the Kingdon framework prompted this research. This research examines the "problem stream" by using federal research funding as an indicator of interest among U.S. policy makers to regulate the use of COREXIT dispersants in response to the Deepwater Horizon spill. Examination of the "policy stream" includes possible policy tools, with incentives and disincentives for the manufacturer, that may be used in the regulation of these particular dispersants. Lastly, examination of the "politics stream" includes evidence of political will from government as well as the perspective of the dispersant industry.

1.2 Objectives

The objectives of this research are:

1. To compare use and regulation of dispersants in the U.S., Norway, and the U.K.
2. To examine the outlook for changes in the regulation of COREXIT dispersants in the U.S. using the Kingdon multiple streams model to detect progress toward the formulation of new regulatory policy.
3. To add to our understanding of dispersant use policies and suggest policy methods which may be used to bring U.S. policy regarding COREXIT use in line with that of Norway and the United Kingdom.

CHAPTER TWO: LITERATURE REVIEW

2.1 Kingdon's Multiple Streams Framework

The metaphor of three streams converging as presented in Kingdon's conceptual model of policy development differs from a linear stages model. In the linear stages model, the policy making process is seen as progressing in distinct, sequential stages that are analyzed independently, each in turn. Traditional policy analysis is customarily broken into the following stages: problem identification by way of calls for government action, the setting of agendas by focus of public attention on the problem, the policy proposal formation by government officials and other stakeholders, policy adoption through action of government and stakeholders, policy implementation and finally, evaluation of implementation and impact of policy (Porter, 1995). In the linear model, each stage is followed by another specific stage in the process with one stage reaching completion before the next can begin. Strengths of the linear model include the fact that it divides the policy making process into concise, easily manageable segments more amenable to analysis, while it has been criticized as not being an accurate reflection of how policy formation actually occurs (Porter, 1995).

Kingdon's framework is more abstract than the linear model in that the three "streams" flow independently of each other. According to this model, all three streams must be flowing in tandem when a "policy window" opens, only then can policy be created (Kingdon, 1984). If a problem has not been identified, or policy solutions do not exist and or the political will to take action does not exist when conditions are right, policy will not be formed.

One defining characteristic of the multiple streams model is the concept of the "policy entrepreneur". The policy entrepreneur exists in the policy stream and attempts to merge the streams when a policy window of opportunity opens up (Nowlin, 2011). Recent research has

produced revisions to the multiple stream model which include adding additional institutional factors such as state government structures, called policy milieu, as well as the expansion of the policy stream to include the problem and politics stream into a "policy field" (Nowlin, 2011).

2.2 History of Dispersants

First used in 1966 on an offshore tanker spill in Germany, oil spill dispersants are an effective and valuable tool in the remediation of oil spills (Etkin, 1998). This and other early successes led to the regular use of these chemicals, with 90% of major spills involving dispersant use between 1966 and 1969 (Etkin, 1998).

In 1967, the Torrey Canyon tanker spill near Land's End, UK resulted in an estimated 38.2 million gallons of crude oil being released into the sea and 420,000 gallons of dispersants being used to combat the disaster (Etkin, 1998). The dispersants, highly toxic, aromatic hydrocarbon based formulations, formed stable emulsions which persisted in the environment and caused ecological damage far in excess of that which would have occurred had the chemicals not been used (Etkin, 1998).

The notoriety of the Torrey Canyon incident led to concern that dispersants were themselves highly toxic and that they made toxic oil components more available to the biota. This concern led to a huge decline in dispersant usage between 1970 and 1979, with only 52.2% of spill cleanups involving dispersant use (Etkin, 1998). These safety concerns led to the development of safer, though less effective, "second generation" dispersants in the 1970's, resulting in a further decline in use to 38% of spills being treated with the chemicals between 1980 and 1989 (Etkin, 1998).

Additional research in the late 1980's and early 1990's led to the development of safer and more effective 'third generation" dispersants which were concentrates comprised of high levels of surfactant and low levels of solvent which were diluted with seawater prior to use (Etkin, 1998). The higher surfactant level (up to 65%) in these formulations makes these chemicals effective at much lower concentrations with dispersant:oil ratios of up to 1:20 and 1:100 depending upon environmental conditions, compared to a ratio of 1:3 for older types (Fiocco, 1999). Despite these advancements, dispersant use continued to decline with only 28.4% of spills between 1990 and 1998 involving dispersants. Some observers feel that, despite reductions in use due to recovery technology advancements, part of the decline of theses 3rd generation chemicals is attributable to lingering concerns about toxicity (Etkin, 1998).

2.3 Chemistry of Dispersants

Dispersants have two principal components, surfactants, that reduce the surface tension of oil and solvents which facilitate the physical breakup of slicks into droplets which disperse into the water column (Fiocco, 1999). Surfactants, which are the active ingredient of a dispersant, have lipophilic (oil soluble) and hydrophilic (water soluble) sections.

As shown in Figure 1, this characteristic allows the surfactant to position itself at the oil-water interface, thereby lowering the oil-water interfacial tension and lowering the energy needed to form oil droplets in water (Fiocco, 1999). Once the slick cohesiveness is lowered, agitation by wave action results in finely dispersed oil droplets which are mixed into the water column (ARPEL, 2007). Surfactants vary in their degree of affinity for water and oil with some surfactants being slightly lipophilic and others slightly hydrophilic. To address this situation, surfactant blends are created to make the dispersant equally soluble in both the water and oil phases (Fiocco, 1999).

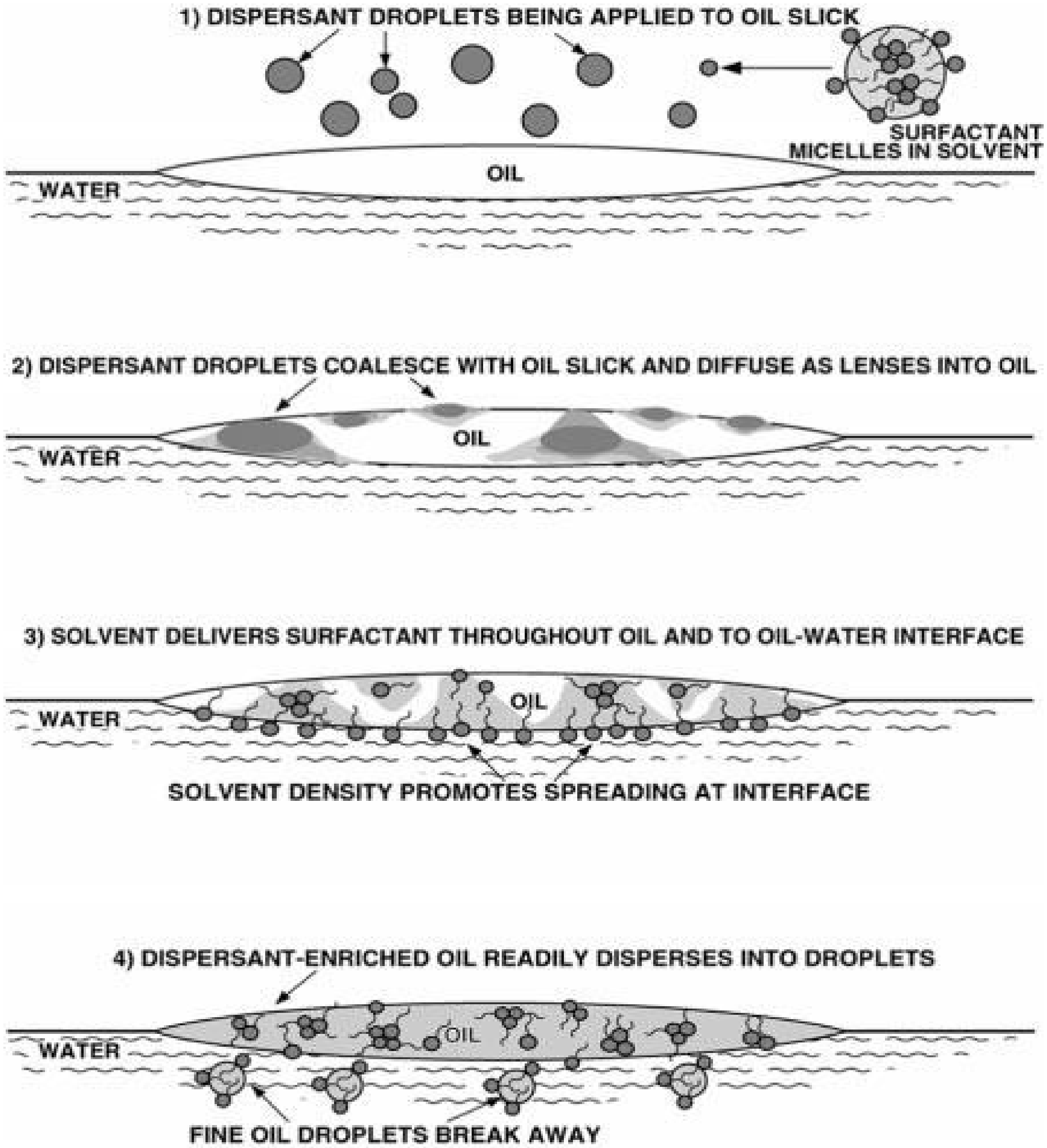

Figure 1. Chemical action of dispersants.
Source: Fiocco, 1999

The solvent portion of a dispersant performs several important functions, including solubilization of the surfactant blend in order to yield a viscosity amenable to the application system used to distribute the dispersant and penetration of the oil slick for the surfactant to reach the oil-water interface (Fiocco, 1999).

