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An Assessment of Oil Spill Response Policy Decisions to Reach Efficient Environmental Outcomes in British Columbia, Canada

I. INTRODUCTION

British Columbia occupies the westernmost province and coast of Canada characterized by inlets, fjords, and islands. The coastal environment offers a wide range of ecological benefits such as species diversity unique to the Canadian coast supporting marine industries and activities such as fisheries, aquaculture development, tourism, utility, and transportation. The interface between land and the sea also offers land-based activities such as forestry, logging, agriculture, mining, and developments of ports, marinas, and human settlements due to rapid coastal urbanization. In addition to this, the coast provides intangible cultural benefits to First Nations' communities who are dependent on its natural resources for both traditional and basic provisions of their livelihood (Singh, 2020).

Oil Spills in British Columbia

Port Metro Vancouver is the primary location of marine transport with 27 terminals offering transport of cargo such as oil, coal, grain, sulfur, potash, liquid, and dry chemicals, etc., alongside urban transport across Washington and Vancouver Island. The movement of oil tankers has played a significant role in the economic landscape of British Columbia since 1957, with approximately 1180 movements per year off the west coast to and from ports of Vancouver and Kitimat and consequently resulting in increased tanker traffic between Alaska, Washington, and California (Visual Capitalist, 2012). Although there are strict regulations in place at Port Metro Vancouver with respect to marine tanker traffic, one cannot completely eliminate the risk of oil spills, thereby reinforcing the importance of continuous oil spill response and prevention provisions to minimize risk. The current scope of oil spill response efforts in British Columbia is aimed at mapping and identification of resources and habitats of economic, environmental, and cultural significance, while ensuring personnel in the task force are equipped and trained to respond to spill events through a command-and-control policy among local, provincial, and federal governments (Ministry of Environment, 2013). Each oil spill event is unique as it is influenced by characteristics of the oil itself, location of the event (such as offshore versus nearshore habitats), amount and rate of spillage, environmental factors such as weather, currents, tides, or biodiversity, and the capacity of disaster management and response to short- and long-term impacts in marine environments (Stone, 2013). For the purpose of this assignment, I will be focusing on environmental policies pertaining to oil risk management from marine tankers.

Ecological Impacts of Oil Spills

Oil spill events in the marine environment impact ecosystem services such as species generation time, interactions, and other demographic characteristics. However, the effects of these events are not homogenous as some species possess unique biological traits increasing their threshold to respond to spill events, which is also categorized by external factors of the environment such as habitat composition and depth. Near-surface species such as marine mammals and birds are the most vulnerable, whereas pelagic species will have minimal exposure. The overarching impacts of oil pollution in the marine environment include direct and indirect effects of ecosystem shifts resulting from altered species interactions, mass mortality, loss or changes to habitats, and competitive pressure, thereby impacting coastal ecosystem services and economies. For example, in a study conducted by the David Suzuki Foundation in developing dispersal models of oil spills in coastal regions of Vancouver, a spill occurring in the Burrard Inlet in one season can impact shorelines in other municipalities, whereas a spill in the same location in a different season may travel inward in the inlet reinforcing variables that impact dispersal of spills. (David Suzuki Foundation, 2013).

Societal Impacts of Oil Spills

Marine oil pollution can also have indirect effects on human society, impacting individual health, local economy, and policies. The indirect effects of ecological injuries as a result of oil pollution to marine environments are impacts to seafood industries (fisheries and aquaculture) through the bioaccumulation of toxins impacting public health, decreasing demand in the industry due to fisheries closure, impacts on water quality for industrial purposes, decline in environmental tourism revenue and other marine-based businesses at the port such as transportation. The impacts of oil spills on local economies are often challenging to evaluate with precision due to limitations in baseline data, long-term monitoring, and lack of valuation of environmental goods, which is subject to change due to the uniqueness of each spill. In addition to addressing direct impairments to market efficiencies, policy provisions are dependent on the local capacity and response to spill which remains untested in many regions, including British Columbia, as current policy provisions focus on recovery through oil clean up and recovery for the short term rather than long term management, and lack harmonization between federal and local government structures limiting the efficiency of oil spill response policies (Chang, 2014). The socio-economic and environmental impacts of oil spill events in British Columbia can threaten coastlines of Canadian municipalities and neighboring US localities, emphasizing the importance of international and interstate communication and cooperation in developing oil risk management policies.

