Energy Research & Social Science 16 (2016) 132–140

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

From whale to crude oil: Lessons from the North American Arctic

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ARTICLE INFO

Article history:
Received 18 November 2015
Received in revised form 18 March 2016
Accepted 20 March 2016
Available online 30 March 2016

ABSTRACT

The Arctic is considered as potential region for energy extraction as it holds vast reserves of hydrocarbons and the region is being targeted for resource development. However, the current trend toward development is not the first time that oil has been extracted from the Arctic. This empirical and theoretical investigation is based on the experiences of the whaling industry that operated in the Arctic over a century ago and extrapolates these experiences to the obstacles faced in contemporary development, identifying lessons that can be learned through historical comparisons of economic and resource development. This article considers the theory of peak production, cost-benefit analysis, the role of technological development and finally the regulatory environment in the development of the oil industry in the environmentally challenging, but possibly profitable, Arctic region.

1. Introduction

In many conversations about the Arctic, the subject of climate change and associated ice melt is nearly synonymous with the extraction of Arctic oil reserves. International focus on the Arctic has intensified by a variety of interest groups since the United States Geological Survey announced potentially large quantities of technically recoverable oil in the region, increasing speculation on energy exploration in the region. This information was convoluted by the perception that the installation of a titanium Russian flag on the seafloor at the North Pole was a symbolic gesture of territorial expansion, territory that was now understood to hold vast quantities of energy resources. The period that follows has been charged with vast public conjecture that sovereignty claims in the Arctic have been pursued because of the discovery of unknown fossil fuels and increasing interest in the development of the shipping routes in the region. In the ongoing saga of development in the Arctic, global attention continues to centre on the sovereignty claims of the Arctic littoral states as they developed governance mechanisms for the region that protect their interests and the activities of the petroleum industry amidst the growing concerns over climate change, environmental and safety issues. Despite the apparent boon that crude oil presents, it may be that the history of a previous oil boom, whale oil, provides valuable lessons for contemporary development of Arctic oil.

Setting aside the moral arguments against further development of non-renewable energy resources to supply global demand and to secure national interests, in an ideal situation, the process from energy extraction to market delivery would be a straightforward exercise without political fray or technological glitches. However, the reality is that recent pursuit of energy in the Arctic has proved to be a minefield, from considerations of climate and weather, the unsettled domestic regulatory environment and the high cost of operating in the remote and harsh region—even before calculating for social resistance from environmental concerns or international pressures on reducing carbon emissions. So while Arctic oil is often seen as expedient strategic resource for the lucky stakeholders, an investigation of the North American Arctic as a historical site of energy development demonstrate that it has often fallen short of the expectations of prospectors. A survey of historical newspaper archives, wreck registers and whaling industry accounts demonstrates the pursuit of whale oil from the Arctic was not the infusion it was expected to be. Oil extraction in the Arctic is not a contemporary phenomenon and because "whaling was just as important to us [in the twentieth century] as the oil industry is today [1]," there are lessons for the present to be learned from the history of energy exploitation in the region.

2. Lesson 1: has Arctic crude been developed too late?

Given the forecasts of recoverable reserves in the Arctic continental shelf, the recent explosion of development enthusiasm for offshore crude energy conceals the reality that interest in the region for the purposes of oil extraction has a history spanning nearly two centuries. An examination of archival resources, employing a Boolean search specifying the terms 'Arctic' and 'oil', produces documents dated beyond the last decade of discourse on crude

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http://dx.doi.org/10.1016/j.erss.2016.03.013
2214-6296/

reserves exploration and development. Instead, it reveals that the Arctic became an energy exploratory field in the middle of the nineteenth century. Long before crude oil became a dominant market commodity behind the industrialized world, whale oil was the product fuelling energy speculation in the Arctic, given the perceived renewable population of whales in the region. However, these speculators failed to realise that global demand for energy would exceed the renewable capabilities of whales and as a result the impulse to boost the whaling industry through north development came too late; by the time the whalers went to the Arctic, the demand for the commodity was in decline.

Although whale oil was an important commodity of the nineteenth century, the impulsion to develop the Arctic as a whaling ground was encouraged as much by politicians in Washington as promoted from the demands of market forces. It is rather unsurprising that it was the same senator who was to later negotiate for the purchase of Alaska who promoted the pursuit of whale oil decades before the U.S. became an Arctic state. While Alaska yet belonged to Russia, U.S. Senator Seward lauded the Arctic whale fishery as "a source of national wealth and an element of national force and strength," especially as fishing in the free seas of the Arctic brought resources to the U.S. which acquired wealth that left the sovereign resources of the country untouched [2]. Washington's viewpoint determined the expansion of the commercial whaling fleet into the Arctic was an act of duty in order to expand the energy and commercial security of the nation.

The expansionist pursuits of Seward and his cohorts ultimately served the resource interests of United States very well in the purchase of Alaska—a purchase which had paid for itself hundreds of times over even before the territory became an organized U.S. state. However, an insurmountable obstacle faced the whaling industry: the decline of the whale population and therefore the ease and the abundance of the yield. As the whaling fleets moved north, the whale population that had once been abundant in Arctic waters was nearly exterminated in the space of two decades due to unsustainable and unregulated fishing [3]. As a result, the whaling hauls faced restricted growth opportunities relative to market demand, a demand convoluted by competition from developing petroleum products. Although the whaling industry remained strategically important for some time, it had become an unsuspecting victim to the trend described in Hubbert's peak theory.