2.4 Fate and Transport of Dispersants and Dispersed Oil

Once the oil has been dispersed and enters the water column, the main concern becomes its ultimate fate. Figure 2 shows that within hours of dispersal application, oil descends into the water column to a depth of 1 to 30 feet with the concentration decreasing as it moves deeper (National Oceanic and Atmospheric Administration). Dispersant use is normally restricted to waters greater than 30 feet in depth in order to prevent contamination of the sediment which would increase the life of the oil in the environment (National Oceanic and Atmospheric Administration).

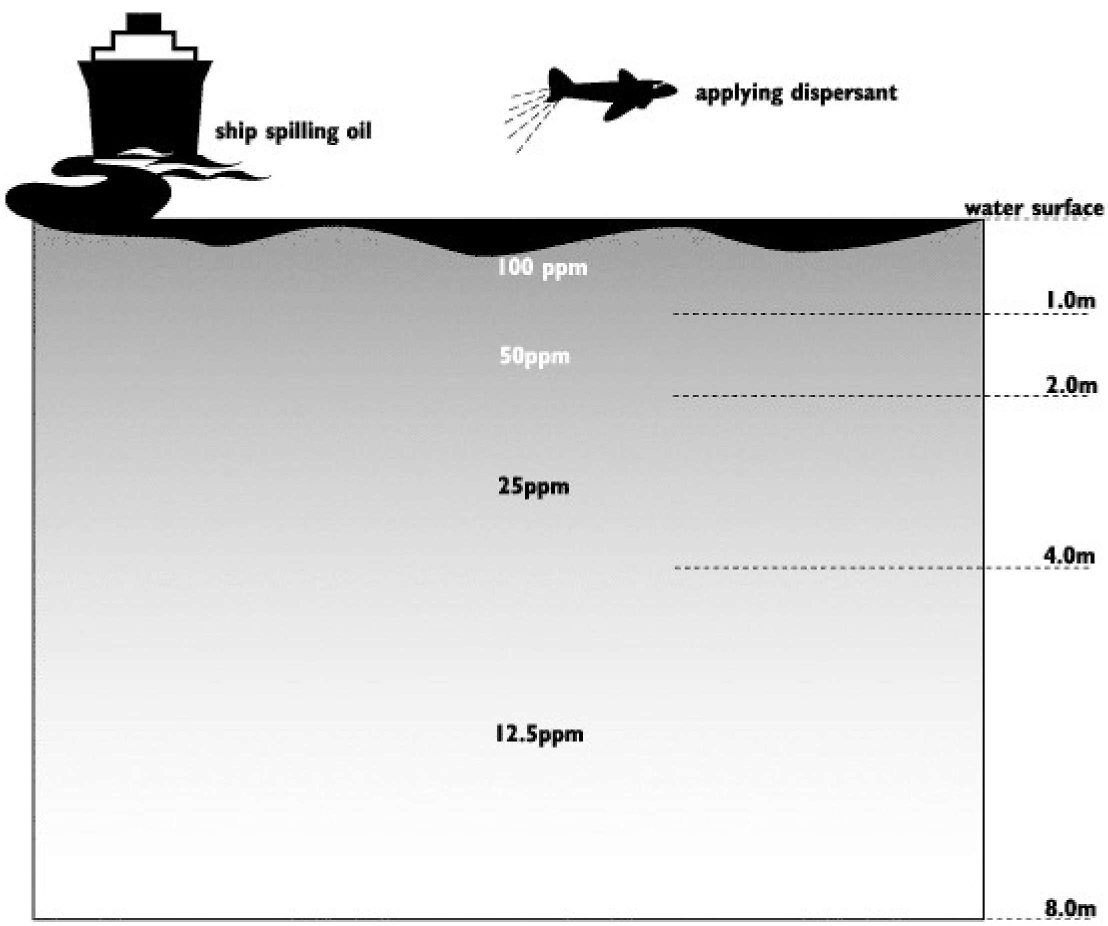

Figure 2. Estimated concentrations of dispersed oil by depth.
Source: National Oceanic and Atmospheric Administration

One of the benefits of using dispersants is the fact that dispersed oil has been shown to degrade faster than non-dispersed oil because the small droplet size of dispersed oil has a greater surface area upon which microorganisms may act (National Oceanic and Atmospheric Administration). As shown in Figure 3, a succession of organisms colonize dispersed oil droplets beginning with bacteria and culminating with higher order organisms such as protozoans and nematodes.

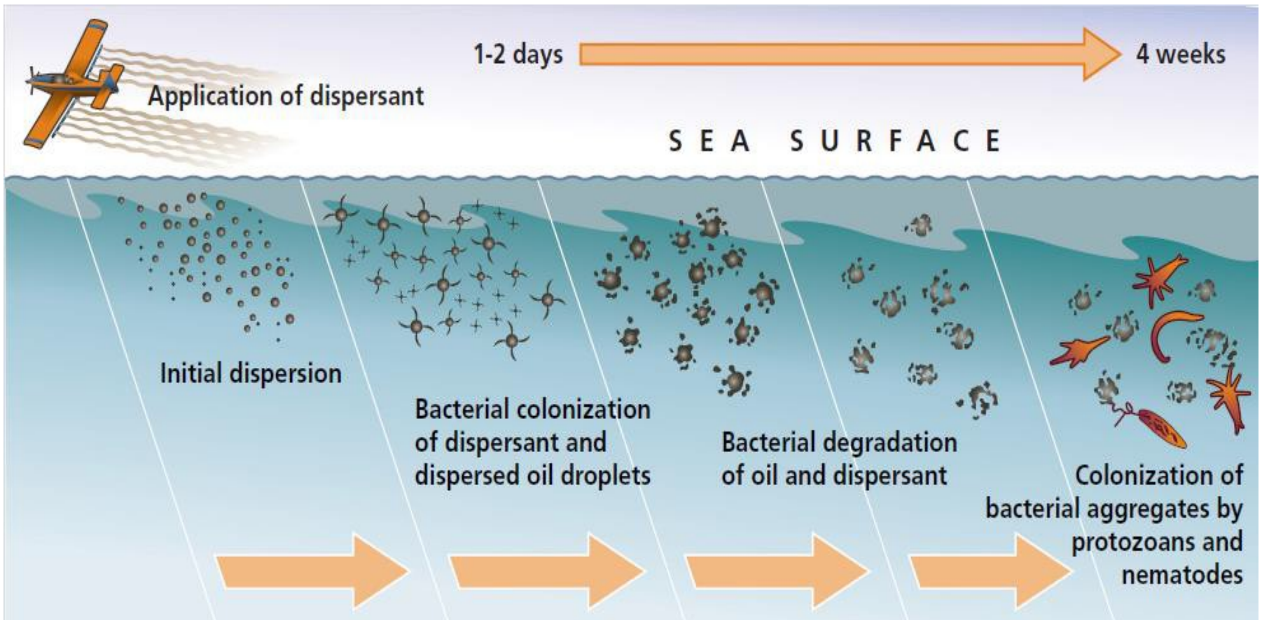

Figure 3. Biodegradation of dispersed oil.
Source: Schmidt, 2010

2.5 Tradeoffs of Using Dispersants

Methods exist for the cleanup of oil spills fall into two general categories: mechanical and non-mechanical. Generally, mechanical methods, which include skimming and the use of booms are preferred because they completely remove oil from the environment however, they cannot be used in all cases and do not recover all of the oil (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Mechanically recovered oil can in most cases be separated from water and reclaimed.

Non-mechanical methods, including in-situ burning and chemical dispersants, result in elimination and breakdown of spilled oil, but do not actually remove oil from the environment, instead redistributing it or its components (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Burning simply breaks the oil into its combustion products and distributes these into the atmosphere where they are diluted and carried away. Dispersants break the oil into small droplets which are then distributed to the water column.

Like other clean-up methods, dispersants have advantages and limitations which must be weighed when making decisions regarding their use. The benefits of dispersants include the protection of shorelines and fragile ecosystems such as estuaries and mangroves by breaking up oil slicks before they can reach these areas, protection of animals such as birds and mammals that have close contact with the water surface, and acceleration of biodegradation of oil by bacteria and other organisms (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). If dispersants are not used, oil can reach sensitive areas such as wetlands, where once deposited and buried, it can have lingering effects such as the disruption of biological and chemical processes, reduction in population size of organisms which comprise the base of the food chain, depression of productivity, and an increase in the susceptibility of the ecosystem to collapse (Louisiana Coastal Wetlands and Restoration Task Force, 2011).

Limitations of dispersant use include increased exposure to subsurface marine organisms such as fish and invertebrates to the oil itself and the increased dissolution of toxic byproducts of oil biodegradation into the water column, which may be more toxic than the oil itself (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Dispersants themselves have been shown in some lab studies to cause direct mortality in fish and invertebrates where the effects on populations can take years to appear and linger for over a

decade (Louisiana Coastal Wetlands and Restoration Task Force, 2011). Another drawback associated with using dispersants is the threat posed by dispersed oil to sensitive ecosystems such as coral reefs and seagrass beds that would be spared if oil is not dispersed (Figure 4).