II. ECONOMIC THEORY

Oil spills as a negative externality

Marine oil spills are gaining great public concern due to damages inflicted on biodiversity, natural resources, and economic impacts on the livelihood of communities dependent on these resources. Despite the presence of centralized and decentralized policies to manage oil spills, the rapid urbanization of coastal metropolitan areas as British Columbia, in addition to meeting local and international demand for oil, would likely increase marine tanker traffic and increase the risk of oil spills. With regards to environmental pollutants such as oil, the pollution model aims to describe the tradeoff between benefits to society by reducing the risk of oil spills and opportunity costs of forgoing profits from transporting oil which is a characteristic of all pollution control activities (Field, 2016). For example, if an oil spill were to occur in or near the Burrard inlet, residues from the pollutant may impact biodiversity and reduce water quality (public good resource) at or near the spill (dependent on factors such as currents, tides, etc.) causing damages to the natural environment and categorized as a negative externality to society as it impacts economic activities such as the seafood industry or local First Nation's communities who are directly dependent on these resources.

In the presence of an externality, market efficiency extends beyond the value and costs of buyers and sellers involved in the market transaction and includes the well-being of society affected indirectly (Mankiw, 2016). One component of this model is the damages resulting from the spill, and the second component comprises pollution abatement costs. As markets fail to account for external costs of damages, response to spills, reduction in risks of spills, and uncertainty of these events, the market equilibrium is not efficient as the equilibrium fails to maximize net social benefits, and policies are inefficient as abatement costs rarely equal marginal damages of the spill.

Why have markets failed to provide an efficient outcome?

Oil spills in Open Access Resources

An open access resource is a resource or facility that is open to uncontrolled access by individuals who wish to use the resource (Field, 2016). In the case of British Columbia, the marine environment is not only used for transportation of goods but is also a mode of transport for society as these waterways form an important resource for neighboring US localities and support international navigation under the United Nations Coastal Law of the Sea (UNCLOS). In Vancouver, tanker traffic alone is expected to increase 5-fold as oil exporters seek modes of transporting fossil fuels from the oil sands in northern Alberta to international markets, which would lead to increases in the number of terminals and points of access offshore of British Columbia (Chang, 2014). Hence, markets face problems with respect to what constitutes as property rights in the presence of an open resource, how they would be distributed amongst a large body of users, and enforcement of regulations while minimizing overarching damages to society. For example, as tankers increase their use of waterways, costs associated will include operational management and social water-related costs pertaining to ambient standards already in place, damage costs to natural resources in the event of a spill, and external costs inflicted on other tankers operating in the system. The problem arises due to a lack of policies regulating uncontrolled access to maritime activities. Hence, in the presence of external costs, markets will not produce socially efficient outputs, justifying the need to implement policies that encourage marine tankers to enforce stricter regulations that help move the economy towards efficiency by minimizing external costs of total damages and maximizing net societal benefits.

Oil spills in public good resources

With respect to marine oil spills and its societal impacts, water quality is a public good (Field, 2016). If oil response programs cleaned up a spill that impacted one individual on the coast, it involuntarily benefits all community members despite having a direct impact on them. However, it may be the case that communities along the coast have a greater willingness to abate damages inflicted by oil spills than those located farther away from the coast, but the end result is net societal benefit due to the value of the marine environment. Hence, this constitutes the problem of free-riding when dealing with public goods. If all community members expect someone else to pay for the oil response programs, such as clean-up of spills, and no one pays, the free-rider problem emerges. In such instances, government interventions may be necessary to move towards market efficiency as individuals who value the environmental quality more may be willing to pay more for response programs and subsequent management of oil spills. The use of policy tools such as taxes may enable tankers and oil response programs to internalize the externality by taking into account external costs of damages whereby the tax imposed will be shared by both producers and consumers, maximizing net societal benefits beyond an individual's utility of the resource.