Although Senator Seward was gleeful about the perceived treasure trove of whale in the Arctic, peak theory was soon to demonstrate his folly. Hubbert's peak theory posits that the "the only *a priori* information concerning the magnitude of ultimate cumulative production of which we may be certain is that it will be less than, or at most equal to, the quantity of resource initially present [4]." While the idea that production results can never exceed initial stocks might seem like common sense information, this was grossly overlooked and as the whale population went into decline, so did the returned revenues. As a living resource, the even development and therefore continued viability of the whaling economy was dependent upon the at least equal repopulation of the whale fisheries; though some realised the whale stocks were in decline, others insisted the supply would continue indefinitely. The effects of a strong negative correlation between the annual whale harvest and the pod's renewability in a climate of an unregulated commercial environment caused supply instability, decreasing market confidence and reliance on whale oil as an energy product.

What follows is that the pursuit of whale oil in the Arctic, depicts the peak theory condition theorised by Hubbert in the shape of a Gaussian curve [5]. Illustrating this condition through a bell-shaped curve, production begins at zero when the quantity of the initial resource is at its maximum quantity and production then accelerates as commercial processes are refined to reach a point of peak production. When this process reaches its optimum efficiency, subsequently, there is no direction to develop except for to decline in production until reaching the final depletion of the resource. Peak production for the whaling industry arrived just before the middle of the nineteenth century—a decade before the North American whaling fleets were at their largest capacity, and in an additional blow, peak whale oil prices were reached even before the U.S. had acquired the Alaskan territory [6]. Despite the abundance of whales in the Arctic, the heyday of whale oil came before the region was tapped for this resource and the promotion by Seward while boosting the whaling industry in the short term, was unable to prevent its eventual decline.

With energy security remaining a high priority on national agendas and awareness that crude oil is a limited resource, there are parallels between the Arctic expansions of the whaling industry and the contemporary upsurge of the petroleum industry's interest in maritime Arctic oil development. Not dissimilar to the whaling fisheries that were easy to access and located in more favorable climes during the middle of the nineteenth century, the oil reserves that were easy to retrieve have already been claimed or developed. Applying the laws of nature and business, an industry must expand, developing new reserves or new methods of production or face eventual decline. In addition, increasing global energy demands and the need to maintain energy security require that today's oil prospectors extend exploration of reserves that were once technologically out of reach for development in order to maximize longevity. So although Arctic energy reserves might prove to be the difficult option they also someday might be one of the last options despite evidence of being past peak.

A second parallel is that the call to develop the non-renewable energy resources of the Arctic mimics the call by expansionist politicians of the nineteenth century as the expected diminishing ice extent makes the development of these areas more accessible. While the U.S. and Canadian governments have not created a correlation with patriotic duty as did Seward in his encouragement the development of oil in the Arctic through impassioned speeches, they have both issued policy statements demonstrating that Arctic oil is included in national energy security strategies. As with the encouragement of the whaling industry in another era, these governments are proactively working with stakeholders and industry to explore and develop the Arctic, a critical area for energy development even though oil is also known to be a finite resource [7]. The prioritisation of Arctic oil within the economic development strategies of these countries, while not implying patriotic duty, at least indicates government cooperation in making this development a possibility, including their active pursuit of the legitimisation of sovereign rights over this oil rich territory.

It is no secret that exploitation of non-renewable resources and resources that are unsustainably exploited, will experience the effects of Hubbert's peak theory; this includes crude oil, despite expansion to the Arctic. It is somewhat ironic that Hubbert's research was in fact, specifically intended to demonstrate to the American Petroleum Institute that the role of fossil fuels was greatly limited in its capacity to contribute to the energy requirements of mankind in the long term. His theory proved valid when U.S. oil production peaked at the predicted moment in the early 1970s, the Canadian oil industry peak following shortly thereafter. What the theory could not account for at the time, was that new reserves and new technologies would expand the margins for recovery, changing the defined boundaries of technically recoverable resources. Thus, the predicted moment for the new peak oil is moves incrementally into the future. Although the predictions vary it is known absolutely that oil is not a renewable resource and as such the reserves will someday be depleted. It is only a matter of time, but eventually, the resource will expire and the Gaussian curve for oil will

mirror the bell shaped development curve of whale oil and associated industrial decline.

A question that remains unanswered is what an Arctic specific Gaussian curve predicts for peak development of Arctic crude as in indicator of viability. Oil exploration and drilling began in the North American Arctic in the 1950s, however, oil production in Alaska has declined over the last several decades and much early industrial development in Canada was abandoned due to its inefficiency [8], a trend that appears to be continuing in current pursuits of oil in the region. The lack of correlation in expected reserves with current extraction indicates that at present, oil extraction in the Arctic has not likely reached peak production. All that can be assured is that the known resources have yet to be depleted and thus Hubbert's curve continues indefinitely into the future so long as the fields of Arctic oil remain an undeveloped, but potential source of national security.

This lesson indicates the naïve optimism for expansion to the Arctic for energy is a chimera of energy security. Given a comparison of the trajectories of the development and decline of the whale oil industry to that of development and future decline of the oil industry, it is theorised that the shape of production does not extend indefinitely in a positive direction. The oil industry may therefore discover, that their fate may be as was the whalers in the Arctic: the move to expand to Arctic resources in a final push to acquire energy security has not advanced soon enough. In the same way that entry into the Arctic fisheries failed to extend peak production for the whaling industry, it may be that crude oil has already peaked for the Arctic and it will be only be discovered at the point when the oil production bell curve reaches its terminus that expansion into the Arctic for crude oil came too late and that efforts should have earlier been turned to the development of other energy resources.