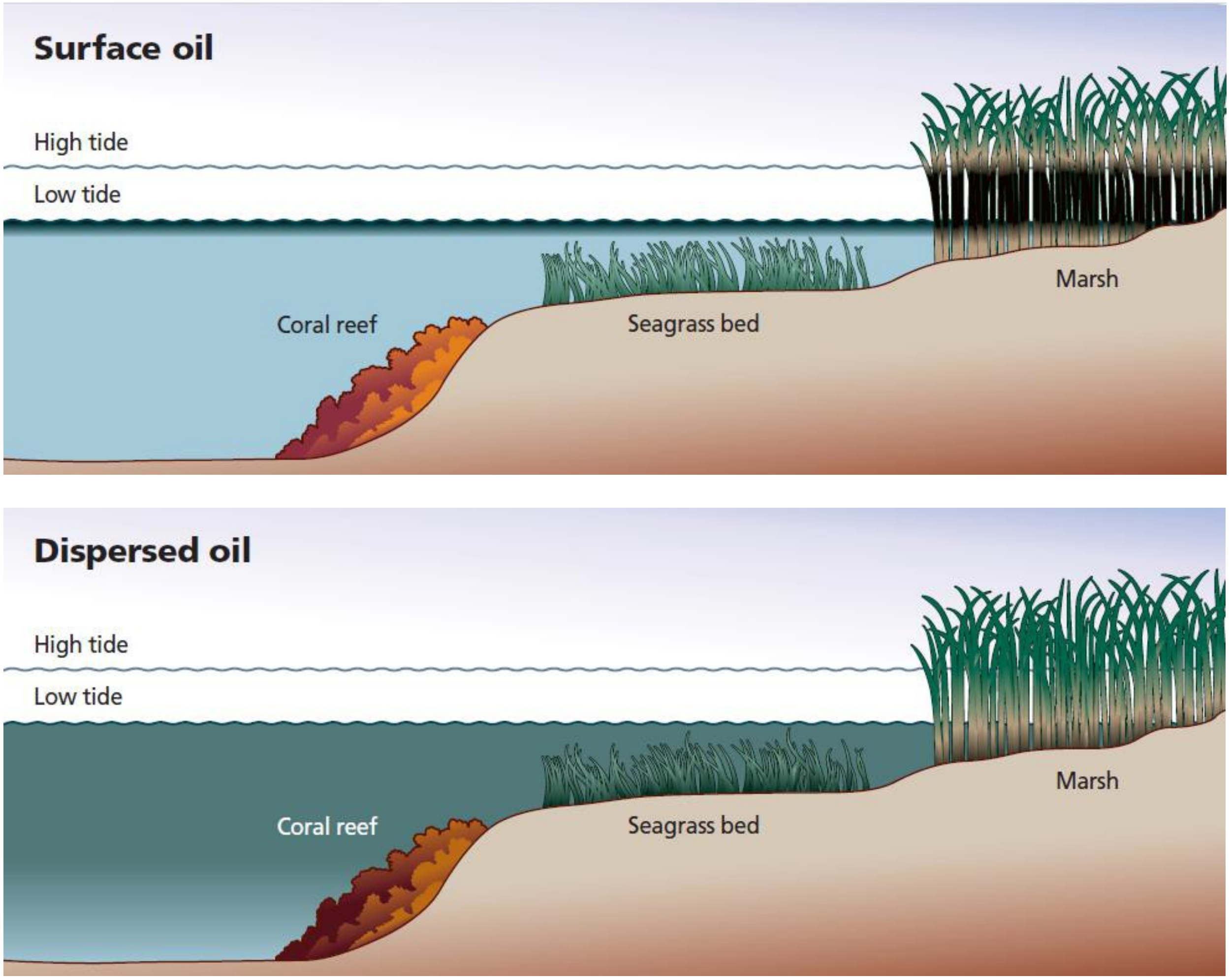

Figure 4. Surface oil vs. dispersed oil.
Source: (Schmidt, 2010)

2.6 Dispersant Application

Dispersants work by enhancing the natural dispersion rate which results from breaking wave action (International Petroleum Industry Environmental Conservation Association, 2001). For dispersants to be effective, they must be applied as soon as possible to an oil spill, before it loses

its ability to be dispersed (ARPEL, 2007). Weathered oil is much more difficult to disperse chemically as the loss of volatile hydrocarbons leads to increased viscosity, the formation of emulsions by wave action, and the slick becomes thinner and breaks into patches (National Research Council, 1989). Water-in-oil emulsion, also known as ‘chocolate mousse’, has a much higher viscosity than the parent oil and a volume up to four times greater due to the high water content which can reach 75% by volume (International Petroleum Industry Environmental Conservation Association, 2001). Normally, small spills of less than 12 bbl are not treated with dispersants, moderate spills of between 12 and 1,200 bbl are remediated using mechanical methods (booms and skimmers) and large spills above 1,200 barrels, if location and environmental conditions are favorable, are treated with dispersants (National Research Council, 1989). Dispersants can be applied using spray systems attached to watercraft, fixed wing airplanes or helicopters. In the case of large accidents, dispersants cannot completely treat the spill but can be used strategically to protect vulnerable areas and ecosystems (National Research Council, 1989). It is essential that dispersants be applied uniformly to the slick with droplets small enough to reach the oil surface at a velocity low enough to prevent penetration to the underlying water but large enough not to be carried away by wind (National Research Council, 1989).

While some conventional and 2nd generation dispersants are still available, 3rd generation dispersants are by far the most commonly used today. These dispersants, also known as ‘concentrate’ dispersants, can be sprayed undiluted at a 1:20-30 dispersant:oil ratio or mixed with seawater and sprayed at a 1:2-3 ratio with undiluted being the most effective and preferred method (International Petroleum Industry Environmental Conservation Association, 2001).

2.7 Deepwater Horizon Spill

On April 20, 2010, an explosion and fire on the mobile offshore drilling unit Deepwater Horizon led to the loss of 11 lives and the subsequent sinking of the unit. Subsequent failure of the blowout prevention device (BOP) and emergency shut off equipment after the collapse of the riser pipe, which connected the wellhead to the drilling platform, allowed the oil to flow directly from the well to the surface (Atlas, 2011). By the time the well was capped and the flow of oil stopped eighty seven days later on July 15, 2010, an estimated 4.9 million barrels (205.8 million gallons) of oil had been spilled into the waters of the Gulf of Mexico (United States Environmental Protection Agency, 2011).

As seen in Figure 5, the slicks rising to the surface directly above the wellhead were so massive that they were hindering the ships gathered there for leak operations (Atlas, 2011). To clear the

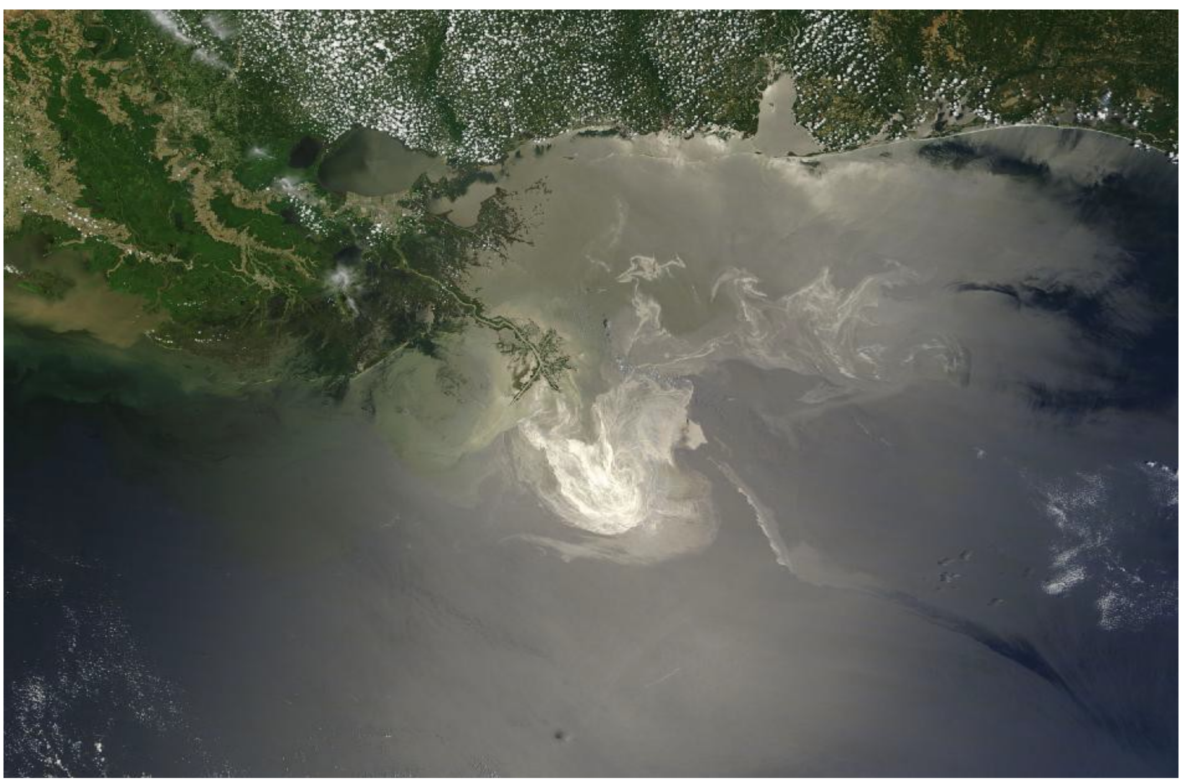

Figure 5. NASA's Terra satellite sees Spill on May 24, 2010.
Source: National Aeronautics and Space Administration

oil from the immediate vicinity as well as to prevent large slicks from reaching the coast, the decision was made to inject chemical dispersant directly into the stream of oil being ejected from the wellhead (Atlas, 2011). Figure 6 depicts the subsurface application of COREXIT 9500 dispersant during the Deepwater Horizon spill.