Damage Assessment of Oil Spills

Lastly, the response to marine oil spills is not only determined by factors of occurrence such as location, time, rate, type of oil, etc., but how society aims to approach the economic valuation of the spill (Stone, 2013). The Canadian government classifies the costs of marine oil spills into five categories of damages – environmental, socio-economic, recovery, research, and other expenditures. However, the costs of an oil spill are generally determined in terms of admissible claims accepted by the compensatory regimes, which never cover the total costs of a spill (Stone, 2013). This is often a result of sociopolitical will, limiting accurate assessments of impacts and lack of baseline data, making it difficult to monetize damages incurred into a dollar value (example: the value of salmon to First Nations tribal members in some ways are priceless). Although tools are present to estimate passive costs, these are merely approximations and may never represent societal value. In addition to this, the impact of spills across sectors of the economy alongside indirect losses is challenging in establishing causality. The notion of ownership becomes especially important in the valuation of public resources to establish the full consequences of the spill event. For example, In the United States government owns the natural resources of the environment under the public trust doctrine for the people; similarly, in British Columbia, the resources allocated are owned by the province and can claim damages in the legal framework. The challenges of damage assessments are exacerbated by the episodic nature of spills whereby valuation of damage is estimated in the short run and as such, policies in place may increase the probability of an accidental spill in the future when long-term impacts are not accounted for. Hence in developing frameworks to capture the total costs of a spill event, it is essential to understand the social processes of valuation and its limitations.

III. POLICY OPTIONS

Regional and Federal Oil Spill Response Programs

As marine tanker volumes and sizes increase to meet the growing urban population's industrial demand, the risk of oil spills and collisions in British Columbia is projected to increase. Canada's oil response regime comprises both command-and-control policies and liability laws in the Response Organizations and Oil Handling Facilities Regulation. Shipowners and coastal oil facilities are required to have a response plan alongside consultation from the Response Organization to mitigate and respond in the event of an oil spill. Standards and regulations are federally certified under the Canada Shipping Act of 1993, which aims to "protect all navigable waters by placing requirements on takers/barges carrying oil in bulk of 150 tonne and greater, on ships 400 tonne and greater, and on handling facilities that receive deliveries from vessels included under the regulation to have a Transport Canada certified Response Organization to manage spills for which they are the responsible party" (EnviroEmerg Consulting Services, 2008). Upon receiving a certification, the Response Organization can collect retainer fees to buy response equipment, hire staff, and undertake preparedness planning; however, this does not enforce obligations on the vessel owner to employ these services in the presence of a spill. There are four Response Organizations in Canada – Eastern Canada Response Corporation, Point Tupper Marine Services, Atlantic Emergency Response Team, and the Western Canada Marine Response Corporation (WCMRC), which is the central oil spill response regime in British Columbia in charge of immediate responses while the federal authorities provide oversight, consultation, and aim to initiate long term management of marine oil spill risks.

The first principle of the oil response regime in British Columbia follows the "polluter pay principle," which is a liability policy under the federal Marine Liability Act that imposes the polluter/vessel owner to be prepared to pay in response to oil spill events (EnviroEmerg Consulting Services, 2008). While preparedness is aimed as a collective initiative of the shipping industry itself, responding to the spill and compensation for damages falls on the vessel owner. Imposing liability laws aim to mitigate tanker spills by guiding vessel owners to make careful decisions when transporting oil. The liability of tankers for environmental damages enables the externality to be internalized. Mitigation of oil spills through liability laws further reduces the compensation payments and aims to ensure abatement costs are less than damages incurred. Theoretically, this policy can be considered efficient in its approach to move emissions towards efficiency as it incentivizes industries to account for environmental damages and costs of abatement. However, the evidence of this is flawed and often times impacted by legal frameworks. For example, there is a legal limit established federally in Canada on the amount of money that a shipowner has to pay, coined as the "limit to financial liability," and upon reaching this limit, the vessel owner is no longer responsible for the spill, and is transferred over to the government. Although there are numerous financial insurances in place to address response action and compensation both nationally and internationally, the uncertainty of financial risk makes it difficult to determine if these arrangements would lead to an efficient market solution as the causality of the incident passes on to the government. This can often lead to transactional costs imposed on the government, and as discussed before, damages pertaining to oil spills are often hard to measure whereby the expected penalties may not reflect the true costs of damage whereby the market will not lead to an efficient solution. This is supported by a report published by the British Columbia Ministry of Environment which states that "there is a "real likelihood that federal and provincial agencies will have to pay for responding to an oil spill without full cost recovery from the spiller. Additionally, there is further risk that government will incur the cost of actions of removing a vessel's cargo, recovering lost cargo, and dealing with the shipwreck itself (Ministry of Environment, 2013)." The episodic nature of marine spills makes it difficult for regulators to initiate continuous monitoring of the system, which is exacerbated by the fact that each oil spill is unique. When a polluter's behavior is difficult to monitor, liability provisions give industries and tankers the incentive to reduce the probability of spill occurrences. However, for these regulations to work efficiently, the determination of liability is a critical component; furthermore, the law's ability to provide efficient outcomes is dependent on actual damages caused. In relation to voluntary action, liability rules do not permit volunteer pollution control actions, and foreign oil responders are not indemnified from the results of their work in Canada, thus rendering mutual aid agreements ineffective (Chang, 2014). Despite Canada's Shipping Act which acts as a statutory pollution control law, British Columbia has also sought international agreements to address this environmental issue. Canada is a member of the International Civil Liability Convention (CLC)/International Oil Pollution Compensation Funds (IPOC) network of funds that apply to most tanker spills alongside the Oil Pollution Fund. This exhibits a challenge to response regimes, as under international agreements, environmental damages are rarely compensated for beyond initial clean-up response costs and economic losses to certain industries such as fisheries.