3. Lesson 2: is Arctic oil worth the cost?

The historical records of the American whaling industry reports that the pursuit of whale oil in the Arctic resulted in extremely profitable returns [9]. The returns also remodelled the overall value of the industry and changed the known understanding of whale quality, as the animals harvested in the region were considered to be far superior to those found elsewhere. However, eventually this bonanza diminished and the industry experienced the condition of negative returns. Even before the U.S. Civil war, a period which saw lower stock reserves and higher commodity prices nationwide, the losses in profitability began, continuing into the period shortly following peak oil production. The whaling historian Starbuck reports that though the Arctic fisheries returned good profits at the outset, "Then came the losses, and as the whales became more scarce and the voyages more prolonged and far more expensive, these reverses became more and more serious. . . [10]". Like the seeming initial abundance of whale oil in the Arctic, the lesson for current energy development of Arctic may be that while the reserves estimates of oil and gas in the Arctic are an impressive addition to crude oil stocks worldwide, that the cost of investment may not provide returns worth the effort, even if global warming reduces the ice cover.

In order to begin operations in the whaling industry, the initial upfront infrastructure costs required significant investment by financial backers. Although some infrastructure was the same for Arctic whaling as elsewhere, including the ships, on board equipment, fuel, foodstuffs and wages, the differenced lay in the quantities necessary for travel to the Arctic, exponentially increasing expenditure on fuel, food and wages. The period newspapers regularly reported on the incredibly long list of principle articles that were supplied for whaling expeditions, materials considered as strictly necessary to conduct the business detailing the investment required for a single Arctic whaling fleet at around 52 million dollars in today's money—and this is only in foodstuffs and equipment and does not account for the investment in ships, insurance and wages [11]. While this may seem insignificant when compared to the contemporary costs of the crude oil industry, it illustrates the upfront costs for which investors had to wait several years before seeing any returns on their invested capital, which in the early days of Arctic whaling proved a worthwhile wait.

The whaling industry's foray into the Arctic coincided with the decline of the Little Ice Age around the middle of the nineteenth century, a climatic transformation which enables the expansion northward. This period saw ice caps that had extended during the ice age decline and "summers became warm enough to melt much of the sea ice in the Arctic, especially the land fast ice along the shorelines [12]." This made the formerly inhospitable and nearly inaccessible Arctic whaling fisheries a possible choice for the industry. However, this climatic shift was to be a short-lived advantage as the unregulated fishing caused the declining whale populations to move further north to escape. This resulted in the whaling fleets taking extended voyages of several years in order to return at full capacity, a situation that became increasingly rare. Thus, those initial outfitting investments experienced diminishing profits and increasing length of delays in returns on the capital. As the viability of profitability declined, this meant that fewer whaling operators were able to return to the field each season.

These reduced yields coupled with the inherently risky nature of operating in the hostile Arctic delivering additional impact on the production costs of the whaling industry. Despite the decline of ice during the summer months, ice remained a serious risk to whalers and the wreck registers of the period list numerous repairs made to ships due to damage from ice, storms or grounding from navigating without adequate marine charts. For some operational years, there are reports of the destruction of the entire fleet due to encounters with pack ice causing a complete loss of ships, supplies and oil harvest, resulting in negative returns on capital investments [13]! While primitive technology can account for some lack of environmental knowledge in the period, it was noted in the reports that the whalers had received warnings from the native populations that the wind would soon shift, sending the pack ice their way. These warnings based on indigenous knowledge went unheeded, with disastrous consequences.

Not dissimilar to operational requirements today, insurance as a risk aversion strategy to prevent wholesale capital losses was an essential component of production costs of operating the Arctic for the whaling industry. As the whaling industry proved to be risky business, the possibility of loss was a likely event making insurance for operating in the region both essential, but also expensive. Due to this likelihood of disaster, it was rare that a ship could be insured against complete loss. Demonstrating a correlation between insurance cover and likelihood of an accident, the Arctic explorer Vihjalmur Stefansson quipped that the "size of the insurance policy" explained the actual amount of loss that a captain tried to prevent intimated that some whaling vessels were only abandoned due to the lack of personal investment by whalers who were more concerned for their own safety than the preservation of an employer's infrastructure [14]. In any case, as a result of continuous and repeated losses, insurance in the Arctic became increasingly costly, "the dangers attending it be so great that insurance companies refuse to take risks upon vessels engaged in it" accelerating the costs of Arctic operations [15].

In addition to the high up front cost of infrastructure investment and high operational costs, the whaling industry faced one more significant obstacle: dwindling demand and dropping prices for their product. During the decline of the whaling fishing as an industry, it was predicted that "the continued low price of oil

will soon prevent the business being followed to any great extent [16].” Although the industry continued for several more decades, the rise of the “petroleum industry signalled the eventual death of the American whaling industry [17].” Although whaling would continue for some products for several more decades, the initial demands for whale oil was eventually completely pushed out of competitive trading with the advent of electricity, changes in social preferences and regulatory mechanisms that made the whaling industry a demoted business enterprise.

There are comparisons to be drawn from whaling operations with the high infrastructural costs relating to the development of fossil fuels in the region. Unsurprisingly, the reports on energy development in the Arctic have continuously reiterated the high cost of operations in the region as part of their overhead concerns. The view is that “costs of building infrastructure also requires companies to carefully consider whether production volumes will be commercially feasible to make these investments worthwhile,” making Arctic development a difficult futures decision [18]. Like the whalers before, the distances from consumption centres, the need for specialist equipment and the unpredictable weather conditions are some of the major concerns facing the industry. Current estimates indicate that technological difficulties will postpone development of new Arctic oil for some time, increasing the cost of production for this region on an extended timeline as operating costs meet with inflationary and regulatory pressures [19].

