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Crude Intentions: Evaluating the Growing Risks of Arctic Alaskan Oil Production

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To my family, thank you for keeping me motivated once I returned home. This time together has been an unexpected gift.

Cover Photo: Northstar Island production facility in Alaska's Beaufort Sea (Bureau of Safety and Environmental Enforcement)

Abstract

The discovery of oil on Alaska's North Slope in the 1920s began a century of fossil fuel exploration, development, and production in the Arctic region. Alaska became integral to the nation's growing energy dominance. However, since 1988, oil production on the North Slope has been in steady decline. In 2015, Shell, followed by several other oil majors, terminated their Arctic Alaska operations. This past year, BP made waves by ending six decades of operations in Alaska. Most recently, five of the six major U.S. banks announced they would no longer finance Arctic oil and gas projects. This paper analyzes these decisions by evaluating the environmental, economic, and reputational risk of engaging in Arctic oil exploitation. A thorough review of existing literature demonstrates waning interest in the region's fossil resources. Operating in and likely harming the pristine and fragile Arctic Alaskan ecosystem requires companies to incur added costs and face growing backlash that diminished potential returns can no longer justify. Consequently, I conclude that despite recent efforts by President Donald Trump to revive the region, Arctic Alaska will lose relevance for national oil production in the coming decades and possibly as early as the mid-2020s.

Ethics

My research did not include any human or animal subjects. I acknowledge I am an outsider to Arctic Alaska having never visited the North Slope. I believe I comprehensively covered the key aspects of oil production in Alaska and properly cited all referenced literature. However, I offer a limited review of the influence oil development has had on indigenous communities on the North Slope. The oil industry has had profound effects, both positive and negative, on nearly all of Alaska, and detailing every impact is beyond the scope of this paper.

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Abbreviations

ANWR	Arctic National Wildlife Refuge
EIA	U.S. Energy Information Agency
IEA	International Energy Agency
Bbbls	Billion Barrels of Oil
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
MMbbls	Million Barrels of Oil
NPRA	National Petroleum Reserve-Alaska
NPR-4	Naval Petroleum Reserve-4
OCS	Outer Continental Shelf
TAPS	Trans-Alaska Pipeline System
Tcf	Trillion Cubic Feet
USCG	United States Coast Guard
USGS	United States Geological Survey

Introduction

When the United States purchased Alaska from Russia in 1867, many Americans questioned the $7.2 million acquisition. Beyond the pursuit of Manifest Destiny, the largely unexplored expanse appeared to hold little value to the United States. *The Holt County Sentinel* (1867), a Missouri-based newspaper, asserted that "ninety-nine hundredths of Russian America [were] absolutely useless," while the New-York Tribune declared there had not been "in the history of diplomacy, such insensate folly as this treaty" (Telegraph to the Tribune, 1867). A half a century passed before the true value of Alaska would become known.

In 1917, Alexander Malcolm Smith became the first white man to discover oil on Alaska's North Slope. Recognizing the region's potential to source the nation's growing oil needs, President Warren Harding designated over 23 million acres of Northwest Alaska as the fourth Naval Petroleum Reserve, later renamed the National Petroleum Reserve-Alaska. With sufficient reserves elsewhere, NPR-4 remained largely untouched and unexplored for the next two decades (Reed, 1958).

World War II demonstrated the world's budding oil dependency, bringing renewed interest to the Alaskan Arctic. A ten-year reconnaissance project spanning from 1944 to 1953 revealed nine oil and gas fields within NPR-4, confirming the North Slope's importance as an energy resource (Reed, 1958). While faced with many challenges due to the harsh environment, the exploratory mission indicated that with proper infrastructure, technology, and preparation, the Arctic could be developed for resource production. Accordingly, the Bureau of Land Management opened parts of the North Slope to leasing five years later. Several oil companies

bid to explore the Arctic's fossil fuel reserves. However, NPR-4 remained closed to development, and in 1960, Congress further restricted exploration with the creation of the nine million acre Arctic National Wildlife Range (Banet, 1991). Despite indications of enormous oil plays, most early exploratory wells came up dry. Quickly, interest in Alaska's resources dwindled. By 1967, nearly all Arctic oil and gas exploration had ceased (Banet, 1991). Most companies had lost millions in their fruitless pursuit of oil and were ready to move on. Then, in January of 1968, the discovery of oil at Prudhoe Bay changed the course of history for the state of Alaska.