The second principle of the oil response regime follows the command-and-control (CAC) policy whereby the government has the ability to mitigate probabilities of externalities by imposing regulations and standards that deem some behaviors as required or forbidden (Mankiw, 2016). The standards set can be a combination of ambient, emission level, and technological standards. The advantages of incorporating a command-and-control policy to oil response regimes can yield low implementation costs and be assumed to be equitable for all participants in the industry (shipping and oil-based industries). However, these actions still do not lead to efficient market outcomes for the following reasons. The first problem arises in setting the initial level of the standard itself by the administrative body, whereby authorities oftentimes only consider damage costs without considerations of abatement costs. Field points out the common principle in environmental law is setting a "zero risk" level standard that establishes a threshold level for externalities whereby all firms follow the same standard at zero. Although this may be appropriate for some pollutants, it is not generalizable to all, and in the case of oil spills, since each spill is unique and type of oil released can have different impacts on damage, the theory is essentially impossible to achieve. In addition, the lack of administrative efforts to distinguish and address short term and long-term effects of oil spill yields is disadvantageous to this policy whereby an implicit tradeoff is made between the damages that will result from temporary deterioration of ambient water quality below the standard level alongside high management and abatement costs that would be necessary to keep ambient quality within standard at all times (Field, 2016).

The implementation of uniform standards is a practical problem in relation to the differential nature of spill events which is exacerbated by the lack of harmonization between federal and regional authorities. In Canada, the Coast guard is the lead agency responding to an oil spill alongside the Province and has responsibilities with respect to its own interests and claims to take over underperforming spill responses (Stone, 2013). This is further exacerbated by levels of government having its own response structures whereby the Coast Guard uses its own Response Management System whereas the British Columbia government uses an internationally accepted form of unified command response regime. In addition, control is also exercised by vessel owners under the liability clause with a financial limit. As response origins vary based on these different regime responsibilities and capacity of response, the outcome is oftentimes not equitable or efficient equimarginally for all operators. In the real world, marginal abatement costs are highly variable across different sources. This observation coupled with varying response regimes across different levels of the government can lead to far less reduction in total pollution output for the total compliance costs of the program than would be achieved with an approach that satisfied an equimarginal outcome. The greater the differences in abatement costs, the more inefficient the approach of uniform standards. Additionally, a command-and-control policy is deficient in creating incentives for innovation as it follows the principle of "all or nothing." If standards of controlling vessel traffic and mitigation of spills are being met, there is no incentive to do better than the standard, even if costs of further emission reductions are negligible. Similarly, the incentives are in place to meet the standards, and in some cases, the last few units of emission reductions may be much more costly than damages reduced and is not cost-effective or efficient in its outcome (Field, 2016). For example, the federal law requires spill response organizations to maintain resources for a 10000-tonne spill which is not applicable to all spills. If control authorities dictate standards in maintaining this level, there are no rewards to find better innovative solutions to respond to larger and more significant spills. Although some incentives under CAC policies can reduce abatement costs to spills, this will consequently require new standards that reflect this change. Hence, it is important to consider the movement away from efficient levels, which may increase compliance costs due to a deadweight loss and further undermine the incentives for innovation.

Incentive-based Tax System

Although the idea of a command-and-control policy using standards imposes a direct control on pollution, they have many challenges, as discussed above. In the case of pollution from oil spills, due to the episodic nature of the pollution and associated uncertainty, it becomes important to address the concept of risk in developing efficient market-based policies whereby it is important to address situations such as the likelihood of accidents occurring with changes in operational management procedures, alongside the benefits and costs to society associated with changing these likelihoods and if individuals find it worthwhile reducing the chances of accidents (Field, 2016). An alternate policy proposal to address accidental oil spills would be an incentive-based emission charge or tax system whereby governmental provisions will set rules and objectives while still allowing producers and consumers the flexibility to incentivize pollution emissions to a level of efficiency through cost-effective means. For the purpose of this assignment, I will analyze specific forms of taxes that can be imposed from the perspective of producers and consumers.