In addition, the incentives to develop the Arctic given the costs of the infrastructure do not appear to be outweighing the potential profit margins with the current price of a barrel of oil remaining at a low in global markets. Global oil prices are impacting the development of Arctic oil from both industrial and political machines, with some oil companies quitting their Arctic campaigns and government departments cancelling offshore oil and gas lease sales for the near future [20]. What this demonstrates is that there is a pattern developing for discontinuing oil exploitation in the Arctic due to the impact of production costs. First, it was the abandonment by the whaling industry, but then it was test wells being drilled and abandoned throughout the Canadian Arctic in the 1960s and 70s and now the trend has again returned with the recent abandonment of oil exploration in the Arctic by big industry players such as Shell, Exxon, Chevron and BP [21].

While climatic predictions indicate that the operating season in the Arctic could become longer due to shrinking ice melt, with varying estimates of an ice free Arctic in as soon as thirty years, at present, operations in the Arctic are heavily dependent upon the good graces of the weather gods [22]. The short summer season has proved problematic for the drilling of exploratory wells, with many of the operations of some of the well-known companies seeing year after year of limited performance, dependent on when the season makes a shift towards Arctic winter. The diminished operating season, using only a few months of the year to make a return on investment costs, invariably decreases the profit margins, especially when the wells continue failing to produce. The short operating season of the Arctic oil fields means slow exploration and development, extending the time period from point of initial investment to a return on capital, not an ideal condition for investment opportunities, especially given the condition of global oil markets.

Despite advances made for increasing operational safety in the Arctic maritime, the inherent danger of operating in the Arctic is substantially higher than in more temperate climes. The whaling industry faced difficulty in both affording the insurance that made some attempt to cover their losses and reluctance of insurers to provide coverage for their Arctic operations. Actuaries in today’s insurance market are still uncertain of the risks versus the costs of providing insurance for current Arctic operations. While the geographic distances and climatic considerations can be factored in, the industry is worried about the ‘unknown unknowns’: what operational risks are yet to become issues? Regarding operations in the Arctic, the industry knows that “insurance capacity for the energy industry is not unlimited. Cover is offered for risks in return for appropriate premiums and on specified terms and conditions [23].” As insurance is intended to offset financial risk, the likelihood that insurance costs will be higher than is realistic for yielding good rates of return on the investment in Arctic infrastructure and the decision on its affordability will undoubtedly factor into future Arctic development.

This cost-benefit analysis lesson from history demonstrates that the development of energy industry in the Arctic, first with whale oil and now with fossil fuels comes at a higher cost than other operation areas. Given the combination of distance to markets, the difficulty of insuring whaling operations, repeated losses of equipment and supplies, long periods of waiting for return on investment and the decline in demand in the face of rising competition ultimately the Arctic whaling market was a poor investment choice. Although technology has improved and climatic issues appear to be a diminish concern, it appears that much might not have changed for the contemporary oil industry. There are still many of the same barriers: distance, infrastructure and operating costs and long waits for return on investment that indicates the industry might be condemned to repeat costs, and perhaps also the losses of the past.

4. Lesson 3: will capitalism make Arctic oil an investment relic?

History tells us that the most lucrative business opportunities are those that can exploit scarcity and create a natural monopoly. The whaling industry was attractive because not only was there a market for the product but at one stage, it faced little competition. The market demand for products derived from whale oil was the primary driver behind the expansion in whale oil production, escalating into industrial levels by the mid seventeenth century and into competitive national whaling industries that were in full operation by the nineteenth century. The expansion into Arctic fisheries was delayed by the abundance of whales in better locations, but eventually scarcity created a focus on the new grounds in the far north. This politically enabled turn to the Arctic coincided with burgeoning industrial demand resulting from the industrial revolution, population growth and the turn from a subsistence to a market economy. Despite the conditions of a natural monopoly once held by the whaling industry, it eventually faced near extinction from replacement products. It may be that despite the potential reserves in the Arctic, the crude oil industry and its products will become obsolete, not only due to scarcity, but also due to shifts in demand, competition and societal pressures.

Although whale parts, from blubber to bones, eventually made it to market, the primary output of the industry was rendered whale oil as a raw product. A messy and exceedingly smelly process, this rendering was often processed *in situ*, sometimes in land based whaling stations or floating factory ships, outfitted with the necessary equipment for transitioning blubber to oil. Today, the Polar Regions are littered with the rusting remains of whaling stations or ‘try yards’ as the environmental impact of the abandoned stations was of less concern than the costs of dismantling the equipment. Through the whaling industry and the whale oil it produced, the Arctic became entangled in the “global system of commerce and exchange” and when whale oil reached the markets, it was then converted to many different products useful for the period [24]. The legacy of this industry still impacts the Arctic in both its physical scars and in its residual effects on the whale populations; however the demand for these products was not to endure.

The use of whale oil for household illumination was one of the primary products of whale oil, used in tallow candles and patented lamps. Although whale oil was more expensive than some earlier forms of lighting fuels, it "burned cleaner and provided a steady, bright light that gave off less odour and smoke than other fuels" making it attractive and desirable to the expanding population [25]. Despite the popularity of whale oil for lighting, only introduced to the market during the 1820s, "it was virtually defunct by the 1860s. Other fuel sources had replaced whale oil, chiefly kerosene, a cheaper and more easily obtainable product [26]." Though it had a heyday, market dominance of whale oil was prevalent only over a few short decades, replaced first by a petroleum product, which was in turn made redundant by the invention of the electric light bulb.