Upon its discovery, Prudhoe Bay was easily the largest oil field in North America. 25 billion barrels of oil, over half of which represent conventionally recoverable resources, lay underneath its subsurface (Lasley, 2005). The discovery brought oil companies racing back to Alaska. 33 new exploratory wells were completed in 1969, and the next BLM lease sale brought in $900 million in bids, up from a meager $6.1 million in 1965 (Lasley, 2005). The sudden increase in activity uncovered several more fields, including what had been North America's second largest oil field, the Kuparuk River oil field. Yet, without a means of transportation, the oil remained in the ground.

Construction on the Trans-Alaska Pipeline System began in 1974, connecting Arctic oil to the global market. Three years later, crude oil from Prudhoe Bay flowed 800 miles south across three mountain ranges to Valdez, Alaska (Alyeska Pipeline Service Company, 2019). Throughout the next decade, the pipeline operated at full capacity. New discoveries and high oil prices fueled steadily increasing production, and several oil companies began exploring oil prospects on the outer-continental shelf in the Beaufort Sea (Lasley, 2005).

While exploration and production grew, as did efforts to protect the Arctic environment. In 1980, the Alaska National Interest Lands Conservation Act more than doubled the size of Arctic National Wildlife Range and renamed the protected area the Arctic National Wildlife Refuge. However, ANILCA also opened a portion of the refuge up for natural resource exploration. Section 1002 of the act provided for an analysis of the environmental impacts of oil and gas extraction and allowed exploratory activity on the surface of the refuge's 1.5 million acre Coastal Plain, also known as the 1002 Area. Any development with the intent to produce oil and gas remained strictly prohibited (*Alaska National Interest Lands Conservation Act*, 1980). In 1986, Chevron and BP drilled the only well in the 1002 Area to date. The results of the project have remained confidential for over three decades, although a recent New York Times investigative report found that the discovery was likely worthless (Eder & Fountain, 2019). Opening up the ANWR to drilling has been a source of debate for many years, but no development has occurred in the Refuge since 1986.

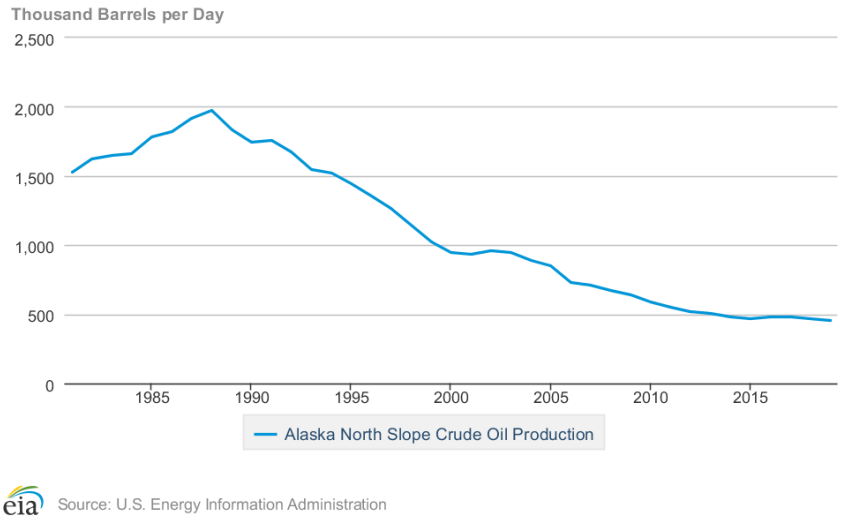


Figure 1. Alaska North Slope Crude Oil Production (U.S. Energy Information Agency, 2020a)

North Slope oil production peaked in the late 1980s, steadily declining since then. In 1988, the North Slope produced nearly two million barrels of oil per day (Figure 1). The region alone brought more oil to market than any state other than Texas, helping make Alaska the top producing state in the country (Figure 8). However, oil prices deteriorated in the latter part of the 1980s, causing a decline in oil production nationwide. While other states have benefitted from the discovery of new reserves and the implementation of new technologies, Alaska has not been as lucky. Last year, Alaska fell to sixth in oil production, with a record low of 451,000 barrels of oil produced per day (Figure 1).