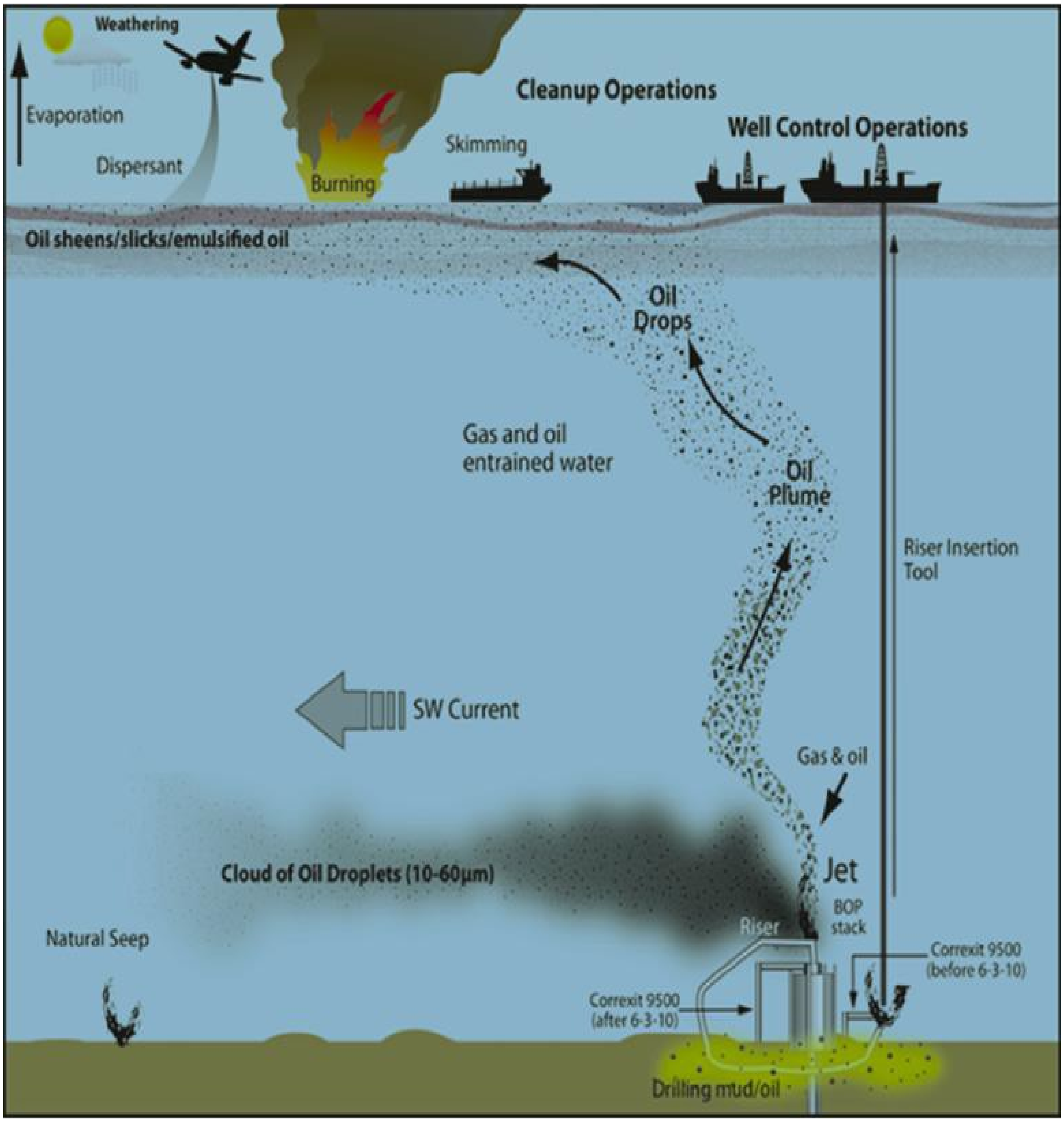

Figure 6. Depiction of subsurface use of dispersant at Deepwater Horizon.
Source: Atlas, 2011

By the time the well was capped, 1.84 million gallons of dispersant had been used with 771,000 of those injected directly in the oil stream coming from the wellhead at a depth of 5,067 feet (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Controversy arose around this action for three reasons: first, never had such quantities of dispersants been used on a spill, secondly, little was known about the effectiveness and potential consequences of dispersant use below the water surface, and finally, federal regulations pre-authorizing dispersant use did not include guidelines or limits for how much could be used or for how long (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011).

CHAPTER THREE: METHODS

3.1 Kingdon's Multiple Streams Model for Setting Policy Agendas

According to the Multiple Streams model, three areas of activity, known as "streams", are involved in the policymaking process: problems, politics, and policy (Kingdon, 1984). As shown in Figure 7, in this model, these three streams must be flowing at the same point in time and coupling must occur in order for a policy "window" to open in which policy change becomes possible (Guldbrandsson, 2009).

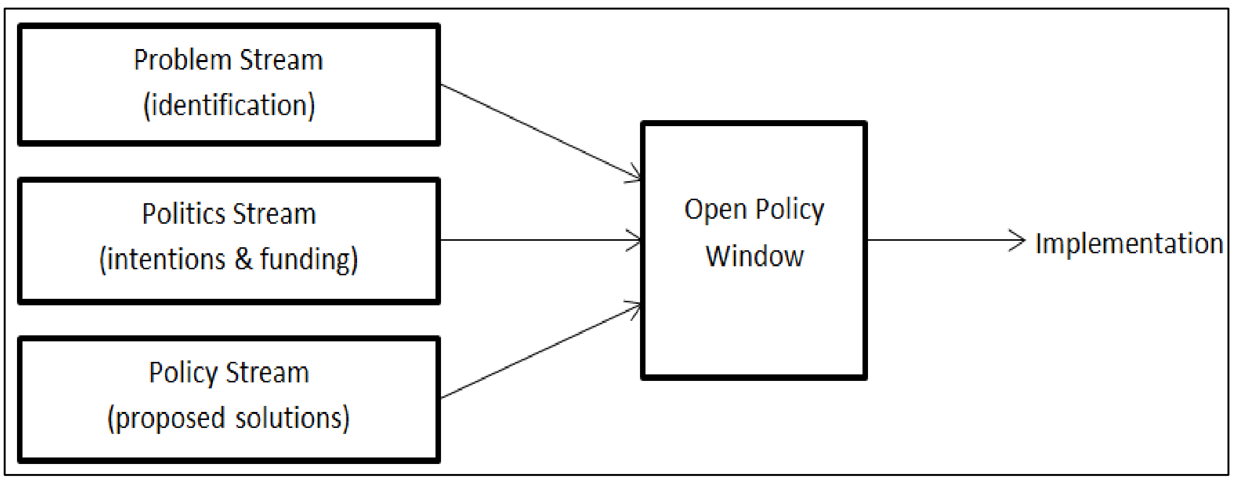

Figure 7. The Multiple Streams Framework.
Source: Adapted by author from Guldbrandsson, 2009.

The problem stream consists of the undesirable situation that needs to be changed as defined by stakeholders, while the politics stream is composed of any political actions by government leaders, government agencies, industry, lobbying groups and/or individuals concerning the problem of concern. The policy stream concerns the solutions to the problem in the form of regulation (Kingdon, 1984). By using the Multiple Streams model, the possibility of change occurring can be gauged by determining if movement is occurring in each stream.

3.2 Applying the Kingdon Model to Regulating Dispersant Use

In the Multiple Streams model, the problem stream for use of oil spill dispersants consists of two major components. First, oil spills represent a grave threat to the environment and human health. Crude oil contains a myriad of toxic compounds which can be carcinogenic, neurotoxic and harmful to the endocrine, immune and reproductive systems of living creatures. Spills can be catastrophic at the local level and have more subtle, chronic effects over a much broader area. Oil spills must be addressed quickly and effectively for environmental damage and threats to health to be minimized. One of the most powerful tools in the arsenal used to fight these disasters is oil dispersants.

Dispersants themselves represent the second component of the problem stream. While they are an effective method available for oil spill remediation, dispersants also pose significant dangers of their own. Some of the most widely used dispersants, including the COREXIT family of chemicals, have been shown to have, when mixed with oil, to have deleterious effects equal to or exceeding that of the spilled oil itself (United States Environmental Protection Agency, 1995). Although safer alternatives exist, the COREXIT family of dispersants were the most widely used in the United States prior to and during the Deepwater Horizon accident. Great Britain and Norway, the two largest EU oil producers abandoned the use of this particular type of dispersant, and removed them from the listing of approved products (Marine Management Organization[2] , 2012).

The politics stream is by far the most complex of Kingdon's "streams". It involves government, industry and all other stakeholders, including lobbyists, the scientific community and environmental organizations. In order for a consensus to be reached, all parties must come together, be heard, and work toward a common goal that benefits all.

In Great Britain and Norway, the governments have accepted scientific evidence of the toxicity of certain dispersants and responded with a ban on their use. In the US, these more toxic chemicals are still in common use.

The policy stream consists of the solution to the problem through government regulation. In this instance, the United States lags behind the EU with respect to the use of safer, less toxic oil spill dispersants. COREXIT dispersants, to a large extent, have been abandoned in the European Union and completely in Great Britain and Norway and where their use is still permitted, they have been downgraded to being used only as a last resort (European Maritime Safety Agency, 2010). COREXIT dispersants are currently listed for use in the United States and despite warnings from the scientific community, COREXIT dispersants were used in unprecedented amounts during the Deepwater Horizon disaster. Not only were dispersants used in vast amounts compared to the EXXON Valdez spill, during the Deepwater Horizon they were also applied in a manner never attempted or studied before.

Following the Deepwater Horizon Spill, dispersants were not only sprayed on the oil at the water surface but were also directly injected into the oil jet plume near the ocean floor. It is unknown what long lasting damage this use of dispersants will cause on the Gulf of Mexico ecosystem. While this method of remediation prevented the oil from reaching the surface and the true magnitude of the spill from being clearly visible, it also prevented its removal from the environment. Had the oil been allowed to rise to the surface, it could have been skimmed and removed, whereas now it continues to linger in the sediments and waters of the Gulf doing unknown damage.