A second and long lasting product of whale oil included its use as a machine lubricant, a product that accelerated in importance with the onset of the industrial revolution and the changes in transportation and farming practices. While petroleum products were introduced as lubricant products as early as 1850, whale oil from sperm whales, with its highly waxy and viscous properties was considered to be the best lubricant on the market well into the twentieth century. The demand for this product continued until social pressures caused whale oil lubricant to become politically unviable when the sperm whale was placed on the endangered species list and as a result, it therefore also became commercially unviable for the end user when the ensuing scarcity caused prices to skyrocket. Rather than being replaced by petroleum, which also produces machine lubricants, whale oil lubricants were replaced by jojoba oil [27]. Here, it is demonstrated that societal pressures forced innovative change in addition to the forces of market pressures.

Machine lubrication is not the only whale oil product that became obsolete due to replacement by a vegetable oil. Whale oil has also been used in considerable amounts in soaps, cosmetics and perfumes. With large percentages of the whaling catch at times being turned toward the manufacture of soaps, "the soap industry was an indispensable buy for the whaling industry [28]." Although there was some resistance to the use of the smelly whale oil soaps, fresh whale oil was considered prized in cosmetics and in perfumes due to its lack of scent and more importantly due to its low melting point. Spermaceti wax was difficult to artificially reproduce and so whale oil continued to be used until scientists were able to developed alternative ingredients based on modified vegetable oils, such as coconut oil [29]. In addition to the social resistance to the use of animal products, whale oil used in these commodities was eventually made redundant by easier to produce chemical alternatives.

In the North American whaling industry, the animals were predominately harvested as a commodity rather than as a food source and the whales would be processed from flesh into oil before being brought to market. However, there was some food value gained from whales in the production of a butter substitute, margarine. Whale oil was an early choice for hydrogenated oil in the middle of the nineteenth century "because large amounts became available on account of its being no longer needed for illumination [30]." The use of whale oil in margarine continued throughout the world wars as a butter substitute due to wartime dairy shortages, but eventually vegetable oils would come to dominate in margarine production. Although whale oil continued to be used into the 1970s in margarine, it continuously faced increasing competition from tastier vegetable oils [31]. Eventually, the pressures of the regulatory environment and social attitudes toward whaling felled usage of whale oil as an ingredient in margarine.

Although important in many commercial products, it was likely whale oil's inclusion in national defence strategies that prolonged its market survival as glycerine, a key ingredient in some explosives, is a by-product of the fat rendered from whale blubber. Nitroglycerine, a liquid explosive first invented in 1848, was developed into "Alfred Nobel's invention of dynamite (nitro-glycerine) in 1860 creat[ing] a more ominous outlet for the whale oil's glycerol (fatty acids) [32]." Whale oil still played an important role in national defence, especially during the world wars, as glycerine became an important ingredient in the development of new generation explosives. During this period, some governments declared whale oil to be essential national defence commodities and purchased large percentages of available stocks during wartime and hearings were held in Congress to discuss which other countries were investigating the development of whale oil explosives [32]. This use of whale oil possibly kept the demand for the industry's existence perpetuating for longer than regular market forces or other environmental concerns would have normally allowed.

Despite the continued availability of this renewable resource, a fast growing population and continued demands for whale oil in various products, the profitability of whaling industry was continuously hampered by discoveries of competitive alternatives, new technological requirements and social mores. Despite the expansion of whale stocks in the Polar Regions, by the middle of the nineteenth century, the industry began its struggle for survival. It is speculated that initially "the market for oil was weak because of the advance of petroleum production, and only the demand for bone kept whalers afloat [33]." As demand for whale oil illumination declined new uses, such as its incorporation into margarine production and its use in explosives helped to keep the industry operating into the twentieth century, but eventually the industry was been reduced to its current small scale due to the domestic and international regulatory environments and social pressures against the use of animal products and Arctic whales are largely hunted as a food stuff.

Although the whale oil industry continues in an increasingly diminished capacity into the twenty-first century, alternative resources have largely replaced whale oil as a raw material, especially by vegetable oils and petroleum. This negative trajectory began with the discovery of petroleum in Pennsylvania in 1850s and shortly following, a different lamp that used a different fuel soon replaced the lamp that had been created to burn whale oil. The same end result has occurred with many other whale oil products, not because whale oil as a resource was completely depleted, but because discovery of new raw resources and new technologies to use those resources rose to market predominance. The capitalist market may have its ills, but with profitability remaining a key pursuit, this encourages innovation and technological development. Hence it may be, that capitalism really did save the whale with "the march of technology [34]." What is not yet fully known, is what will save the world from petroleum.

However, the petroleum industry should expect the same transition that occurred for whale oil to also hold true for fossil fuels. Should the global supply of hydrocarbons become infinite and without repercussions to the climate, there would be little need for innovation and progress; but such is not the case. Scarcity certainly plagues the oil industry and the continuous pursuit of new fields and new mechanisms for extraction, demonstrates that the longevity of the industry is limited. Additionally, this resource is plagued by geopolitical insecurities, creating instability in production, price and procurement. It remains to be seen how petroleum will be replaced, but there is already vast innovation to this end and both scarcity and insecurity are strong motivators for development and innovation.

Drilling for oil in the Arctic has received a considerable amount of attention by environmental activists. This is not without just deserts as the "environment is paying a serious price for our unbridled consumption of fossil fuels and our climate is warming at a rate that may cause irreversible consequences [35]," although fossil

fuels are also responsible for many of the advantages that civilization now enjoys. The predominate focus by environmental activists against the activities of oil companies in the Arctic is to communicate "resistance to Shell's plans to drill for oil and secure new oil reserves in the Arctic [36]." These types of activism that gain widespread media attention tend to focus on the use of crude oil in the development of fuel and its contributions to carbon emissions, but generally fails to trickle down to activism that rejects the use of any products that petroleum brings to civilization: mobile phones, toothbrushes and clothing and the kayaks that environmentalist sometimes use to protest oil drilling in the Arctic.

