Estimating the Effectiveness of New Policy Legislation at Incentivizing Investment in Oil Recovery Technologies

Qusai Bhaijeewala

ABSTRACT

My study uses the Deepwater Horizon (DWH) incident as a case study to determine if this new policy will incentivize mechanical recovery technology. The new policy will allow the responsible party (RP) to discount recovered oil from their spill fines. My research question asks how much money the RP will save after the initial cost of the response, and what will it cost to recover a barrel of oil using mechanical recovery technology after the proposed fine reduction. Moreover, my sub question asks, is the decrease in total cost associated with the recovery effort of the DWH spill enough to incentivize investment in mechanical recovery technology?

KEYWORDS

oil spill response, BP oil spill, Deepwater Horizon, Macondo Well blowout, mechanical recovery, skimming, policy proposal, oil recovery technology, incentivization

INTRODUCTION

Due to several major oil spills in recent years, oil spill response has become an important area of concern for policy makers. Following the Deep-water Horizon (DWH) spill on April 20, 2010, oil-spill response teams primarily used in-situ burning and chemical dispersion, citing their effectiveness in large-scale remediation (Griggs 2011, Barron 2012). In-situ burning is a technique in which oil is gathered on the ocean's surface and combusted. The oil has to be at least one millimeter thick in order to burn. However, response teams must prepare fire resistant boom surrounding a potential burn site before they can start burning. Usually the fire resistant boom is made of metal lined with fire resistant cloth. The responders then use an ignition device to set the oil on fire. These ignition devices range from diesel soaked rags, which are set on fire and thrown into the oil, to helitorches. A helitorche is a device that hangs from a helicopter and drops burning gelled gasoline into the oil, which burns like napalm. The fire will burn all of the oil within the fire resistant boom (Scholz et al. 2005). Burning can have a net environmental benefit depending on the situation; for instance, when response teams burn oil right before it destroys a sensitive coastal region. There are, however, some tradeoffs associated with in-situ burning. Although burning is cost effective, and has a high oil removal rate and level of efficiency, it has environmental costs associated with combustion byproducts. One of the byproducts of this combustion is the creation of residuals. If the residuals sink into the water column, they can pose a toxic hazard to benthic organisms; additionally, if the residuals float on the ocean surface, they may affect marine wildlife. However, it is important to note that leaving the oil emulsions on the ocean surface could potentially be detrimental to wildlife (Buist et al. 1999). Additionally, particulate byproducts released by the burns also have costs linked to respiratory disease in response workers (FOSC 2011). Chemical dispersion, like in-situ burning, can prevent oil sludge from reaching the shoreline, which can prevent both the increase in response costs and the destruction of sensitive shoreline ecosystems (Etkin 1999). Chemical dispersion is a process in which chemicals break up oil globules and convert them into tiny oil droplets (Azwell et al. 2011). Chemical dispersants are usually sprayed onto the ocean by airplanes or boats (FOSC 2011). There are two reasons why response teams use chemical dispersion. The first reason is that it can prevent destruction of sensitive shoreline ecosystems, as mentioned earlier, and the second reason is that dispersants allow oil to become more bioavailable for microbial degradation (Atlas and Hazen, 2011). However, the mixture of oil droplets and chemical dispersants can be a toxic hazard to benthic organisms (Lessard and DeMarco 2000). It is important to note that dispersing oil, in specific scenarios, might put more wildlife at risk. Marine animals usually avoid big oil emulsions; however when the oil has been dispersed into the water column, animals cannot avoid the oil. This is analogous to the smoke and smog example. People know not to go near smoke because it is dangerous, but when it is dispersed into the atmosphere and turned into smog, people cannot avoid the smog. The tradeoff is that smog is not as concentrated as smoke just like oil droplets are not as concentrated as oil emulsions. The main dispersant used in the DWH spill is Corexit 9500, which may be toxic to coral larvae and can result in the loss of coral repopulation (Goodbody-Gringley 2013). Given the environmental and economic costs associated with burning and skimming, other approaches such as oil recovery methods might be preferable.

Oil recovery methods, which include skimming, booming, and use of sorbents, are the safest, most ecologically and economically preferred techniques for oil spill response because, by removing oil from the environment rather than chemically dispersing it or leaving combustion residuals, they do not add toxicity to marine ecosystems, cause occupational health problems, or cause declines in fish populations (Azwell et al. 2011, SOT 2013). Skimming involves the use of mechanical skimming devices on boats to remove oil from the ocean surface; Additionally, booming depends on floatation devices to prevent surface oil from reaching the shore (FOSC 2011), and the use of sorbents involves placing absorbent materials into the water to collect surface oil (EPA 1999). Oil recovery methods are extremely useful for preventing oil from reaching shorelines; however, oil recovery technologies are not as efficient as burning and dispersing when responding to large-scale oil spills (EPA 1999 and Etkin 2004). Skimming manufacturers determine the efficiency of a skimmer based on the amount of oil it collects compared to water; consequently, there are multiple methods and practices that responders can implement to increase the efficiency of skimmers (FOSC 2011). Given that oil recovery is the best way to reduce the environmental and economic costs of oil spills, industry should invest in oil recovery technology to make it a more viable and effective option for oil spill response. Yet, current policies fail to incentivize investment in skimming and other recovery methods.