Despite the region's declining production, the North Slope and OCS remained of key interest to oil companies for the remainder of the 20th century. Exploration for oil has continued with varied success both onshore and offshore and in federal and state waters. BP and ConocoPhillips emerged as the two major players in the region, but several other companies have remained invested in the Arctic. Shell led the early charge in offshore exploration, but they failed to make any profitable discoveries and closed their Alaska offices in 1991 (Rosen, 2015). A minor breakthrough occurred in 1994 when ARCO Alaska, which later became part of ConocoPhillips, announced the discovery of the Alpine oil field near the western boundary of the NPRA. The discovery of a major oil field outside of Prudhoe Bay, along with recovering oil prices toward the end of the 20th century, once again brought oil companies back to the Arctic (Lasley, 2005). Following the success at Alpine, the BLM opened up the NPRA for exploration in 1999. North Slope oil production briefly stabilized in the 2000s, and high oil prices set oil exploration in Arctic Alaska up for another, perhaps final, surge.

Shell returned to the Alaskan Arctic in 2005 to lead a new round of offshore oil exploration. In 2005 and 2007, oil companies spent nearly $90 million on Beaufort Sea leases, with Shell accounting for $83.5 million (Bureau of Ocean Energy Management, 2020). In 2008, oil companies set a new record for offshore lease spending, with high bids totalling over $2.6 billion (Minerals Management Service, 2008). Shell acquired the vast majority of the leases, spending $2.1 billion (Rosen, 2015). Despite the massive spending, a lone exploratory well would be completed between 2005 and 2015. Shell's second venture into the Arctic Alaskan seas proved disastrous. Inadequate preparation for the possibility of an oil spill or the severe environment caused several delays, and in 2012, Shell's floating oil rig, the *Kulluk*, ran aground in the Gulf of Alaska on its return from the Arctic (Funk, 2014). Finally, in 2015, Shell announced they would be terminating all activity in Alaska. By 2016, nearly every company exploring the Arctic OCS had also relinquished their leases (Dlouhy, 2016).

President Trump attempted to reignite interest in the region by opening up the ANWR to leasing in 2017, but only a few companies continue to operate in Alaska. In 2019, BP, which had until recently accounted for two-thirds of the state's oil production, announced the sale of all of their assets in Alaska. BP's decision ended their nearly six decades of operations on the North Slope (BP, 2019). Five of the six major U.S. banks have also sworn off of the Arctic, promising to no longer finance new oil and gas projects in the region.

Oil companies have backed out of Alaska several times throughout the state's production history only to return when market conditions improved. However, this most recent retreat may have been the last. An increasingly fragile ecosystem, weakened Arctic oil market, and passionate environmental movement threaten the long term viability of oil production in the

state. In the context of growing environmental, economic, and reputational risk, this paper analyzes the recent changes to Alaska's oil industry, concluding that as global oil demand wanes, other oil companies will not hesitate to follow BP's lead in closing their Arctic operations.

Methods

The following pages discuss why the many risks associated with oil production in Alaska may no longer be worth the reward. I begin by characterizing the current situation for Arctic oil and gas exploration, development, and production. Drawing from company press releases and newspaper articles, I present recent decisions by oil companies and banks to distance themselves from the Arctic. In contrast, I detail the remaining oil and gas activity in the region and explain efforts by the federal government to open the ANWR and OCS to exploration.

The discussion section of my paper analyzes why these decisions were made. First, I consider the unique environmental challenges associated with drilling for oil and gas in the Arctic. By consulting existing studies of the Arctic Alaska environment and ecosystem, oil spill risk and response feasibility assessments, and research on Arctic climate change and its impact on oil production, I demonstrate the costly challenges of operating in the Arctic Circle. Second, I describe the financial challenges for Arctic Alaskan oil projects. I utilize various analyses to explain the added monetary costs of environmental risk, compare the cost and timing of oil projects in multiple locations throughout the United States, and estimate economically recoverable oil and gas resources at different oil prices. In addition, using press releases, interviews of financial analysts, and newspaper articles, I assess and speculate about the impact

of the decisions by banks to no longer finance Arctic oil projects. Finally, I turn to journal and news articles to consider the role of reputational risk in preventing further Alaskan oil development.

I conclude by asserting why these environmental, economic, and reputational challenges will prevent further development in Arctic Alaska. State, federal, and global energy projections strengthen my argument. In addition, I contemplate the impact a political shift at the federal level would have on Arctic oil.