The amount of public funding for dispersant research can serve as an indicator of interest in a particular policy problem. A report issued by the United States Government Accountability Office (GAO) in May, 2012 titled "OIL DISPERSANTS Additional Research Needed, Particularly on Subsurface and Arctic Applications" will be used to study oil dispersant funding at the federal level. This study provides a listing of federal funding by agency, amount, research topic, and duration between the years 2000 and 2011. This time frame allows study of funding pre and post Deepwater Horizon. Through comparison of the amount of funding present during these two time periods, an indication of movement in the politics stream can be assessed.

CHAPTER FOUR: RESULTS

4.1 Dispersant Regulation in the United States

In the United States, oil spill dispersants are regulated under the Federal Water Pollution Control Act, as amended (Clean Water Act, or CWA) and the Oil Pollution Act of 1990 (OPA) both of which set for the United States Environmental Protection Agency's response responsibilities (United States Environmental Protection Agency, 2011). Section 311 of the CWA gives the EPA and USCG authority to create a program for oil spill prevention, preparation, and response which the EPA implements through the National Oil and Hazardous Substances Pollution contingency Plan (National Contingency Plan, or NCP) (United States Environmental Protection Agency, 2011). The OPA, enacted following the Exxon Valdez spill, increased the federal government's role in oil spill response and provided new government and industry contingency planning requirements (United States Environmental Protection Agency, 2011). In 1991, Executive Order 12777 implemented OPA and gave EPA, the U.S. Department of the Interior, and the U.S. Department of Transportation responsibilities under Section 311 of the CWA (United States Environmental Protection Agency, 2011).

The National Response System, the federal government's mechanism for emergency response to oil spills in navigable waters, involves entities from federal, state, local and tribal levels as well as industry (EPA, 2011). This system is a three tiered framework consisting of the National Response Team (NRT, headed by the EPA and Coast Guard), Regional Response Teams (RRTs, also co-chaired by the EPA and Coast Guard), and Area Committees (National Research Council, 2005). The RRTs have actual authority over chemical dispersant use with the U.S. Coast Guard serving as the Federal On Scene Coordinator (FOSC) which is charged with ensuring response efficacy and safety (National Research Council, 2005). In the event of a spill, the FOSC, after obtaining the concurrence of the federal co-chairs and state representative to the

RRT and consulting the U.S. Department of Commerce and U.S. Department of the Interior (federal natural resource trustee agencies), may authorize dispersant use (National Research Council, 2005).

The National Contingency Plan (NCP), a key component of the National Response System, is the federal government's blueprint for dealing with oil spills and hazardous substances releases, first published in 1968 in response to the Torrey Canyon spill off the Coast of Great Britain in 1967 (United States Environmental Protection Agency, 2011). The NCP gives the federal government three basic functions : preparedness planning and response coordination, notification and communications, and response operations (United States Environmental Protection Agency, 2011). If a spill occurs in the coastal zone, the FOSC (USGC Commandant) can declare it a Spill of National Significance if the size, severity, location, environmental or public health and welfare impact or complexity of the response warrant it (2011). According to the NCP, the USCG is the lead agency and appoints the (FOSC) for spills connected to the coastal zones, while EPA does the same for inland spills (United States Environmental Protection Agency, 2011). In the case of a coastal zone Spill of National Significance, the USCG has the ability to name a National Incident Commander who assumes the role of OSC, communicating with the public and affected parties and coordinating all available resources at the national level (United States Environmental Protection Agency, 2011). The NCP also mandates contingency planning under OPA through the establishment of Regional and Area Contingency Plans.

Executive Order 12777 also gave to EPA's Administrator the responsibilities concerning schedules of dispersants outlined in CWA Section 311 and set down in Subpart J of the NCP (United States Environmental Protection Agency, 2011). The Product Schedule lists dispersants

and other chemicals used to mitigate spills that may be employed while carrying out the NCP (United States Environmental Protection Agency, 2011). Subpart J also lists 12 types of data that manufacturers must submit to EPA in order for their dispersant product(s) to be considered for listing, which include application and storage methods, and information concerning efficacy and toxicity (United States Environmental Protection Agency, 2011). Testing requirements include acute toxicity studies on two species, one fish and one shrimp and at least a 50% ±5% effectiveness (45% oil dispersal) score on the average of two crude oil Swirling Flask Tests (United States Environmental Protection Agency, 2011). Laboratories must conduct these tests and the results are reviewed once by an EPA contractor and a second time by an Office of Emergency Management (OEM) Product Schedule Manager who checks for completeness before listing (United States Environmental Protection Agency, 2011). Once a product is listed on the Product Schedule it is not implied that the product is approved by EPA for use, only that it may be authorized for use by the FOSC.

Three types of approval exist for dispersal usage: case-by-case, expedited, and pre-approval. In case-by-case approval or incident-specific RRT approval, the FOSC must obtain approval from the RRT which reaches its approval with agreement of the USCG and EPA co-chairs and affected state(s) with DOI and DOC input (National Research Council, 2005). In expedited or 'quick' approval, the same entities must concur, but the quantity and type of information provided by the FOSC to gain concurrence is limited as well as the time in which a decision must be made, usually within 2 hours (National Research Council, 2005). Expedited approval may also have other limitations including geographic zone, distance from shore and water depth (National Research Council, 2005). The third type of approval is pre-approval where established criteria are set for dispersal use in specific zones and if these conditions are met, further approval is not needed. These conditions, like expedited approval, include geographic zone, distance

from shore and water depth (National Research Council, 2005). As shown in Figure 8, with the exception of Alaska, Washington, Oregon, and three of the Hawaiian islands, dispersant use is pre-authorized in the United States. The depth of water at which dispersants may be applied varies by region, ranging from 33 to 60 feet (10 to 18 meters). The distance from shore at which dispersants may be used also varies by region, ranging from 0.5 to 3 nautical miles (926 to 5556 meters).

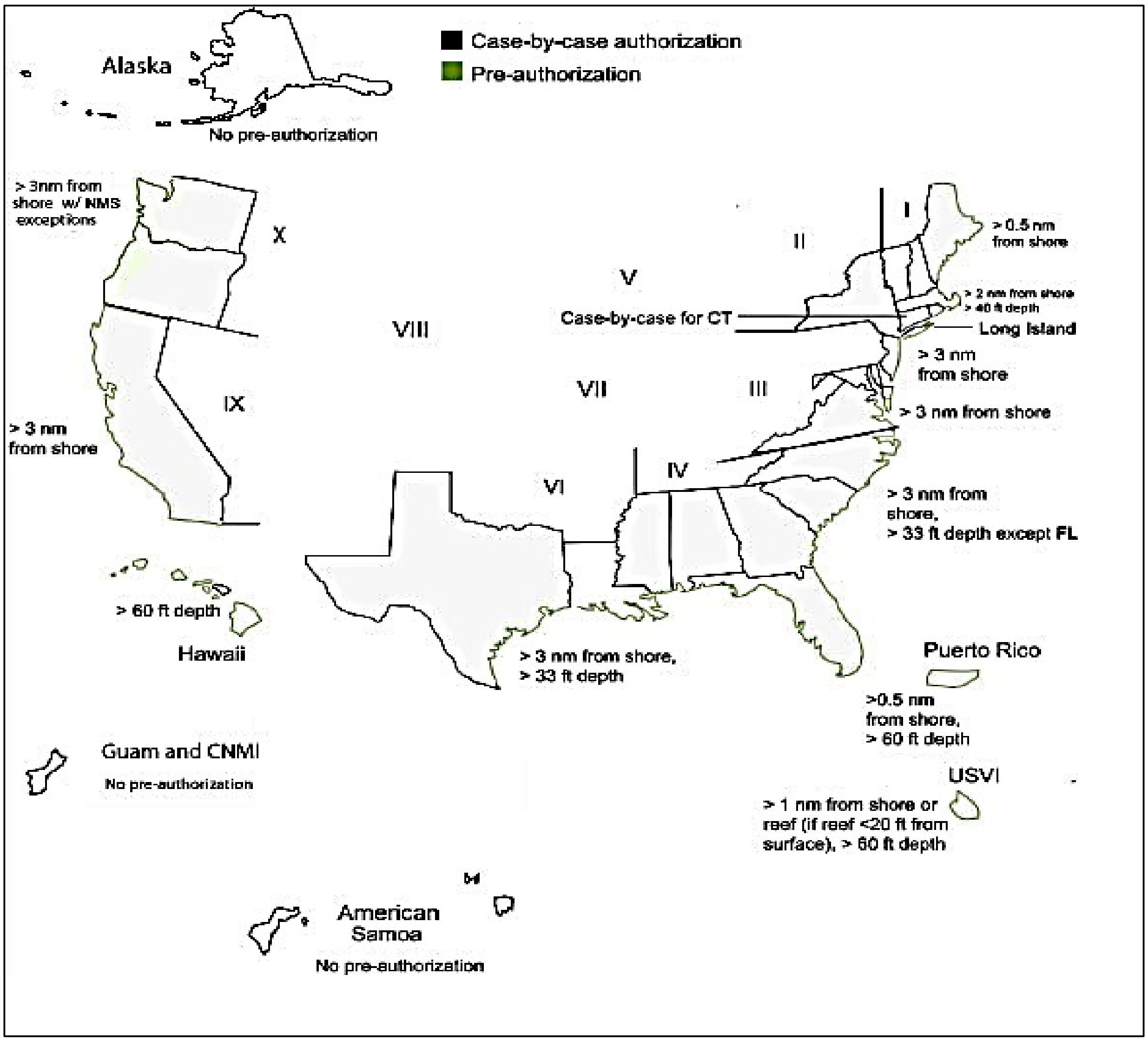

Figure 8. US Coast Guard Dispersant Usage Map.
Source: United States Coast Guard

4.2 Dispersant Regulation in the United Kingdom

In the United Kingdom, the Fisheries Department has authority over dispersal use decisions in which dispersants are considered a first response tool (Bonn, 2012). The chemicals are regulated under Part 2 of the Food and Environmental Protection Act of 1995 and the Deposits in the Sea (Exemption) order 1985 (Bonn, 2012). Dispersants are pre-authorized in waters 1 nautical mile (1853.2 meters) beyond 20 meter depth or the coastline. In shallow waters, the Department for Environmental, Food & Rural Affairs (DEFRA) is charged with the determination (Bonn, 2012).