Oil spill response is primarily regulated under the Clean Water Act (CWA), the National Oil and Hazardous Substance Pollution Contingency Plan (NCP), and the Oil Pollution Act

(OPA). While there are many other policies that govern oil spill response, I will only discuss these three main ones. Section 311(b) of the CWA prohibits the release of hazardous substances in United States navigable waters, but in the case where that law is violated the CWA requires governmental agencies to remediate hazardous substances, monitor the spill site, and determine liability (FCOSRC 2012). The OPA and the NCP specify which agencies are responsible for the tasks mentioned in section 311 of the CWA. The CWA section 311(c) authorized the federal on-scene coordinator to direct the DWH spill response effort, and mandates the creation of a trust fund that collects all revenues from liability fines and uses that money for environmental restoration and economic development (FOSC 2011, Ramseur and Hagerty 2013). The NCP mandates a multileveled coordination plan by creating a national response system with four main components: the National Response Team (NRT), Regional Response Teams (RRT), Area Committees (AC), and the federal on-scene coordinators (FOSCs). The Environmental Protection Agency's (EPA) regions dictate where the regional response teams serve (see Appendix figure 1 EPA Regions). The Area Committees are responsible for information that can help in area contingency planning. The fourth component of the NCP is Federal on-scene coordinator, who directs the response operations (FCOSRC 2012). The Oil Pollution Act designates authority to different agencies for specific response tasks. For example, the OPA grants the President and the United States Geological Survey (USGS) the authority to use federal resources to clean up oil spills, monitor the response of the Responsible Party (RP), or lead the RP's clean-up activities. The OPA also allocates oil spill response and clean up duties for land-based spills to the EPA, and assigns spill response in the US coastal zones to the USGS. Currently the OPA uses the criteria listed in Table 1 to impose fines to the RP for the oil spill.

Table 1: Criteria for determining federal oil-spill penalty fines

Natural resource destruction
Personal property damage
Loss of existing use of natural resources
Loss of revenue and profits from destruction of property and/or the environment
The cost of providing additional public services during or after the oil spill response

(FCOSRC 2012)

The United States Department of Justice (DOJ) is still determining whether to charge BP 1,100$ per barrel or 4,300$ per barrel spilled for the Deep-water Horizon incident. The DOJ would only fine BP 4,300$ per barrel, if the spill was caused by gross negligence (Rushe and Agencies 2013). Gross negligence, defined by the law, is when a company consciously disregards measures that would prevent harm to people and/or property. These policies guide response efforts and mandate specific contamination standards, determined by the CWA, but do not specify guidelines or prioritize safer response methods. These policies do not incentivize investment in oil recovery methods. Oil recovery methods have the least amount of environmental costs, and therefore, should be a priority. This suggests the need for new policies that will incentivize oil recovery.

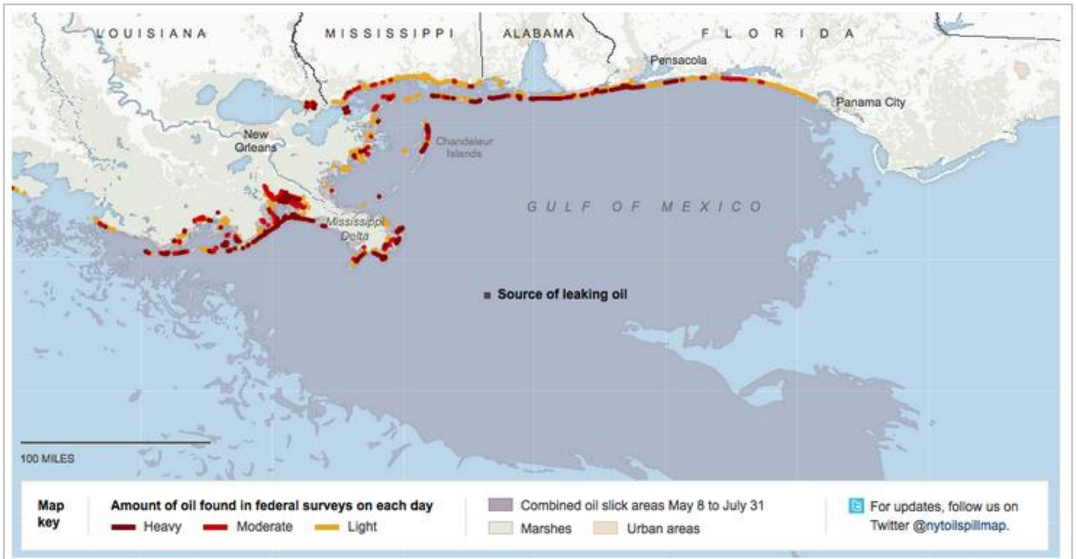
The new legislation is a policy that would discount recovered oil from the RP's spill fine, which means that the RP will not have to pay the per barrel fee for every barrel of oil recovered from the environment; consequently, this policy would incentivize the investment in oil recovery technologies. Money saved by the oil industry by discounting recovered oil from fines levied on a per-barrel spilled basis could incentivize investment in oil recovery and oil removal technology. Corporations rely on a basic principle for generating the most amounts of profits, which is, if there is a way to save the maximum amount of money than the company will take that path. That is why this new legislation will incentivize oil recovery methods. The key premise of this policy proposal is that, if the RP party saves more money from fine reduction than they used to recovery the oil, they will invest in oil recovery research, technologies and infrastructure. The more money the RP saves, the greater the incentive to invest in mechanical/oil recovery technologies. Efficient recovery methods will lead to more oil recovery, which will generate more savings. Yet there is no assessment of potential industry savings if they are allowed to discount recovered oil from spill fines.

I use the DWH as a case study, to assess both the financial viability and effectiveness of this new legislation at incentivizing investment in oil recovery techniques by considering the following: What is the RPs net cost after they were permitted to discount recovered oil from spill fines associated with the Deepwater Horizon incident, and would that amount be small enough to incentivize oil recovery technology? I determine this by examining the economics of four scenarios, two scenarios involving a finding of gross negligence and the other two without gross negligence. In all cases, I determine the RPs net cost by finding the difference between the costs of the mechanical recovery effort and the total fine reduction. I draw on existing literature to calculate the total costs of both oil recovery methods employed in the deep-water horizon case and the amount of money the RP would save were they able to discount recovered oil from their spill fines.