Study Area

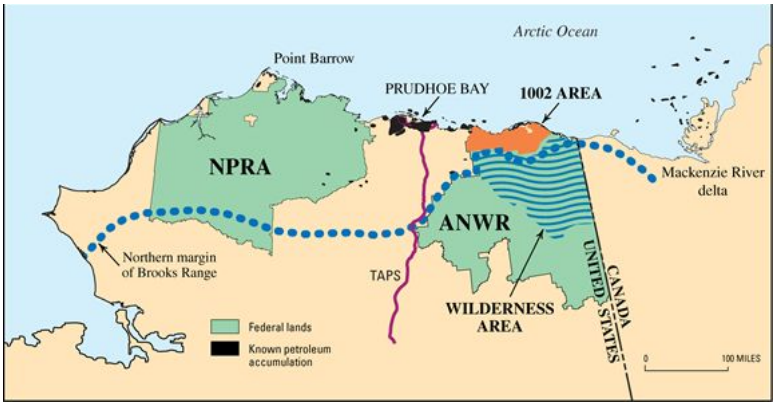


Figure 2. Map of Alaska's North Slope with various land boundaries. TAPS is shown in Purple. (U.S. Energy Information Agency, 2018)

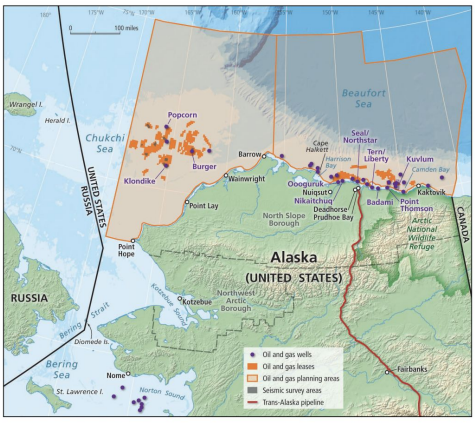


Figure 3. Chukchi Sea and Beaufort Sea planning and lease areas with well locations. (National Resource Council, 2014)

The Arctic Alaska Petroleum Province encompasses most of Northern Alaska. The province extends north from the northern margin of the Brooks Range to the edge of the continental shelf in the Chukchi and Beaufort Seas, west to the offshore border with Russia, and east to the Canadian border (Bird & Houseknecht, 2011). The area includes the majority of the North Slope Borough, the National Petroleum Reserve in Alaska, and the Coastal Plain of the

Arctic National Wildlife Refuge. The province's underlying geology makes the area ideal for oil and gas formation. Sandstone reservoir rocks lie above shale source rocks and below stratigraphic marine shale traps. Nearly every sandstone unit in the province contains oil and or gas (Bird & Houseknecht, 2011).

The entire Arctic region contains immense untapped oil and gas resources. Approximately 13 percent of the world's undiscovered conventional oil and 30 percent of the undiscovered conventional gas may lie in the Arctic (Gautier et al., 2009). Of the nearly 90 Bbbls of oil estimated in the Arctic, one third likely exists in Arctic Alaska, by far the most for any Arctic province. Further, 13 percent of the Arctic's 1,669 tcf of gas lies in Arctic Alaska (Gautier et al., 2008).

Most of Alaska's oil and gas resources formed underneath the ocean floor in the Beaufort and Chukchi Seas or along the Arctic coast. Additional significant accumulations exist in the 1002 Area and NPRA. A Bureau of Ocean Energy Management resource assessment estimated that over 23 billion of the approximately 30 Bbbls of undiscovered oil and half of the undiscovered natural gas in Arctic Alaska lies on Alaska's OCS. The Chukchi Sea contains an estimated 15.38 Bbbls of oil and 76.77 tcf of natural gas, while the Beaufort Sea contains an estimated 8.22 Bbbls of oil and 27.64 tcf of gas (Lasco, 2017). According to a 1998 USGS assessment, the 1002 Area likely contains 7.7 Bbbls of oil, and nearly all of the oil accumulates in the western third of the region (Bird et al., 1998). Finally, the NPRA contains just under 1 Bbbls of oil (Houseknecht et al., 2010).

Results

Shell's decision to suspend its offshore drilling program in Alaska in September 2015 shocked many. After years of championing the Chukchi Sea's ample oil and gas resources and weathering multiple near disasters and legal obstacles, they abruptly closed their operations. Shell had spent nearly $8 billion on exploration and left without producing a single barrel of oil (Dlouhy, 2016). The company's press release cited "indications of oil and gas… not sufficient to warrant further exploration" (Royal Dutch Shell, 2015). The high costs of the project along with the strict regulatory process contributed to the decision to cease exploratory drilling for the "foreseeable future" (Royal Dutch Shell, 2015).