Even so, the arguments of activists against fossil fuels are not without foundation. According to the U.S. Energy Information Administration, a barrel of crude oil can be refined into gasoline, diesel, jet fuel, gasoline, heavy fuel oil, liquefied gases and other products, showing that over 80% of a barrel of crude oil is used for the production of fuels which are largely used in transportation [37]. The demand for transportation fuels makes up a large part of rationale for pursuing crude oil as the entire global economy relies on the movement of goods and people around the world in a timely manner, an exercise, which at present requires the use of fossil fuels. Research is underway to transition away from the use of fossil fuels in transportation to the use of electric or other renewables, and both the technology and demand are escalating in a way that may "force change in the automobile industry [38]." A transition away from gasoline and diesel would represent a two-thirds product loss to the suppliers of crude oil, and while it may not yet be the competition that will eliminate dependence on oil, it certainly is on its way. Not only does scarcity demand this transition but capitalism also encourages it.

Transitions occur within a system when a new rule is added to cause the norm to deviate [39]. For the whale oil industry, the new rules were a combination of scarcity, technology, political and social demands; this combination eventually proved lethal for the profitability of the industry. There is little evidence to demonstrate that these same rules will not also apply to the continued reliance on hydrocarbons in order to fuel the globalised economy. Scarcity demands that new sources of energy be found, capitalism demands that innovation continues and society is realising that climate change is a real and impending danger. Hydrocarbons are hardwired into society and the transition to alternatives may be slow, but it may well be prudent for the oil industry to learn early the lessons experienced by the whaling industry and facilitate this transition into a new product investment rather than invest in the oil fields in the Arctic.

5. Lesson 4: are the dynamics of the regulatory frameworks creating investment insecurity?

As a region in development, the Arctic and those who wish to expand business ventures to the region are faced with the uncertainty that accompanying regulatory transitions brings. The Arctic whalers of an earlier era faced changes in sovereignty over fishing areas and the application of legal frameworks of maritime delimitation to the region. Today's energy investors still face some sovereignty disputes, but they also must assess investment risks that changing international governance and domestic legislation introduce to investment environments. The regulatory environment in the Arctic is currently in a state of constant flux, which has potential to "harm the business environment by imposing unnecessary costs, increasing uncertainty and risks and erecting barriers to competition [40]," while legislative bodies work to determine what is in the public interest: safeguarding the environment or providing for economic and energy security. While it was the uncertainty in the regulatory environment that initially spurred oil interests in the Arctic in the 19th century, this same category of uncertainty now creates barriers to development.

When Senator Seward made his speech to Congress in 1852 noting that the expansion of the U.S. whaling fleet to fishing in the Arctic would leave national stocks untouched, he was referring to the regulatory environment of Alaska as being outside of the territory of the United States. At this time, Alaska was the sovereign territory of Russia administered, albeit poorly, by the state sponsored charter company, Russian American Company. Alaska did not become a territory of the United States for another fifteen years when it was purchased from the Russians in 1867 for 7.2 million dollars. During this time, many of the North American whalers were in fact poaching the sovereign resources of another nation. This activity was noticed by Russian administrators who claimed this whaling harmed the environment, destroyed the ecosystem that provided the sustenance of the natives and also resulted in many shipwrecks from a lack of adequate maritime charts [41]. However, due to Russian security interests being focused on the Crimean war, coupled with the inherent corruption of the Russian American Company, this created an environment prime for exploitation. The only recourse for the Russian administrators was to cooperate with the U.S. navy once these resources had been deemed within the national interest of the United States [41].

However, this apathetic attitude towards the respect of fishing within territorial boundaries of another states was to return to haunt the United States' efforts to secure another maritime resource in the region a half a century later. When the U.S. purchased Alaska, a period of "close fisted commercialism [42]" was to follow. This resulted in policy where the U.S. prevented Canadian sealers from hunting in the Bering Sea on the grounds that as Russia had claimed sovereignty over the entirety of the sea, a sovereignty that the United States had ignored. As a result of the 1867 Alaska Treaty, the United States expected to be entitled to sovereignty over their half of the Bering Sea; however an international tribunal found the United States in breach of to the principle of the freedom of the seas and they were required to recompense the economic losses of the Canadian sealers. While this ruling was specifically attempting to protect U.S. interests in the seal population, the ruling also had impact on the whaling stocks within the same seas by limiting the amount of environmental legislation that could regulate for whaling harvests and delaying the introduction of environmental stewardship until the Marine Mammal Protection act in 1972, officially terminated the activities of whalers within the United States for operators except indigenous groups.

On the Canadian side of the Alaska boundary, sovereignty games also impacted the profitability of Arctic whaling operations, especially for American whalers. Without any evidence of authoritative sovereign claims, the British crown transferred the Arctic islands to the Dominion of Canada in 1880. Although the first step toward sovereignty included the discovery of new territory and several countries, including the United States, had explored the North American Arctic, Canada intended to enforce this transferred title. In 1907, Canadian Senator Poirier invoked the 'sector principle' and proposed that Canada extend its territorial borders all the way to the North Pole [43]. By 1926, maps issued by the Canadian government showed all Arctic islands in the Canadian archipelago as Canadian territory, despite their lack of either initial discovery or effective occupation of this territory.