METHODS

Study site

The Deepwater Horizon incident, which occurred in the northern Gulf of Mexico off the coast of Louisiana on April 20th 2010, was the largest oil spill in United States history; since then, the oil has caused serious economic and environmental damage (Figure 1). The DWH spill started when a series of explosions caused the Macondo Wellhead to break and release oil from the well into the gulf environment, and eleven people on board the Deepwater Horizon vessel lost their lives after the explosions (DHSG 2011). The Macondo well leaked for 84 days, releasing a total of 4.9 million barrels of crude oil into the Gulf of Mexico (Chen 2011). One of the major consequences of the oil spill was the decline in both fish population and biodiversity of marine ecosystems in the Gulf of Mexico (Montagna 2013). Aside from the environmental damages, there are also economic costs associated with the incident, including a 77% decline in the Louisiana fishing industry’s production in 2010 (Jefferson and Bowling 2011). The Responsible Parties (RP)s in the DWH oil spill - BP, Halliburton, and Transocean - also incurred costs from losing their product, federal fines, and cleanup expenses.



This map shows the amount of oil on the coastline as reported on July 31 by the federal government based on information from air and ground surveys. For the first month of the spill, the oil stayed mostly in the gulf. But in the last week of May, waves of oil began washing into Louisiana's fragile wetlands and beaches. In June, oil landings began to be reported more frequently in the states to the east. Survey areas for Louisiana were first released on May 24 and for Mississippi, Alabama and Florida beginning on June 12. Credit: New York Times

Figure 1. Fate and spread of oil from the Macondo Blowout in 2010

Data collection

I collected data sets, from existing literature, on the outcome of the Deepwater Horizon spill such as the fate of the oil, response costs, and spill fines. The first data set (Table 2; Figure 2) is the breakdown of the fate of oil, namely the percentages of the 4.9 million barrels that response teams managed to deal with by employing specific oil-spill response methods (Kerr 2010).

Table 2. Fate of Oil

Percentage of the 4.9 million barrels of oil (%)	Fate of Oil
3%	skimmed/mechanically recovered (4,630,500 gallons)
5%	Burned off the ocean surface
8%	chemically dispersed
17%	Directly recovered by Macondo Wellhead

The second data set represents the per-barrel spill fine for the responsible party. The standard fine is $1,100 per barrel of oil spilled, but the gross negligence fine is $4,300 per barrel of oil spilled (Rushe and Agencies 2013).

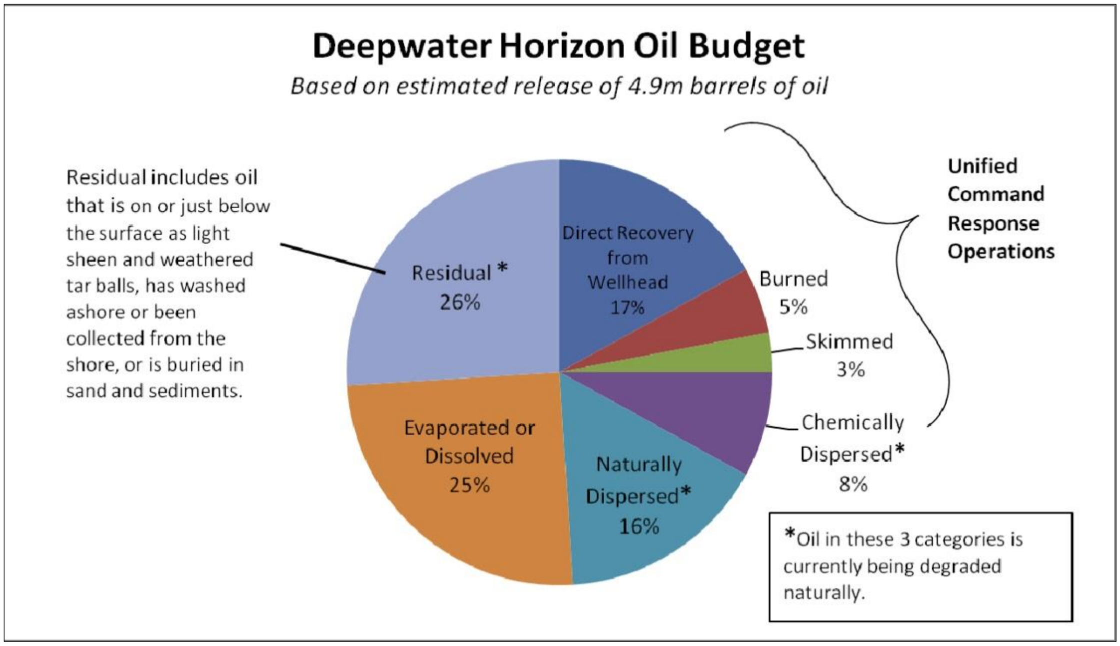


Figure 2. Percentage breakdown of the fate of the 4.9 million barrels of oil. (FOSC 2011)

Data analysis

The lower the RPs net cost through the proposed fine reduction -- which I will determine using equations from the EPA Basic Oil spill Cost Estimation Model (BOSCEM) -- the greater the financial incentive for RP investment in oil recovery technologies. The EPA BOCEM extrapolated their cost estimates using the response cost trends from 1993 to 2003, accounting for location, spill amount, oil type, response method and efficiency, shoreline effects, socioeconomic and cultural value, wildlife sensitivity, and freshwater vulnerability (Etkin 2004, Etkin 1999). The original BOSCEM equation yields the total response cost of the remediation effort using in-situ burning, chemical dispersion, and mechanical recovery ([1]Equation 1).

[1] Per Gallon Response Cost: This is a dollar per gallon value based on the type of response method and efficiency and the volume and type of oil (Appendix 1). Medium Modifier: This is a unit less value that adjusts the cost of response based on spill location, which affects the spread and diffusion of oil (Appendix 2). Total Amount Recovered by Mechanical Recovery: This is the amount of oil recovered mechanically.