Producers

The economics of imposing a tax on oil polluters can be depicted by figure 1. For example, if the tax rate of oil emissions per ton was set at $100/ton/month and a polluter was at its maximum level of emissions of 10 tons/month, the polluter's payment for using the environment would be 1000$. A profit maximizing firm wants to minimize its total compliance costs (TCC) comprised of the tax bill (a) and total abatement costs (b), hence if the firm were to lower its emissions to 9 tons/month, it would save a $100 in tax bill consequently reducing the total cost comprised of the tax bill and abatement costs. This will continue until marginal abatement costs equal the tax bill. However, this system assumes the presence of enough competitive pressure among different tank operators in the industry to incentivize reduction in emissions by minimizing costs, and this may be applicable to marine tankers operating in British Columbia due to high reports of vessel traffic as a result of major marine transportation projects proposed in its coast. The frequency of oil spills in Canada is greater for smaller vessels of spill sizes between 100 to 10,000 liters (Clear Seas, 2021), whereby competitive pressure to reduce emissions may be applicable to smaller vessels than larger ones. In addition, unlike a CAC policy where the total costs will only be total abatement costs; with a tax, the polluter is essentially paying more for the environmental services, which can essentially be used to develop a management regime that can respond to future spills and compensate long term impacts (double-dividend). A challenge to this system in the case of oil spills is determining the level of tax without accurate representation of damage costs that are variable with each oil spill. A solution to this problem may depend on a method of trial and error of setting a tax rate and gradually observing responses to environmental quality (improvements in quality will lower the tax rate). However, this is a cumbersome process of investing in continuous monitoring of tankers and the environmental quality. Although the charge rate can incentivize polluters to adopt better pollution control practices, a change in rate will be burdensome for both the polluter and governmental authority and hence relies on determining the level of charge in the beginning to avoid future conflicts.

Figure 1: The Economics of Emission Tax

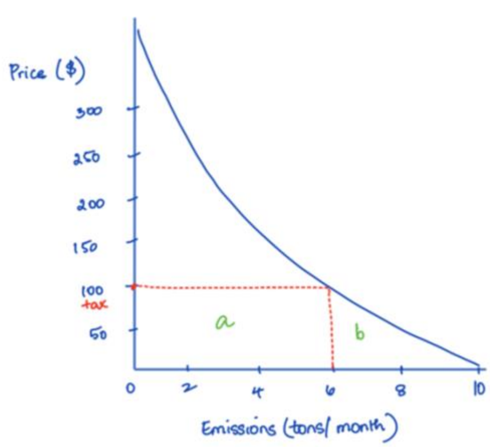

Figure 1. The Economics of Emission Tax
At the maximum level of emissions, the firm would produce 10 tons of emissions, and the TCC would be $1000. The imposition of a tax incentivizes industries to reduce emissions until marginal abatement costs are equal to the charge on emissions.

The level of charges can ideally be determined by the amount of oil transported in each vessel, whereby tankers carrying a greater amount will be charged a higher tax rate than those with a lower amount. However, the disadvantage of setting the level of charge using this principle can lead to greater administrative costs in determining damage costs associated with different types of spills and subsequently greater abatement costs and tax rates for those tankers that have the potential to cause a greater spill even if damage from reducing emissions can be equalized across all tankers. An advantage of a fixed tax system on tankers is its effectiveness in controlling multiple sources (types of vessels) by satisfying the equimarginal principle. Since the marginal abatement costs can vary with the uniqueness of spills and types of tankers in operation, the same tax rate will incentivize polluters to reduce emissions until each of their abatement costs equal the tax rate, equalizing the costs of abatement across all polluters. In addition, since it is often difficult to acquire exact abatement costs of specific tankers for each spill, this principle can ideally work without knowing the abatement costs curve, which proves more advantageous than the CAC policy of standards which is unable to provide efficient outcomes in the face of uncertainty in the industry (Field, 2016). On the other hand, a disadvantage of this system would be administrators are unable to attain by how much emissions will reduce especially with differences in abatement cost curves between polluters, whereby a flatter marginal abatement costs (MAC) curve will respond with greater changes in emissions to changes in tax rate and prove time consuming and costly for administrators to determine the charge that will provide an efficient level of emission which is why policies often fall back to standards. Lastly, a benefit of a tax-based pollution control policy is the incentive for producers to innovate through technological advancements to aid in pollution control. This is further explained by figure 2, where the polluter experiences an added gain in benefits through a much larger reduction in costs through new forms of pollution control technology resulting from research and development.