Witnessing Shell's many struggles, every other company with holdings in the Chukchi Sea relinquished their leases, leaving a handful of tracts in the Beaufort Sea representing the only active leases in the OCS. In 2013, at the height of Shell's debacle, ConocoPhillips, Alaska's largest oil producer, paused their offshore exploratory program. The company blamed unclear federal regulations (Lefebvre & Fowler, 2013). In 2016, ConocoPhillips decided to cede all 61 of their leases in the sea, determining they no longer represented competitive investments (ConocoPhillips, n.d.). Similarly, in 2015, Statoil, now Equinor, determined their offshore holdings were no longer competitive and abandoned all of their claims in Alaska (Equinor, 2015). Total also chose to rule out further exploration in the Arctic ice pack due to high costs. The decision came as a broader move by Total toward a more diverse and clean energy portfolio (Total, 2017). Repsol, Iona Energy, Eni, Encana, and Armstrong Energy also ended their work in

the Chukchi Sea in either 2015 or 2016 (Dlouhy, 2016). Today, of the 694 leases awarded in the 2005, 2007, and 2008 sales, 11 remain active, all in the Beaufort Sea (Bureau of Ocean Energy Management, 2020). President Barack Obama closed the door on further developments in the Arctic OCS in 2016, banning leasing in nearly all federally owned Arctic waters (Davenport, 2016).

The election of Donald Trump represented a potential change in tune for oil exploration in the Arctic. He quickly went to work attempting to undo Obama's lease ban through an executive order. However, an Alaskan judge ruled President Trump's reversal was unlawful last year (Eilperin, 2019). To date, Arctic offshore leasing remains illegal. The president also opened up the 1002 Area to leasing in his 2017 tax reform. The act required two federal lease sales in the ANWR by 2027 and allowed for up to 2,000 acres of surface development (Tax Cuts and Jobs Act, 2017). The BLM's subsequent environmental impact assessment recommended opening up the entire Coastal Plan for leasing, the most lenient plan proposed in terms of environmental protection (U.S. Department of the Interior, 2019). The report acknowledges that the decision will result in unavoidable and likely long-term ecological impacts, including habitat losses, migration pattern disturbances, and subsistence resource decreases (U.S. Department of the Interior, 2019).

While many large oil companies had left Alaska by 2016, ConocoPhillips, ExxonMobil, Eni, Repsol, Hilcorp, and a few smaller Alaskan companies remain invested in the region. Last year, Eni completed an exploratory well at Spy Island, the first completed offshore well since Shell's in 2015, and the first in the Beaufort Sea since 2003 (Bureau of Ocean Energy Management, 2019). The well's development comes as part of the company's expansion in

Alaska over the past several years in which they have acquired 124 new exploratory leases and stakes in existing oil fields. CEO of Eni Claudio Descalzi called Alaska a "main target" for the company (Stricker, 2019). Meanwhile, in 2017, Repsol announced a 1.2 Bbbl discovery on the North Slope, the largest conventional onshore oil discovery in 30 years. They expect production of the massive oil field to begin next year (Repsol, 2017). Senator Dan Sullivan of Alaska hoped that the find could "usher in a new renaissance for economic growth" in Alaska (2017). Hilcorp has also initiated plans for increased production, as BOEM approved their plans for the Liberty Project, the first offshore production site in the federal waters of Alaska, in late 2018 (U.S. Department of the Interior, 2018). The moves by these companies to increase their stakes in Alaska are not necessarily surprising, as smaller companies will often take on increased risk and cut costs to try to revive dwindling reservoirs.

In August 2019, BP, historically one of the largest producers in the region, decided they were not willing to shoulder the risk of operating in the Arctic. In BP's press release, CEO Bob Dudley explained that their projects in Alaska no longer aligned with their long-term business strategy nor did they represent competitive investments (BP, 2019). Hilcorp bought all of BP's Alaska assets, making them the second largest producer in the state. ConocoPhillips and Hilcorp now control 72 percent of the state's production. Wood Mackenzie analyst Rowena Gunn predicted ExxonMobil, the state's third largest producer, would soon follow BP (Wood Mackenzie, 2019). ExxonMobil, however, seems to have focused their interest on natural gas on the North Slope. The company has invested $4 billion into their Point Thomson reservoir just west of the Coastal Plain. The project marks a "new era" for ExxonMobil in Alaska, as they have

laid the “foundation for future gas development” (ExxonMobil, 2018). As the world begins to embrace cleaner energy, perhaps Alaska’s future could hinge upon gas, not oil, production.