Equation 1: Original equation (EPA, BOSCEM)

$$\begin{pmatrix}\text{per gallon}\\ \text{response cost}\end{pmatrix}\begin{pmatrix}\text{medium}\\ \text{modifier}\end{pmatrix}(\text{spill Amount}) = [\text{total response cost}]$$

After modifying the original BOSCEM equation to use mechanical recovery as the only response method, I estimated DWH spill mechanical recovery costs (Equation 2). I adjusted the 2004 BOSCEM values for inflation and used the per gallon response cost for crude oil, which is based on the volume of the oil spilled and a mechanical recovery efficiency of 10% (Appendix 1). However, the BOSCEM does not account for different types of crude oil. Louisiana crude oil is very light, which decreases the mechanical recovery efficiency (FOSC 2011). I used the BOSCEM default medium modifier of 1, representing the medium of open water and oceans (appendix 2), and calculated the total fine reduction by multiplying the per barrel fee by the volume of oil recovered in the DWH spill (Equation 3). Consequently, I derived the total net cost of the mechanical recovery effort of the DWH spill (equation 4a) from the difference between the RP's total fine reduction (Derived from Equation 3) and the amount of money spent mechanically recovering the 3% of the 4.9 million barrels of oil (Table 1). Additionally, I divided the total net cost by the amount of mechanically recovered oil to determine the per barrel response cost for mechanical recovery after the proposed fine reducing legislation (Equation 4b). To assess the savings, I compared the per barrel cost of mechanical recovery with (Equation 4b) and without the discount (Equation 5).

Equation 2: Modified equation

$$\begin{pmatrix}\text{per gallon}\\ \text{response cost}\\ \text{for}\\ \text{mechanical recovery}\end{pmatrix}\begin{pmatrix}\text{medium}\\ \text{modifier}\end{pmatrix}\begin{pmatrix}\text{total amount}\\ \text{recovered}\\ \text{by mechanical}\\ \text{recovery}\end{pmatrix} = \begin{bmatrix}\text{total response cost of}\\ \text{mechanically}\\ \text{recovering 3\% of the}\\ \text{4.9 million barrels of oil}\end{bmatrix}$$

Equation 3: Total Fine Reduction

$$\begin{pmatrix}\text{3\% of the 4.9 million}\\ \text{barrels recovered}\end{pmatrix}\left(\frac{\text{\$ fine}}{\text{barrel}}\right) = \begin{bmatrix}\text{total fine reduction}\\ \text{for recovering 3\% of the 4.9}\\ \text{million barrels of oil(\$)}\end{bmatrix}$$

Equation 4a: Net Cost

$$\begin{pmatrix}\text{total response cost}\\ \text{for recovered oil (\$)}\end{pmatrix} - \begin{pmatrix}\text{total fine reduction}\\ \text{for recovered oil (\$)}\end{pmatrix} = [\text{net cost}]$$

Equation 4b: Per Barrel Response Cost after Discount

$$\left(\frac{\begin{matrix}\text{total response cost}\\ \text{for recovered oil}\\ \text{(\$)}\end{matrix}}{\begin{matrix}\text{3\% of the 4.9 million}\\ \text{barrels of oil (barrels)}\end{matrix}}\right) - \left(\frac{\begin{matrix}\text{total fine reduction}\\ \text{for recovered oil}\\ \text{(\$)}\end{matrix}}{\begin{matrix}\text{3\% of the 4.9 million}\\ \text{barrels of oil (barrels)}\end{matrix}}\right) = \begin{bmatrix}\text{per barrel cost of}\\ \text{mechanical recovery}\\ \text{after discount}\end{bmatrix}$$

Equation 5: Per Barrel Response Cost before Discount

$$\left(\frac{\begin{matrix}\text{total Response cost}\\ \text{for recovered oil}\\ \text{(\$)}\end{matrix}}{\begin{matrix}\text{3\% of the 4.9 million}\\ \text{barrels of oil (barrels)}\end{matrix}}\right) = \begin{bmatrix}\text{per barrel cost for}\\ \text{mechanical recovery}\\ \text{before discount}\end{bmatrix}$$

I derived the per barrel cost of mechanical recovery if the RP is able to discount 3% of the spilled oil from their spill fines (Equation 4b). This value changes if the RP recovers more oil from the ocean or if the per barrel spill fine changes. Because the RP does recover more oil from the ocean, I assessed two different scenarios for determining the per barrel cost of mechanical recovery (Figure 3, 4), with one scenario assuming recovery of 3% of the total oil spilled (147,000 barrels) and the other assuming recovery of 20% of the total oil (980,000 barrels). The RP might be able to discount 20% of the total oil (980,000 barrels) from their spill fine since 3% of the total oil was recovered using mechanical recovery technology, and the Macondo wellhead directly recovered 17% of the total oil after the spill. Both scenarios assume a federal per barrel fine of $1,100, but each can be altered (Figures 3, 4) if the gross negligence fine ($4,300) is used rather than the original fee. Therefore, I developed four total scenarios for finding the per barrel response cost for mechanical recovery (Table 2).