Figure 2: Emission Tax as an Incentive to Innovate

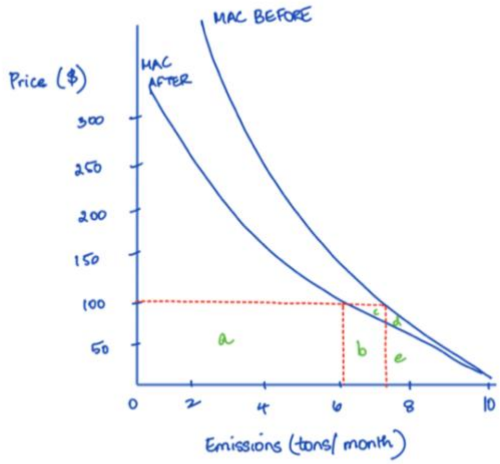

Figure 2: Emission Tax as an Incentive to Innovate
The figure depicts a firm's marginal abatement cost curve (MAC) before and after the firm adopts technological advancements. Before innovation, the total compliance cost is comprised of d+e (abatement costs) + a+b+c (tax bill). However, after innovation, the total compliance cost is b+e (abatement costs) + a (tax bill), whereby the benefit to the firm from innovation is d+c (added gain from tax-based inventive to innovate in comparison to a command-and-control policy where the benefit from innovation is d).

Consumers
As mentioned before, the uncertainty and non-uniform nature of oil spills require administrators to account for risk in developing policies. In addition to taxing the source of the problem, it may be worth considering options for taxing consumers that can increase the double dividend in preventing future spills, mitigating long-term impacts, and addressing gaps in economic inequality. Vertical equity occurs when two taxpayers who have the same income face the same tax obligations whereby the tax charge changes with the taxpayer's ability to pay and is an example of a progressive tax system (Millsap, 2016). The introduction of a more equitable tax system can subsequently impose benefits through tax reforms that are evenly distributed. An alternate form to this principle would be to tax the 1% of wealthy individuals to generate enough funds to develop and manage oil spill response programs and environmental quality, which can further result in tax reductions in other sectors in the presence of excess funds. However, this can oftentimes be regarded as unconstitutional, whereby the gap between taxpayers and beneficiaries of the tax system widens. In this case, stakeholdering and transparency of the tax system can play a crucial role in developing necessary support for the public goods problem at hand and effective decision making that will remove the number of exemptions, help determine accurate calculations of the charge/revenue generated and modify tax brackets to propose equitable outcomes.

The most common form of consumer tax within the economic chain of oil companies falls on the products; although this creates the incentive for consumers to consider their own carbon footprint, often the burden falls disproportionately on low-income households; hence a consumer tax can better serve equitable outcomes through a more general applicability to all goods and services. An alternate policy option would be a hybrid between subsidies and taxes called a deposit refund system. In this system, a subsidy (refund) is paid to consumers when they return an item to a designated collection point. The purpose of this subsidy is to provide the incentive for people to refrain from disposing of these items in damaging ways to the environment (Field, 2016). The funds for paying the subsidy are raised by levying taxes (deposit) on these items when they are purchase (Field, 2016). This concept can essentially be applied to oil spill management programs; for example, Germany has introduced a deposit refund system for the management of lubricating oil disposal in the environment. In this system, the lubricating oil producing entity is subject to a tax which is used to develop a special fund used to subsidize (refund) oil waste recovery and processing, which provides a better incentive for polluters (producers) to reduce contamination to the environment and effectively reducing their compliance cost (Walls, 2013 & Field, 2016). Although the most evident challenge to this system is the incentive to reduce consumption of these products by consumers, stakeholdering can create a public view that is well informed on the issue on the consumer side and subsequently improve the gathering of information needed to target mitigation and adaptive oil spill responses and enhance the efficiency of these outcomes.