To be approved for use, dispersants must be tested for efficacy and toxicity. The National Environmental Technology Centre of AEA conducts efficacy testing while toxicity testing in conducted by CEFAS, the Centre for Environment, Fisheries & Agriculture Sciences (Bonn, 2012). Once prospective chemicals pass testing, they are listed for approved use by the Marine Management Organization (MMO) (Burgess, 2012).

The U.K., like the U.S., has a NCP (National Contingency Plan). In the event of a spill of national significance, the Maritime Coastguard Agency is notified and the NCP takes effect (Burgess, 2012). The party responsible for the spill activates their Emergency Response Center (ERC) which is attended by a Department of Energy and Climate Change (DECC) Environmental Inspector who acts as a point of contact between the responsible party, the DECC and the Secretary of State's Representative (SOSREP) who decides if the responsible party's plan of action is adequate and gives direction if it is found to be lacking (Burgess, 2012).

4.3 Dispersant Regulation in Norway

In Norway, the Norwegian Pollution Control Authority (SFT) is charged with decisions regarding dispersal use (Bonn, 2012). The Norwegian Coastal Administration Department of

Emergency Response is charged with ensuring that the responsible party implements the proper response measures. Mechanical containment and recovery methods are predominantly used to remediate oil spills in Norway and dispersants, while recognized as a valuable oil spill remediation tool, are used as a second option only when it is considered the best alternative for the environment (Lindgren, 2001). If the responsible party for a spill does not have a preapproved plan in place, an application for authorization must be made to the Norwegian State Pollution Control Authority (SFT) and use of dispersants is not allowed in waters less than 20 meters deep nor less than 200 meters from shore (Bonn, 2012). All spill incidents require the completion of a form using guidelines for a decision matrix for dispersant use. Required efficacy and toxicity testing is conducted by oil product companies and no official product listing is kept (Bonn, 2012).

As seen in Table 1, with the exception of COREXIT use and official listing, dispersant regulation is very similar between the three countries. While the United States is slightly more conservative with regards to water depth, it is much less stringent when it comes to the level of dispersant toxicity permitted in that there is no limit on how toxic a dispersant may be, only that the testing be done and on file with the EPA.

Table 1. Comparison of Dispersant Use Between the U.S., the U.K., and Norway.

	PRIORITY	PRE-APPROVED USE	DISTANCE FROM SHORE	WATER DEPTH	TOXICITY TESTING	LISTING	COREXIT
US	1st order	yes	> 926 - 5556 m	> 10 - 18 m	yes	yes	permitted
UK	1st order	yes	> 1853 m	> 20 m	yes	yes	banned
NORWAY	2nd order	yes	> 200 m	> 20 m	yes	no	banned

Source: United States Coast Guard, and Bonn, 2012. Compiled by author.

4.4 Funding of Dispersant Research in the United States

Dispersant research funding is highly variable between years and between agencies. Federal dispersant research funding between 2000 and 2011 came from six agencies, including the Bureau of Safety and Environmental Enforcement (BSEE), part of the Department of Interior, the National Science Foundation (NSF), the Environmental Protection Agency (EPA), the National Oceanic and Atmospheric Administration (NOAA), the Department of Health and Human Services (HHS), and the United States Coast Guard (United States Government Accountability Office, 2012). Since fiscal year 2000, over $15.5 million of dispersant related research in 106 projects has been funded by these six federal agencies with more than half occurring since the Deepwater Horizon accident (United States Government Accountability Office, 2012). Between 2000 and 2011, BSEE funded the greatest number of projects (47), but the NSF had a higher funding level ($4,395,419) over the same period (Figures 9,10). The NSF and EPA also funded large numbers of projects, 37 and 34 respectively, between 2000 and 2011 with the HHS and US Coast Guard only funding a combined total of six (Figure 10).

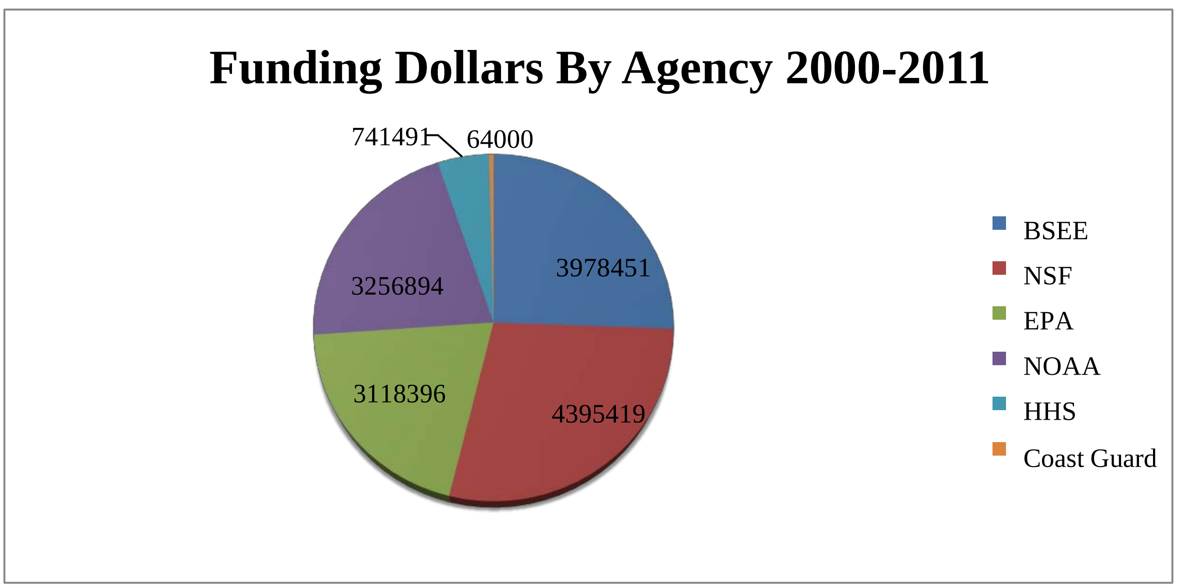

Figure 9. Funding Dollars by Agency 2000-2011.
Source: United States Government Accountability Office, 2012. Compiled by author.

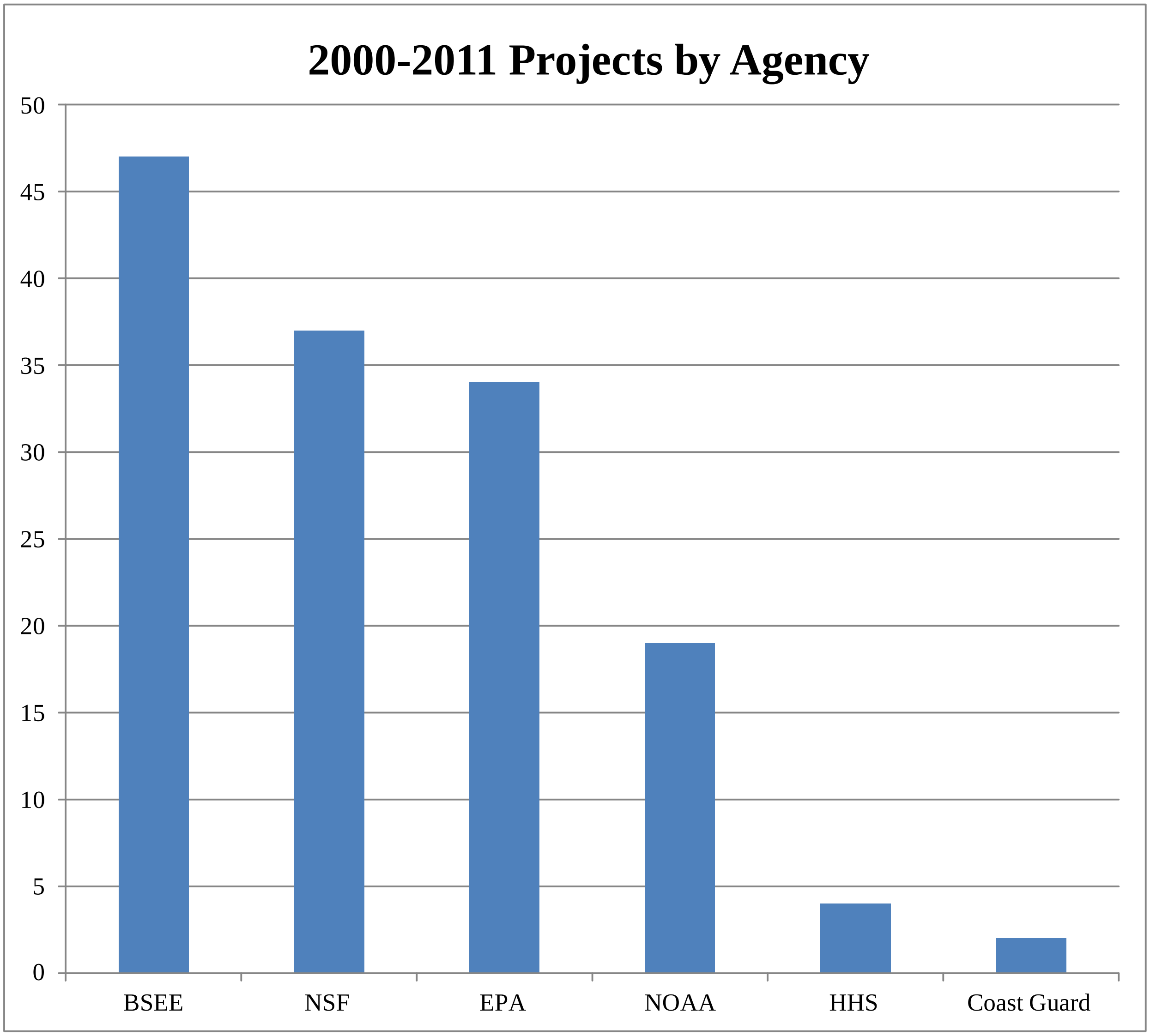

Figure 10. 2000-2011 Projects by Agency.
Source: United States Government Accountability Office, 2012. Compiled by author.