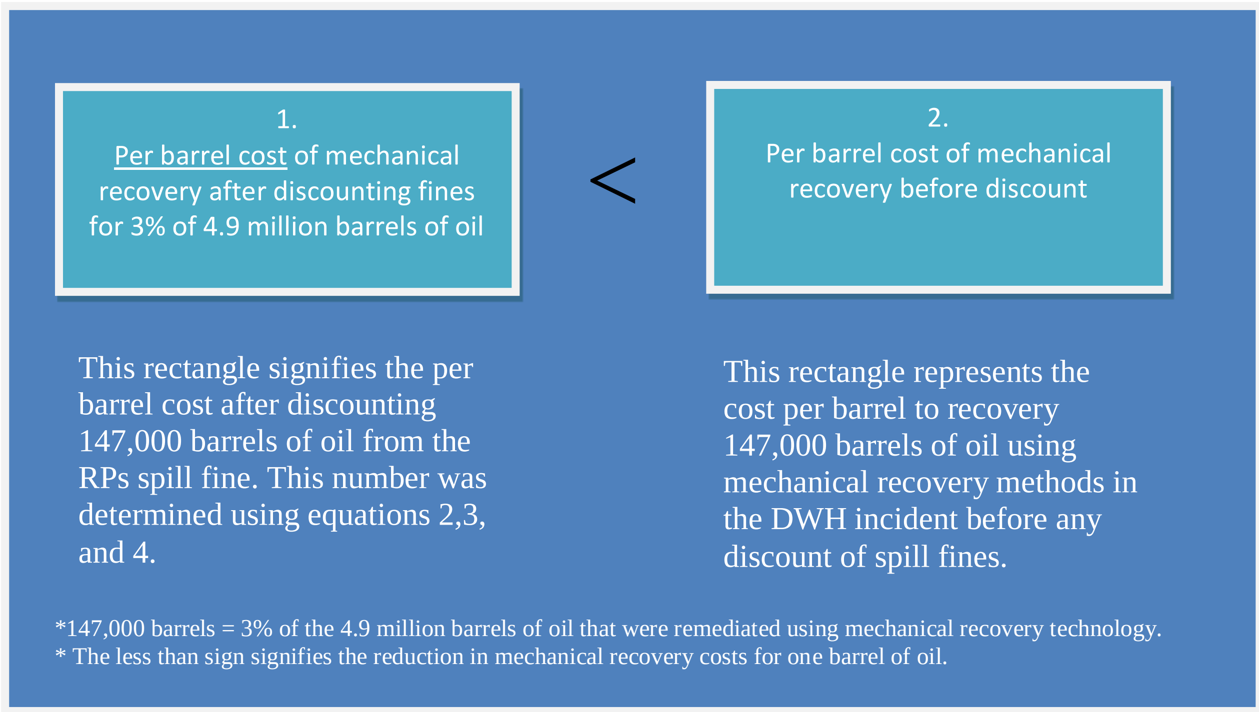


Figure 3. First scenario for determining the per barrel cost of mechanical recovery

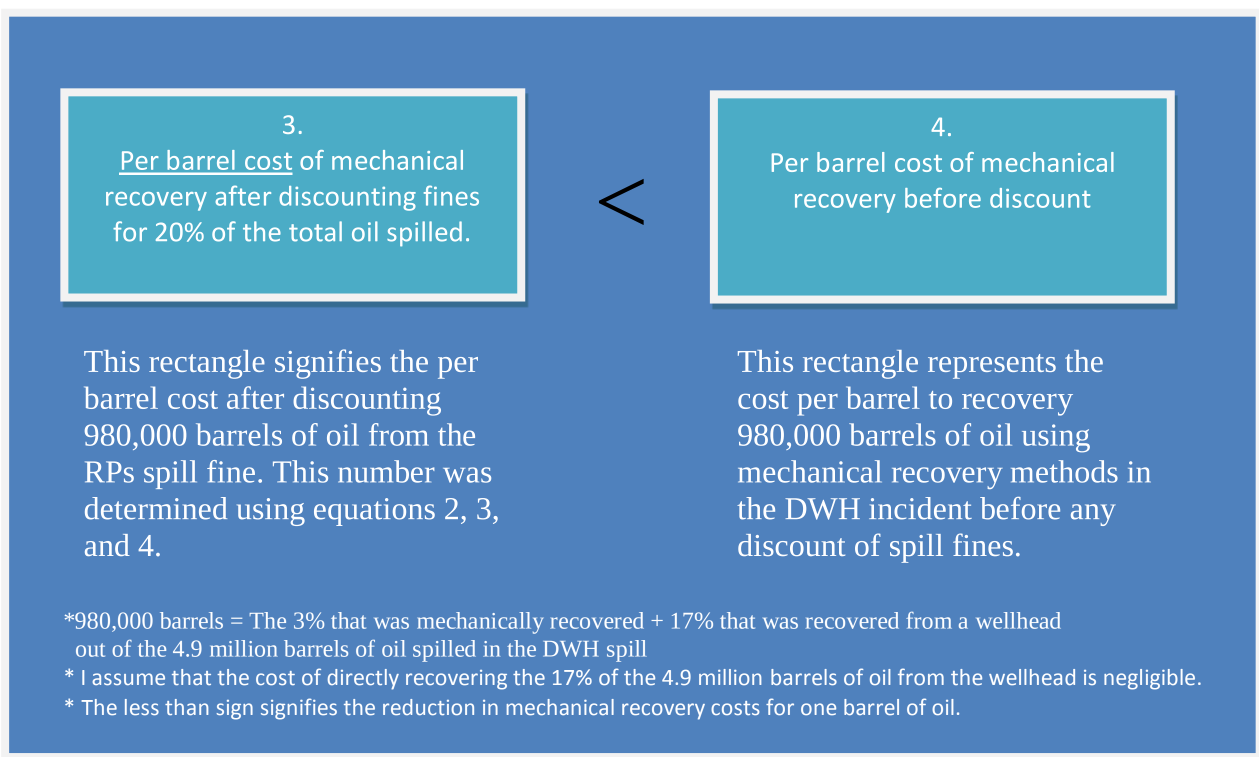


Figure 4. Second scenario for determining the per barrel cost of mechanical recovery.

Results

Table 2: Total Net Cost

Scenarios	Barrels discounted from spill fines (barrels)	Per barrel fee ($/barrel)	Total response cost for mechanical recovery ($)	Total Fine Reduction ($)	Total Net Cost ($)	Per barrel cost of mechanical recovery before discount ($/barrel)	Per barrel cost of mechanical recovery after discount ($/barrel)
1	147,000	1,100	379,701,000	161,700,000	218,001,000	2,583	1,483
2	147,000	4,300	379,701,000	632,100,000	-252,399,000	2,583	-1,717
3	980,000	1,100	379,701,000	1,078,000,000	-698,299,000	2,583	-712.55
4	980,000	4,300	379,701,000	4,214,000,000	-3,834,299,000	2,583	-3,912.55