IV. INFORMATION

The most common approach in policy decisions is through the systemic process of a cost-benefit analysis whereby an efficient economic policy maximizes net benefits to society. In the context of accidental oil spills, market costs of the policy decision are generally estimable through the equipment and labor costs of clean-ups associated with the spill (Assaf, 1986). However, the impact of oil spills on the marine environment as a public good with an infinite supply of ecosystem services can be difficult to capture in the commercial market due to these services not always traded in the market and hence not valued. When the market provides services as a result of the marine environment, such as through tourism, fisheries production, recreational activities supplied by private brokers, consumer products, etc. the losses to consumers and producers can be estimated based on market prices; it is more difficult to value the loss of these services when noncommercial attributes of the services provided by the ecosystem are to be considered, whereby the total economic value is underestimated. It is important to consider these losses through various nonmarket valuation tools; otherwise, we are implicitly assuming nonmarket goods have zero value, which is an unjustifiable assumption in policy decisions pertaining to environmental quality (Assaf, 1986). Comprehensive baseline data on natural resources and socio-economic entities in the region would better inform environmental and economic impact studies, recovery plans, and value associated with these services.

Firstly, it would be important to understand the value of the marine environment to those users at the coast whose value cannot be estimated through market prices. One method of achieving this is through the hedonic pricing method, whereby an attribute of the housing price is associated with being at the coast. Property owners at the coast may be willing to pay more due to both use and non-use values associated with the marine environment. However, this method fails to account for how the policy decision will impact other users, not at the coast, who may have values associated with the ecosystem service and only captures the willingness to pay for perceived differences in housing attributes (Conservation Strategy Fund, 2015). In the context of imposing a tax region wide in British Columbia, it will be important for all users to be well informed on the basis for initiating the policy decision. A contingent valuation may be used to reveal people's willingness to pay when placed in "contingent" situations (Assaf, 1986). The advantages of this method are that it reveals not only valuations of specific attributes of the environment but also aims to estimate the individual's value on the outcome of environmental quality and is consequently a better estimate of the total economic value associated with use, non-use, and option values (Conservation Strategy Fund, 2016). The money users are willing to pay for the environment can represent their valuation of maintaining environmental quality through the implementation of taxes or subsequently having the environmental good replaced.

The episodic nature of accidental oil spills calls for the valuation of risk and can help develop baseline information and models to produce the expected value of oil spill occurrences (Field, 2016). Modeling of spills in key areas of British Columbia can provide information on dispersal rate relative to types of oil spills and can emphasize risk-prone regions that may require more attention than others. Previous studies can also help build this foundational model by investigating other technological and natural disasters on the coast to evaluate the capacity required to manage spill response programs alongside other management efforts in British Columbia (Chang, 2014). In addition, data on population levels of biodiversity, economic activities, human population, and health outcomes in sensitive areas relative to non-risk zones can further improve risk analysis in developing models for expected values and indicate how individuals are likely to respond to risky situations in developing efficient policy decisions that can address not only short-term impacts, but also long terms impact of the unforeseeable future.

V. CONCLUSION

From this analysis, it is evident that no one solution exists to public goods problems such as accidental oil spills. It is often difficult to attain the efficient level of emissions for accidental oil spills due to the episodic nature of the externality and the lack of sufficient data to estimate marginal costs of damage relative to abatement costs to incentivize and hold industries liable. However, with relevant information through the market and nonmarket valuation tools, one can build better efficient and cost-effective outcomes in policy decisions. In addition to exploring whether the net benefits outweigh the costs of implementing a command-and-control policy versus an incentive-based tax system, this paper further develops an important notion of minimizing risk for environmental externalities in which cost-benefit analysis can lead to uncertainty. Although the command-and-control policy is portrayed to be efficient in creating standards region wide to control pollution and aid in the response and recovery of oil spills in the short run, the incentive-based tax system is more efficient in the mitigation of long-term damage and associated abatement costs. It is also important to recognize that it may take multiple policy tools to minimize externalities to environmental goods and services as their value is always not captured within the market and encompass a wide range. This will require investing in research to fill in these knowledge gaps and include variables pertaining to the spill's sources and characteristics, impacts on the environment, socio-economic interests, risk assessments, and account for unforeseeable global pressures such as climate change which can exacerbate the effects of environmental issues. In addition, it will be important to consider those benefits to society that may not always be valued in the eyes of the consumer, such as the implementation of policies that carry equity in decision making and understand the process of decision making by weighing in moral and political considerations in the future.

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