Although there was no official outcry from states that may have held inchoate title over Arctic islands, the Canadian government wanted to flex their administrative muscles in the region. Thus, the remedy for this vacuum of effective occupation and administration by the Canadian authorities was to levy regulatory mechanisms on whalers operating in the region, especially on the American whalers. Regulation of whalers became a method whereby states could enforce their sovereignty claims to the region, enforcement

that appeared to be asymmetric in application as, the American whalers faced harsher regulatory conditions, although the Scottish whalers were in reality more active in the Canadian Arctic [44]. It was ultimately the whalers who objected to Canadian administration over what they considered historic fishing grounds rather than any states contesting Canadian claims to sovereignty. It was this increased regulation and the reduction in hunting areas that greatly reduced the profitability of an industry already battling diminishing stocks and reduced yields.

Both the United States and Canada made turns toward environmental stewardship, placing protective moratoriums on whaling hunting on the basis of moral grounds rather than as a result of free market policies. These domestic turns into legislative practices were reinforced by commitments to international conventions on whaling. Although Canada has withdrawn from participation of the International Whaling Commission it still maintains a domestic legislative ban on the activity and uses other environmental legislation to protect its sovereignty over the Northwest Passage, including the Arctic Waters Pollution Protection Act 1972. So while the whaling industry initially thrived in the anarchic regulatory environment of the Arctic, they struggled when faced with operational costs and losses due to the harsh operating conditions coupled with the transitory domestic and international regulatory frameworks, contributing to the industry's final demise in North America.

Due to the lack of an established regulatory environment, the whaling industry, while in itself a microcosm of a globalising economy, was situated geographically within a 'lawless' region, with only domestic effective occupation initiatives to provide guidance on the stability of operations in the region. In time, frameworks also began to develop in the international realm, especially in the development of the Law of the Sea frameworks, which worked to solidify claims to resources sovereignty by Canada and the United States. The most notable conceptions to contribute to the economic development of the Arctic in the maritime regions include the establishment of the exclusive economic zones and the consideration of the continental shelf as a natural extension of a states territory. It is this extension of territorial limits and the protection the sovereignty allows that provides for the considerable potential of fossil fuel extraction by today's energy industry.

However, while providing fixed resource sovereignty, the international regulatory environment with regards to the oil industry and especially to the development of the oil industry in the Arctic is yet a framework in flux. The members of the Arctic Council have agreed on *non-binding* operational guidelines in their *Agreement on Cooperation on Marine Oil Preparedness and Response in the Arctic*, which intends to reinforce existing bilateral and international agreements on the issue of oil pollution in maritime regions. Aside from the facilitation of response to pollution incidents in the Arctic by coordinating movement of teams and equipment across borders and the exchange of information, the agreement does little to prevent an oil spill incident from occurring. While regionally coordinated governance goes some way to facilitate political cooperation in the region, the effect of this agreement is merely to refer the matter back to the guidelines provided within international law.

Despite this, the frameworks in international law regarding oil spill incidents refer specifically to pollution from ships and at present, drillships are excluded from these provisions. That is not to say that the international community has been silent on the matter. In 1977, the Convention on Civil Liability For Oil Pollution Damage Resulting From Exploration For And Exploitation of Seabed Mineral Resources (CLEE Convention) was proposed, but never entered into force. Instead, it is domestically legislated regulations on oil pollution that provide the teeth for liability response in the event of an oil spill incident. This was seen in the *Deepwater Horizon* case where liability and compensation were made possible through the US Oil Pollution Act 1990 [45]. Outside of domestic legislation, the Offshore Pollution Liability Agreement 1975, a voluntary industry scheme, also provides some recompense potential in the event of a maritime oil disaster, but only for participating international oil companies in participating states. At present, this does not include all operators or states in the Arctic. What is certain is that case precedent indicates that the political and financial fallout from an Arctic oil disaster could be considerable.

It is unlucky for the energy industry that the recent turn towards developing the fossil fuel resources in the Arctic coincided with the wake of the *Deepwater Horizon* incident, resulting in strong pressures by the U.S. Federal Government to force oil companies to demonstrate the safety of their operations. The consequence is that this has presented a shifting regulatory environment for the oil companies seeking to expand Arctic operations, with the Federal Government changing the guidelines for establishing safe operating procedures before the granting of exploration licenses. This includes the preparation of streamlined analysis of oil spill response and broad environmental assessments for operation in the Arctic [46]. Although the government eventually approved the license for Shell to drill in the Chukchi Sea, the company ceased operations citing "the 'challenging and unpredictable' federal regulator environment for offshore Alaska [47]." Thus, it appears at present, the shifting regulatory environment creates more investment risk than some oil companies are willing to shoulder.

Additionally, a special regulatory regime has been established for the Arctic under the Law of the Sea through Article 234, specifically for ice-covered waters. The result of this provision introduces the role of stewardship in the legal protection of the Arctic within international law. The role of environmental steward for the protection of economic resources was once attempted by the United States to prevent damage to the seal industry in the Beaufort Sea and it is currently being applied by both Canada and Russia through legislation intended to enhance their sovereignty over the Northwest Passage and the Northern Sea Route, via the notion of economic stewardship. In the changing regulatory environment, it may be seen that the sovereign implications of stewardship develop into increased economic liability for damages to sovereign resources in the event of an oil disaster in the Arctic. This is undoubtedly a shift that greatly increases the financial risks of drilling for oil in the Arctic.

There are also the additional costs of infrastructural development that the Arctic regulatory environment brings. In 2014, the International Maritime Organisation approved the implementation of the Polar Code, passed not as a new body of legislation, but rather as amendments to an existing body of international law. Not only did this approach require less political wrangling to cause the Polar Code to enter into effect, but also the formal adoption of the code is a significant industry milestone will have impact on the energy industry [48]. As the regulatory mechanisms of the IMO apply only to vessels in transit and not to stationary drilling rigs, the majority of the impact of the Polar Code on production will be in the vessels used to support operations in the Arctic region. Accordingly, the code will have an effect on the training and safety equipment necessary in the Arctic, increasing the cost of investment in the region.