Scenarios 1 and 3 were calculated using the per barrel fine of $1,100, and scenarios 2 and 4 use the per barrel fine of $4,300. However, scenarios 1 and 2 both discount 147,000 barrels from the RP's spill fine, which is 3% of the total 4.9 million barrels of oil spilled. Scenarios 3 and 4, on the other hand, discount 980,000 barrels from the RP's spill fine, which is 20% of the total 4.9 million barrels of oil spilled. After imputing values from each scenario into the equations discussed in the methods section (equations 2-4), I determined the total net cost and the per barrel cost after the discount for each of these scenarios (Table 2). Scenario 1 shows a net cost that is positive, but it is lower than what the RP would have had to pay were there no policy change. Scenario 2,3, and 4 all have negative total net recovery costs; however, scenario 3 is a lower negative value than scenario 2, which means that scenario 3, even though it had a larger fine reduction, would not incentivize mechanical recovery as much as scenario 2. The RP may use this money to lower their overall federal fine. Scenarios 3 and 4 have the most negative total net costs. If you look at the per barrel price for recovering oil using mechanical recovery, every scenario has a lower per barrel cost after the discount than the cost before the discount. In every scenario, the RP saves a substantial amount of money. In order to evaluate incentivization, I compare the per barrel cost of mechanical recovery after the discount to the per barrel cost of using other methods (Table 3). I find that in scenario 1, it is still cheaper for the RP to choose in-situ burning instead of mechanical recovery, but that is not the case with chemical dispersants. For scenario's 2-4, mechanical recovery is cheapest option.

Table 3. Comparing per barrel costs

	Volume (Barrels)	Dispersants[2,3]		In-Situ Burn[4]		Mechanical[3,5]	
		Low	High	50%	80%	(before discount)10%	(After Discount) 10%
Crude Oil[1]	> 31,500,000	$1,827	$2,016	$693	$346.50	$2,583	(Sc 1) $1,483
							(Sc 2) -$1,717
							(Sc 3) -$712.55
							(Sc 4) -$3,912.55

[1]Crude (except specifically-identified heavy- or light- crudes, intermediate fuel oils, waxes, animal fats, other oils, edible oils, non-edible vegetable oils, and mineral oils. [2]Per-Barrel costs include on-water dispersant response, shoreline oil removal, mobilization, source control, protective booming. [3]Removal assumed by dispersants for on-water recovery or dispersants. Shoreline oiling assumed reduced by % on-water oil removal. Low/high removal by dispersants for light fuel/crude 40%/80%, for heavy oil 35%/70% (Pond et al. 2000). [4]ISB costs based on per-gallon, converted in to per barrel, operation costs in Allen and Ferek (1993), plus costs of shoreline cleanup of unburned oil. [5]Per barrel response costs include on-water mechanical recovery, shoreline oil removal, mobilization, source control.

DISCUSSION

As seen in the results, the per barrel costs of mechanical recovery in scenarios 2-4 can incentivize investment in mechanical recovery, which may promote improvement in mechanical recovery technology and practices, and ecosystem conditions. With investment in mechanical recovery, developers can improve the efficiency of skimmers by developing new technologies that account for common situations. There are also many improvements in the protocol and procedures of mechanical recovery the responders can improve to increase the amount of oil recoverable. Some of these improvements can be made on the multiple levels starting from vessel manufacturers to what responders decide to utilize during the response. The environment and the ecosystem also benefit from these enhancements. These improvements/changes can increase the effectiveness of mechanical recovery, which will also reduce particulate matter, volatile organic compounds in the atmosphere, and will eliminate further damage to the environment. Incentivizing investment in mechanical recovery is extremely important and it is in the best interest of society.

Improvement in Mechanical recovery

Incentivization can allow for improvement in efficiency of mechanical recovery. New skimming technologies should be developed to increase efficiency in rough seas and variable summer temperatures. This would drastically improve the amount of oil recoverable. In the DWH incident there were skimming boats that had to continue to return to shore in order to empty out their oil storage. It was the only way to continue to skim oil. Most of the liquid that the skimmers collected was water and only a portion oil. If every vessel had oil and water separators, they could collect more oil and stay offshore longer. Alternatively, developers could manufacture skimmers that retrieved more oil than water. Incentivization can not only improve efficiency, but also improve practice and preference of mechanical recovery technology.

Improvements in practice

Incentivizing mechanical recovery would also mean using the methods for a larger percentage of the cleanup and improving the practice of mechanical recovery. In the DWH spill, only 3% of the total oil was skimmed. However, there were vessels called Vessels of Opportunity (VOO) that were equipped with containment boom, but were not equipped with skimming devices (FOSC 2011). Granted a VOO can help with gathering oil in one place; however with this policy implementation, a lack of equipment will not be a problem. The VOO's effectiveness in the DWH incident was extremely low. If each of those boats were equipped with proper skimming devices and oil and water separators, then the percentage of oil recovered in the DWH spill would be a lot higher. Some VOOs would not suite this amount of equipment, and responders should not have considered them as vessels of opportunity because doing so would be a waste of energy and resources. Improvements in practice can also be made on the manufacturer's level. If ocean vessels were manufactured to have oil storage tanks built into the hull of the ship, they could be repurposed when disaster happens. This would also reduce the need for a designated response ship fleet. If these dual-purpose ships were prepared with additional oil storage tanks on top of the tanks built into the hull, responders could conduct longer skimming journeys. These new dual-purpose VOOs could become an economic asset to ship owners because they could be contracted for oil spill response. Another improvement that can be made is to use oil recovery instead of in-situ burning. In-situ burning constituted 5% of the total oil of the DWH spill, but in-situ burning and mechanical recovery share similar conditions. In fact, in-situ burning conditions are the most ideal conditions for skimming because burning requires gathered oil and calm seas. It would be extremely effective to skim for oil instead of burning the oil. Many of these improvements in the practice of mechanical recovery stem from having a lack of equipment. This policy would incentivize recovery methods and increase the amount of equipment available. With the proper boats, technology, and practices, mechanical recovery could have potentially removed 5% of the total oil of the DWH spill. Improving the efficiency and the amount of mechanical recover technology used in oil spill response, can drastically improve the condition of the environment.