When divided into pre and post Deepwater Horizon, a period of ten years compared to a period of two years, the funding difference in disproportionately large. In the ten year period prior to the Deepwater Horizon, the yearly average number of projects funded was 5.8 compared to a yearly average of 42.5 for the two years after the spill (Figure 11).

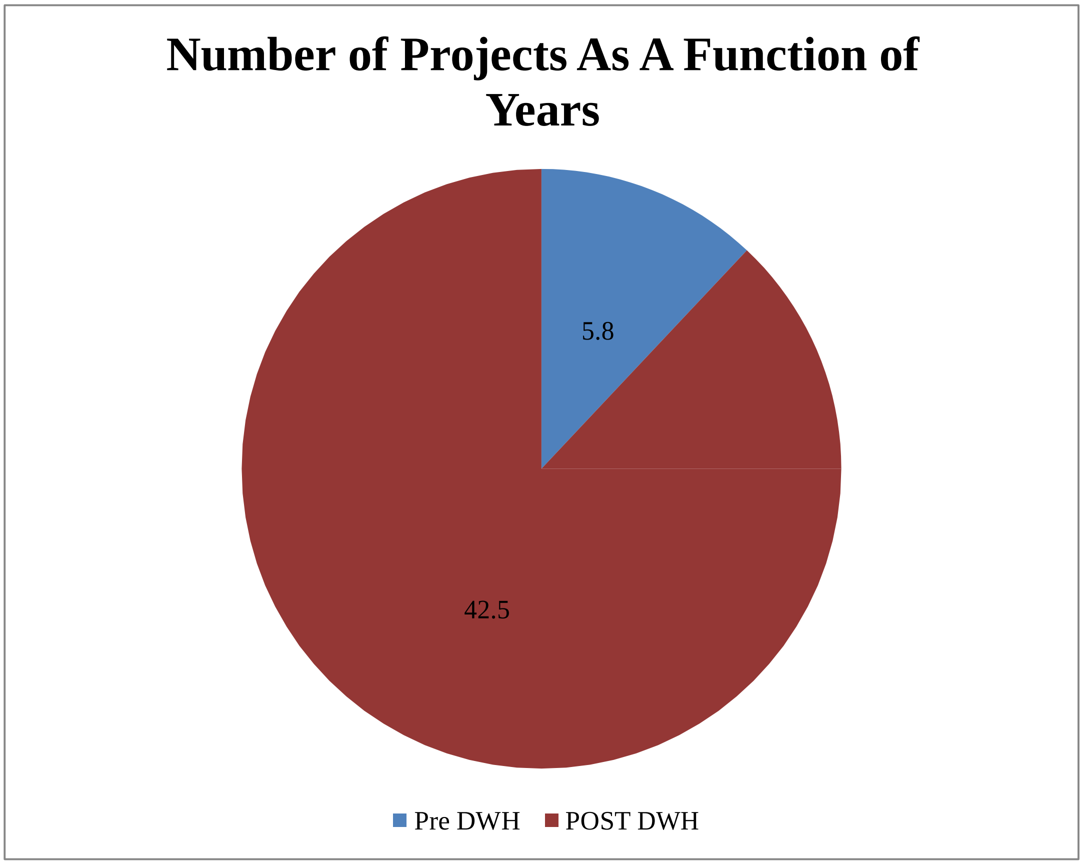

Figure 11. Number of Projects as a Function of Years.
Source: United States Government Accountability Office, 2012. Compiled by author

In the six federal agencies listed, the priority research areas have shifted since the Deepwater Horizon spill. Increases in the number of projects were seen in the areas of fate and transport, human health, subsurface use and formulations as opposed to the areas of effectiveness, toxicity, modeling, monitoring, general research and the use of dispersants in Arctic conditions (Figure 12). Concerns regarding the toxicity of COREXIT dispersants, the health of cleanup crews, and the lack of information regarding dispersant use near the floor of the Gulf of Mexico may have contributed to this shift. The number of projects regarding fate and transport and toxicity doubled, while projects concerning human health, subsurface use and formulations went from zero to six, three, and four respectively (Figure 12).

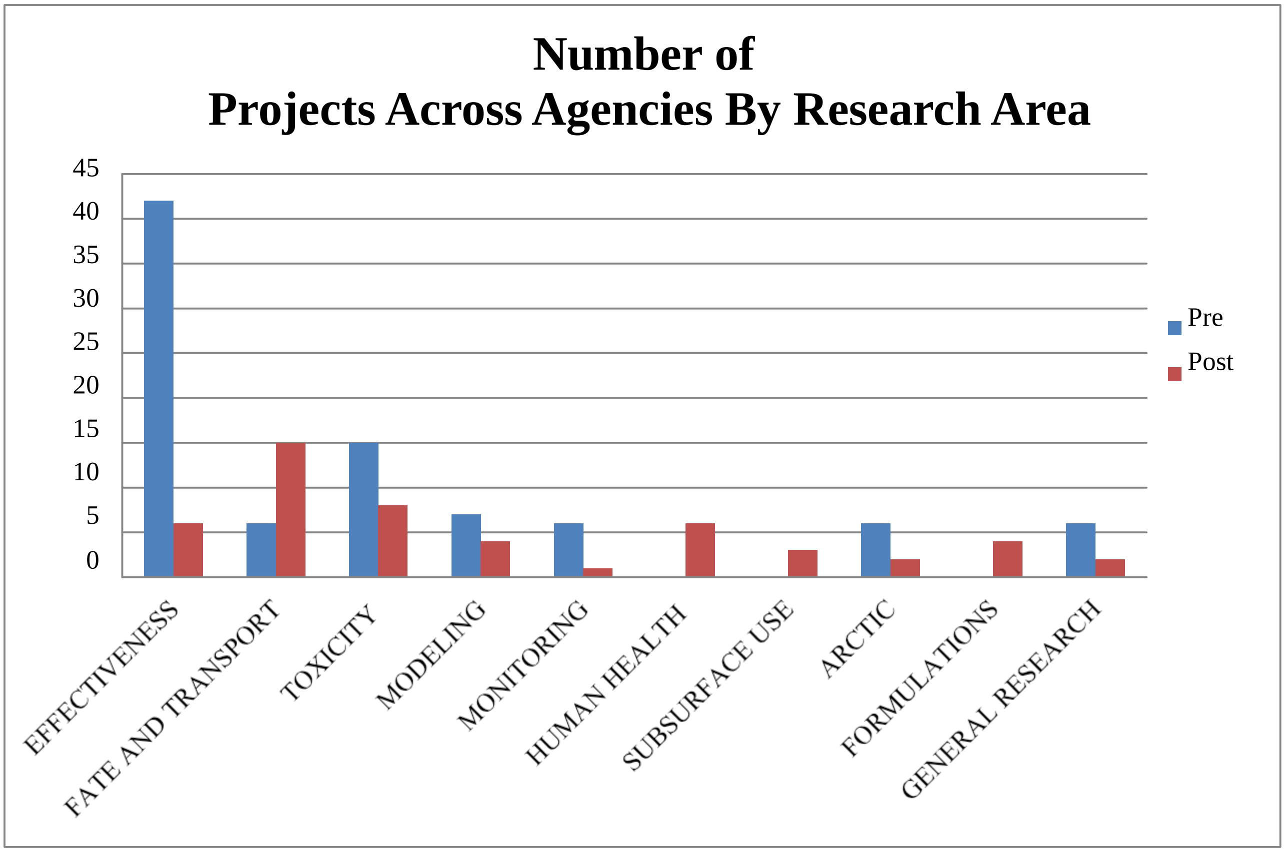

Figure 12. Number of Projects Across Agencies By Research Area.
Source: United States Government Accountability Office, 2012. Compiled by author.

The number of funded projects was highly variable in the 2000-2009 and 2010-2011 time periods. The BSEE and EPA have been consistent funders of oil spill related research and have expressed intent to continue in the future (United States Government Accountability Office, 2012). The NSF funded thirty six oil spill related projects as a result of the Deepwater Horizon, compared to one program prior to the event (Figure 13). The funding was provided through its rapid response grant program which was designed to address unusual circumstances where a quick response is needed to provide answers to research questions (United States Government Accountability Office, 2012). The NSF, along with NOAA and the HHS, have indicated that no

further projects dealing with dispersants are planned (United States Government Accountability Office, 2012).