The role of the Polar Code in the Arctic is primarily intended to improve the safety of navigational operations in the Arctic and to diminish the risk of environmental damage to the region. While many parts of the Polar Code may not directly apply to drilling platforms, it remains to be seen what impact the code will have on drillships or semi submersibles and the requirement to have polar class equipment. History shows that even floating ships can become trapped, crushed and destroyed by the force of moving sea ice and the Arctic has seen at least one disaster with the destruction of *Ocean Ranger* by a storm in 1982. Like the victims of the *Titanic*, many of *Ocean Ranger*'s casualties were caused by cold conditions.

Even more recently, the U.S. Coast Guard had to launch a rescue when an ice-reinforced oil rig ran aground in the Arctic, fortunately without spilling its cargo [49]. Though it cannot guarantee safety, the provisions of the Polar Code might prevent some misadventure; however, this is not without additional cost to infrastructural and operational costs, reducing the attraction of the investment opportunity.

Although the Arctic is thought to have significant percentages of fossil fuel reserves lying offshore the Arctic maritime, there is not a coherent regulatory system for mitigating the uncertainty for region operations. For investors, the regulatory environment has been in transition since commercial interests began engagement with the region. The early issues for the regulatory environment had to confront the establishment of sovereignty in the region and the shifting territorial boundaries. While this issue is mostly resolved, a sovereignty delimitation dispute still remains in the Beaufort Sea, an area considered attractive for fossil fuel exploration. International law regarding the liability for oil spill pollution remains incomplete and thus it falls to the domestic sphere to provide regulations. Finally, the infrastructure requirements generated by the Polar Code potentially introduces additional operational costs to the energy industry. Combined, these factors create an uncertain and dynamic regulatory environment that results in increased risks and costs for operators in the region as exploration and operational licenses rest on fulfilling the changing goalpost of domestic regulations.

6. Conclusions

The development of the Arctic for the extraction of oil is often portrayed as a rush for liquid gold. Although the Arctic does appear to hold vast reserves of fossil fuels, the remote and hostile region has been proving resistant to development by the modern oil industry, in not a dissimilar fashion to the hesitant welcome it extended to the whalers of a bygone era. It may be that there are a series of lessons that can be learned from considering the engagement of the whaling industry with the region, applying the lessons they learned in their experiences to the energy development interests of today.

The first lesson may be that like the whalers of the nineteenth century, international oil companies have arrived too late to develop the oil industry in the region. The whalers arrived after peak production had been reached in the whale oil market and although the discovery of the rich resources of Arctic whales extended production period, the Gaussian curve had already passed its maximum production point. Although technically renewable, whale oil was not an infinite resource and Hubbert's theory would prove to run its course when faced with decreasing production capabilities. Fossil fuels are also a finite resource and subject to the laws of peak production, and although the discovery of fossil fuels in the Arctic might extend hydrocarbon production, ultimately the resource will someday be exhausted.

A second lesson can be learned from the operational and production costs with combined risks that the whale oil industry experienced through a cost-benefit analysis. Operating at the end of the Little Age Ice, the whalers found the Arctic climate hostile to operations. The remote location from markets requiring high operational costs and long intervals of time before a return could be seen on capital investment, meaning that whaling investors saw slow rates of return. These returns were only possible *if* the whaling fleet or its cargo managed to return to home ports to deliver the goods and often, the losses for both the investors and their insurers resulted in long periods of negative returns. For the contemporary oil extraction industry, operational costs in the warming, but still hostile Arctic region remain high and to date there have been few returns on the investment in the exploration, if any at all. In addition, like the whalers before them, current development faces high insurance costs associated with the riskiness of engaging in Arctic operations as the industry calculates for externalities including anything from climate to environmental activism.

The third lesson can be learned from the knowledge that new technologies will develop and new sources of energy will be found. Early demands for whale oil were diminished by the discovery of petroleum, the invention of the electric light bulb and aside from limited use as a foodstuff, it was eventually made completely redundant by the extraction of oil from vegetables. It is the laissez faire nature of the capitalist market that has created the long-term demand the oil industry needs to survive, but this same system will ultimately lead to its demise. Continued profitability requires either a monopoly or innovation in order to remain successful in the marketplace, thus it is the technological developments that research and development produces that will likely also create the technologies that will ultimately reduce global reliance on hydrocarbons. The estimates for this date vary wildly, but it is certain that one day it will come.

Finally, as long as the regulatory environment continues to be dynamic in response to international and domestic legislative developments, the oil companies engaging in exploration and extraction of Arctic oil will face the same uncertainties over continued future production as did the whalers of the nineteenth century. While designation of sovereign territory is a significantly more stable concept today, there still remain some disputes over areas expected to hold hydrocarbon resources. While the whalers were able escape culpability for the environmental damaged they caused, today a primary risk facing the extraction industry is the liability for causing environmental and thus economic damage over resources considered as sovereign property. The volatile nature of the regulatory environment and the changing goalposts that accompany these changes increases the costs of Arctic operations.

Although current developments indicate that the development of hydrocarbons in the North American Arctic are on standby, in a world of increasing energy insecurity, it is likely that these resources will remain an attractive option to politicians and the oil industry alike. Yet, with some hope, these agents will realise that the future lies not in investment toward the extraction of hydrocarbons from the Arctic, but in the investment in research and development that can create security in new forms of energy. If this occurs, it may be that these lessons from the history of the whale oil industry operating in the Arctic region do not also have to be learned by the oil companies of today when it is realised that they arrived too late for Arctic oil.

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