Benefits to the environment

The environment and marine ecosystem directly affect both the general public and economy, and incentivizing mechanical recovery will improve the condition of both the environment and the marine ecosystem allowing for better environmental services. If more mechanical recovery were employed, there would be less chemical dispersants that may threaten coral repopulation (Goodbody-Gringley et al. 2013). Increasing the amount of mechanical recovery would mean a reduction of oil, which would solve multiple problems. Reduction in oil would allow for fish repopulation, which would help the fishing industry. It would also improve health because there would be less oil on the shore releasing volatile organic compounds. The ecosystem would be able to recover faster as well, which also means better conditions for plant and wildlife. The improvement and outcomes of this policy are vast (Figure 5). In order to access if the incentivization will work, we must consider the limitations of to this policy.

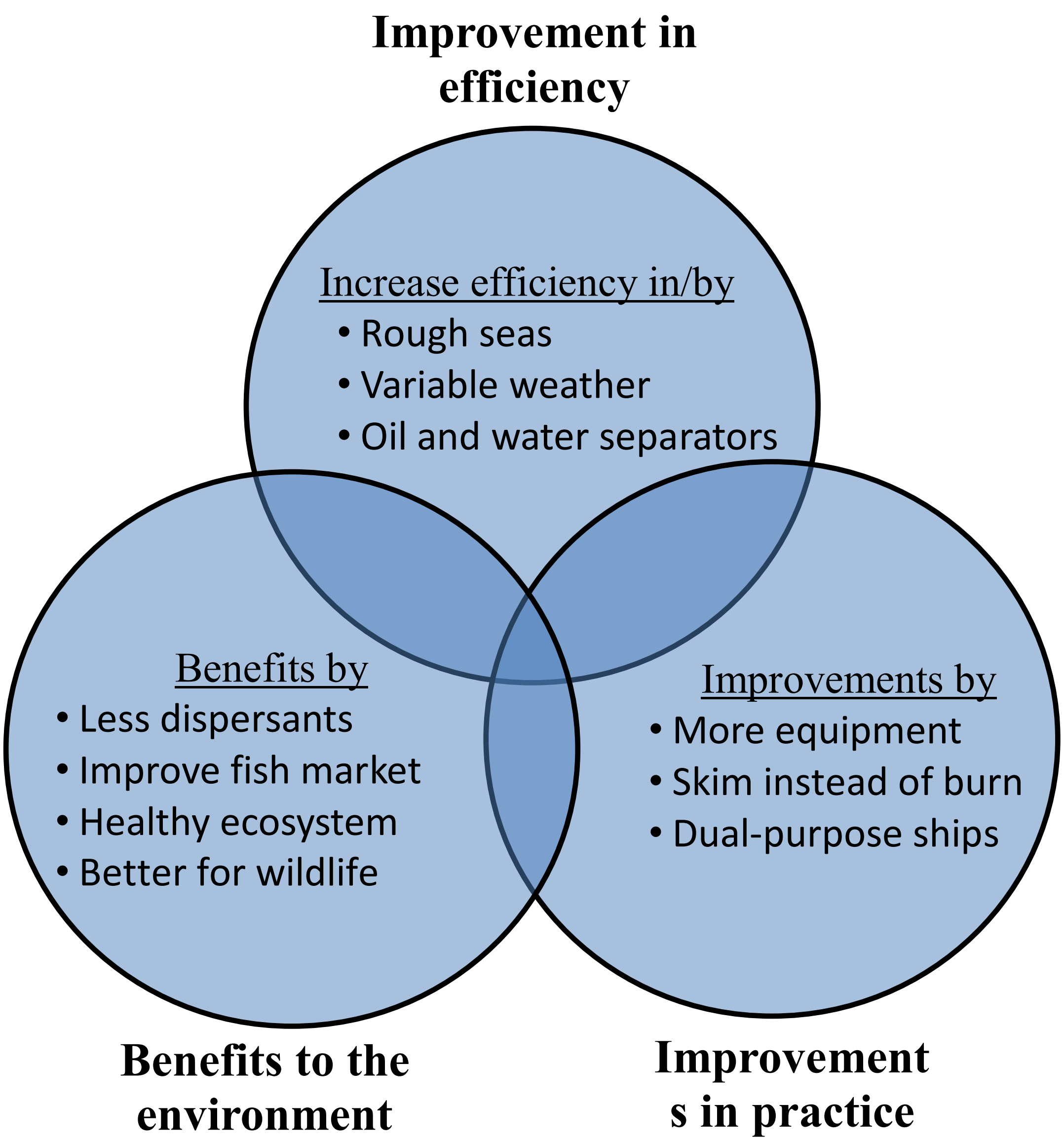


Figure 5: Potential outcomes of policy implementation

Limitations

The point of this legislation is to incentivize mechanical recovery by creating a win-win situation for all actors in the field, but it is important to consider the long term effects and potential flaws in this legislation. In the DWH spill, on-shore recovery was exponentially more expensive than mechanical recovery offshore. This raises the concern that even with this policy, on-shore oil recovery will not have a great enough incentive. More research can be done to determine if, in fact, on shore oil recovery would lower the incentive acquired through this policy. Although, when oil reaches the shore, in-situ burning and chemical dispersion become less desirable methods of recovery because they affect public health. The general public would prefer not to see burning oil outside of their window, or a plane spraying chemical dispersants near their neighborhood. Granted, this might work in areas that do not have public residences. Mechanical recovery is usually the main method of response on shore. However, there are new developed technologies that make shoreline mechanical recovery easier. One such technology, called Cytosol, is a vegetable oil based biosolvent that uses lift and float action to allow for easier oil recovery. This technology allows oil to float to the surface making it available for skimming. This new technology, if used, could drastically reduce the cost of shoreline recovery, and maintain high incentives. The US Coast Guard has already used Cytosol for the decontamination of vessels. (Wedal 2010) Another important limitation that should be addressed before drafting this policy is the determination of the concentration of a "recovered barrel of oil" and requirements for monitoring of this endeavor. If there are no set guidelines for what a "recovered barrel of oil" is, than the accuracy of claims cannot be upheld. Technical standards must be made before enacting this legislation. It is also important to have monitoring of this project as well in order to verify claims before granting fine reductions to RPs. Considering all of the limitations, how will this policy help all the actors of the field?