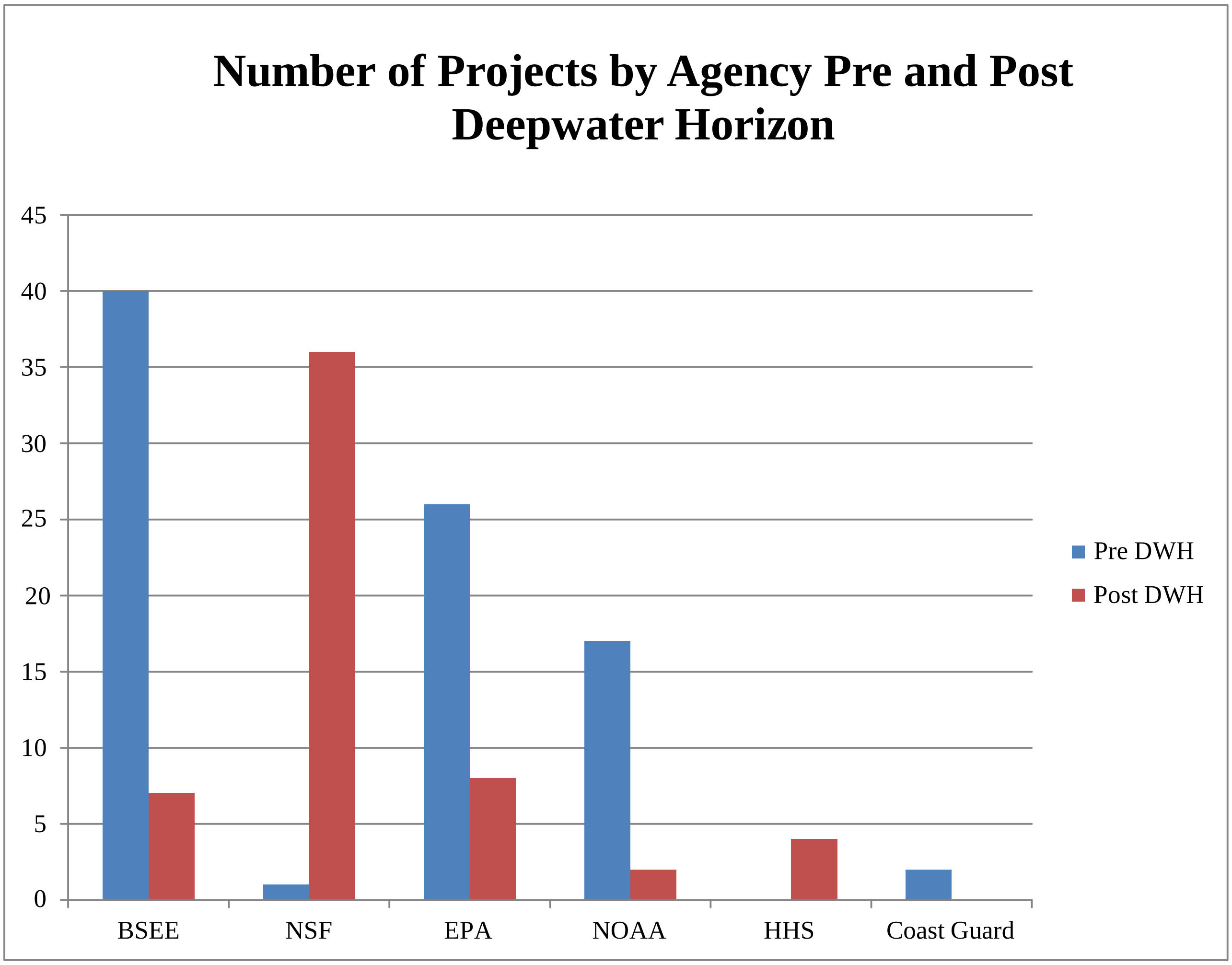

Figure 13. Number of Projects by Agency Pre and Post Deepwater Horizon.
Source: United States Government Accountability Office, 2012. Compiled by author.

4.5 Policy Tools

In 1995, the Office of Technology Assessment released *Environmental Policy Tools: A User's Guide*, which outlined multiple possible solutions to the reduction of harmful hemicals/pollutants released into the environment. As seen in Figure 14, policy tools range from harm-based

standards, which allow companies to choose which compliance method will be used, to outright product bans, which prohibit manufacture and use of designated compounds.

rsTools That Directly Limit Pollution				Tools That Do Not Directly Limit Pollution	
Single-Source Tools		Multisource Tools			
Harm-Based Standards	Describe required end results, leaving regulated entities free to choose compliance methods.	Integrated Permitting	Incorporates multiple requirements into a single permit, rather than having a permit for each individual emissions source at a facility.	Pollution Charges	Require regulated entity to pay fixed dollar amount for each unit of pollution emitted or disposed; no ceiling on emissions.
Design Standards	Describe required emissions limits based on what a model technology might achieve; sources use the model technology or demonstrate that another approach achieves equivalent results.	Trackable Emissions	Allow regulated entities to trade emission control responsibilities among themselves, provided the aggregate regulatory cap on emissions is met.	Liability	Requires entities causing pollution that adversely affects others to compensate those harmed to the extent of the damage.
Technology Specifications	Specify the technology or technique a source must use to control its pollution.	Challenge Regulations	Give target group of sources responsibility for designing and implementing a program to achieve a target goal, with a government-imposed program or sanction if goal is unmet by the deadline.	Information Reporting	Requires entities to report publicly emissions or product information.
Product Bans and Limitations	Ban or restrict manufacture, distribution, use or disposal of products that present unreasonable risks.			Subsidies	Provide financial assistance to entities, either from government or private organizations.
				Technical Assistance	Provides additional knowledge to entities regarding consequences of their actions, and what techniques or tools reduce those consequences.

SOURCE: Office of Technology Assessment, 1995.

Figure 14. Potential Policy Tools for New Regulation of Dispersants in the U.S.

In the case of COREXIT dispersants, not all of the listed policy tools would apply. Product bans and limitations, liability, subsidies, and technical assistance may be useful in dealing with dispersants.

Product limitations controlling the amount of COREXIT dispersants produced as well as total bans are the most drastic policy tools available. While product limitations greatly reduce the exposure of the environment to these chemicals, bans completely eliminate it.

Liability exposure would be a powerful disincentive for the manufacturer to continue production of COREXIT products. Costly litigation and the possibility of large judgements would adversely affect the reputation and profits of the company. Liability would also serve as an incentive to the company to invest in the development of less toxic products.

Subsidies in the form of research grants may be useful in the development of less toxic alternatives to COREXIT dispersants. One condition of acceptance of the funds by the manufacturer would be that the company limit use of COREXIT products until suitable replacements are found. The incentive to the manufacturer would be the replacement of lost revenue due to reduced product use while funding development of new products.

Technical assistance might also prove valuable in this situation. By informing the company of the threat that COREXIT products pose to the environment as well as offering guidance as to what options are available to limit that threat, the manufacturer may be more inclined to self- regulate and make the changes necessary in order to avoid direct intervention by policy makers.

Nalco Energy Services, a division of Nalco Company, is the sole manufacturer of COREXIT dispersants. With only one manufacturer, discontinuation of COREXIT would may be more easily accomplished since a united industry front does not exist. Multiple companies produce myriad alternative dispersant products that have been deemed less toxic than COREXIT. While recommendations regarding which policy method to implement in the case of COREXIT dispersants regulation is beyond the scope of this study, it is possible that a complete ban will eventually occur in this case.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

5.1 Summary of Results

The first research objective was to compare dispersant use and regulation in the United States, Norway, and the United Kingdom. The regulatory frameworks governing dispersant use are very similar across the three countries. While some minor variations exist in the criteria used to justify dispersant use in certain instances, dispersants are seen as a valuable tool used in the cleanup of oil spills. In all three countries dispersants are used mainly to prevent oil slicks from reaching shorelines. Shoreline cleanup of spilled oil is an extremely expensive and difficult operation. The major concern of coastal oil pollution is contamination of the sediment. Once oil reaches sediment, it is sequestered under conditions that prevent or greatly slow its breakdown, resulting in contamination for extended periods, increasing the damage to sensitive ecosystems.

One large difference between the three countries is the toxicity of dispersants listed for use. In particular, Norway and Great Britain have abandoned use of the COREXIT family of dispersants while their use is still permitted in the United States. COREXIT dispersants were widely criticized during the Deepwater Horizon accident by the scientific community, the press, and governmental officials. The EPA is currently considering protocol changes for dispersant effectiveness and toxicity testing and a proposed rule revising the dispersant Product Schedule listing requirements is scheduled to the issued in winter 2012 (United States Government Accountability Office, 2012). It has been suggested that the changes will remove COREXIT dispersants from listing by the U.S.

The second research objective gauged the outlook of changes in regulation of COREXIT dispersants in the U.S. using the Kindgon model. This was accomplished by examining federal dispersant research funding in the U.S. prior to and after the Deepwater Horizon spill as a

possible indicator of changes in regulation in the near future specifically regarding COREXIT dispersants. An increase in research funding would indicate movement in the problem and politics stream. Federal funding was found to have increased after the Deepwater Horizon, but several agencies currently funding dispersant research as a result of the spill have indicated that additional projects will not be funded. It would appear that in the short term, the political will exists to make changes to dispersant regulation in the U.S. Once the memory of the Deepwater Horizon spill begins to fade and if no spills occur in the near future, the political will may decline along with research-funding dollars. Another factor which would bolster activity in the politics stream and keep it flowing would be the discovery, in the years ahead, of negative effects of dispersal use at great depths. Should conclusive evidence be found of long term environmental damage resulting from subsurface dispersant use, the necessary political will might be present to support new regulations.

5.2 Limitations and Future Research

Limitations of this research include the fact that the three streams of the Kingdon framework are in constant flux, movement may spring up where none existed previously and existing movement in one or more streams may suddenly slow or dissipate. In particular, the analysis of the politics stream using federal agency funding levels can be misleading and inconclusive in the event of a catastrophic event such as the Deepwater Horizon spill because interest may decrease and funding may disappear over time unless a new event occurs to sustain the will for a change in regulatory policy. Future research is warranted in this area and should be conducted at intervals of five and ten years in order to determine if the Deepwater Horizon event was sufficient to spur increased regulation of use of dispersants in the United States.

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