Broder implications

The current oil spill response legislation, CWA, NCP, and, OPA, do not prioritize safer response methods; however, it is important to consider who is affected by this new legislation and how (Figure 6). The three sectors of society that I have considered are economics, politics, and the environment. In each sector, I consider an actor. The actor for the economy is the oil industry, the actor for politics is the government, and the actor for the environment is the general public. The oil industry benefits from this policy by the reduction in their spill fines. It also allows them to recovery the oil for reuse. Although, some recovered oil cannot be reused. Nonetheless, there is potential for reuse of the spilled oil. This policy will also help the RP's public image because there will be less oil, which means less public claims and lawsuits to deal with. This legislation would allow the RP to engage in corporate social responsibility (CRS). The government would also benefit through further legitimization. This would prove to the general public even further that the governmental agencies are legitimate. This policy would also provide research funds for better technology for the future. The third actor, the general public, benefits the most because there is less on shore oil. On shore oil drastically reduces property value even after it has been cleaned up. There is also an aesthetic value that is lost when there oil is on shore. The public would also benefit from reduced air pollution that comes from volatile organic compound entering the atmosphere through oil and in-situ burning. They would also benefit from a healthier ecosystem, more plant and wildlife, and greater biodiversity.

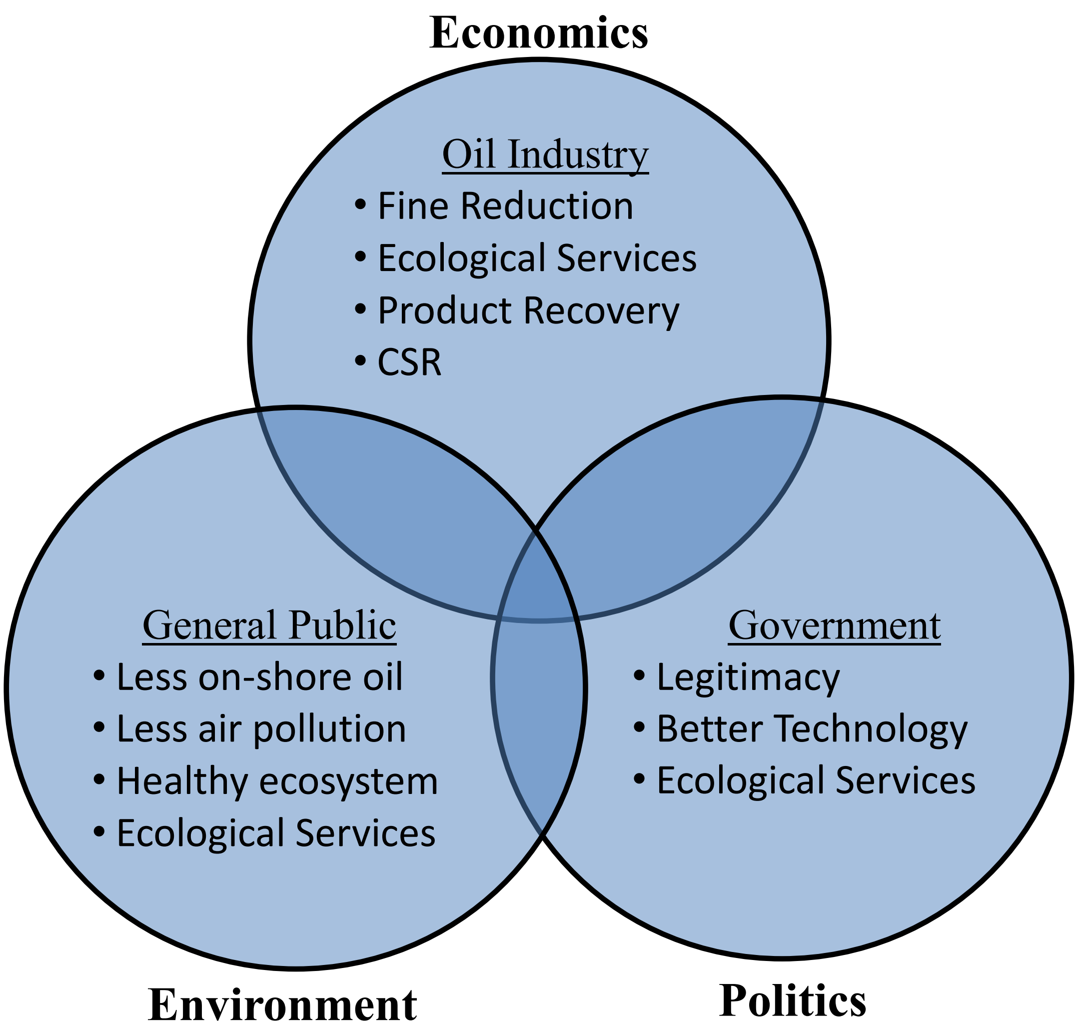


Figure 6: Actors that benefit from policy

There is one thing that benefits all three of these actors and that is ecological services. Ecosystem services are benefits provided by ecosystems for humans (NWF 2014). An example of an ecosystem with such benefits is the everglades in Southern Florida. They provide the residents of Florida with carbon sequestration, a natural water filtration system, and Charismatic Mega Fauna (NWF 2014). The economy benefits from fishing opportunities and increased real estate property values, the government benefits through preservation of national resources, and the general public benefits from a cleaner ocean and increase biodiversity. Rarely in policy can you achieve a win-win scenario for all of the actors in the game. It is important that we take advantage of this policy to make our lives, our children's lives, and future generation's lives better.

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