Even with ExxonMobil’s moves, nearly every major U.S. bank and over a dozen foreign banks have followed BP’s lead to move out of the state. JPMorgan Chase, Citi, Wells Fargo, Goldman Sachs, and Morgan Stanley have each announced within the last six months that they would no longer finance new oil and gas development in the Arctic, including within the ANWR. However, these decisions still allow the companies to aid in Arctic transactions and fund existing projects. The announcements largely came as part of larger scale environmental policy alterations. Bank of America stands as the only major U.S. bank willing to finance new Arctic oil and gas projects (Bank of America, 2019). Without a clear source of financing and limited interest from oil companies in new projects, the future of Arctic Alaskan drilling remains uncertain.

Discussion

The decisions by oil majors and banks to end their work in the Arctic were carefully researched and planned maneuvers. The companies aimed to reduce their exposure to risk in three interconnected areas: the environment, the economy, and their reputation. In the following sections I will investigate these three risk areas and demonstrate why, when considered cumulatively, they prove too great to warrant proceeding with any further Arctic operations or investments.

Environmental Risk

Arctic Alaska contains large oil and gas resources, but the harsh and remote environment creates unique challenges for their exploration and production. For nearly half of the year, temperatures rarely reach above freezing, plunging as low as -50ºC at times, while in the Summer, they hover just above 0ºC. Near complete darkness shrouds the region for two months of the year, and sea ice covers the Chukchi and Beaufort Seas for another eight to nine. High winds, thick fog, and large waves are common as well (The Pew Charitable Trusts, 2013). These challenges slow down operations, decrease total operating time, and create additional risks for all Arctic oil and gas procedures.

Resource development also inevitably has several negative impacts on the diverse and fragile Arctic ecosystem. Construction of roads, buildings, and other infrastructure associated with oil production can cause more rapid permafrost melting, harm or kill tundra vegetation, and contaminate water sources. Offshore and onshore development also encroaches upon and alters the habitats of marine and terrestrial animals, including polar bears, bowhead whales, seals, caribou, and numerous birds and fish species (National Research Council, 2003). Possible oil and gas activities on the Coastal Plain have received special attention for the impact they will have on the Porcupine caribou herd, the largest and one of the healthiest caribou herds in North America. The herd lives primarily in the ANWR and utilizes the Coastal Plain for calving. They are also a key subsistence resource for indigenous people on the North Slope (Cornwall, 2017).

A recent vulnerability analysis of the herd predicts that the risk of population decline increases over the next ten years with the introduction of oil and gas activities in the refuge, potentially requiring severe hunting restrictions (Russell & Gunn, 2019). The BLM's Coastal Plain environmental impact assessment requires suspending construction activities for a month during calving season. The assessment also requires various environmental studies and implements additional restrictions to protect ecosystems (U.S. Department of the Interior, 2019). While significantly weaker than necessary for proper environmental protection, these measures add more costly and time-consuming hurdles for companies in their pursuit of oil.

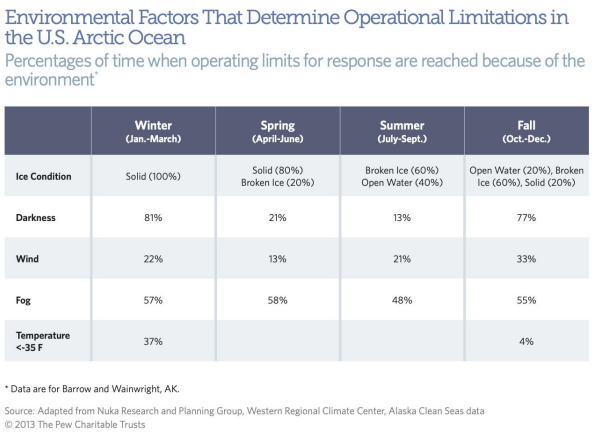
Climate change serves to further complicate oil and gas development on Alaska's North Slope and OCS. The UN Intergovernmental Panel on Climate Change estimates that the last five years have successively set new records for warmest annual mean Arctic temperature. The 2016 and 2018 mean winter temperature anomalies more than doubled previous records (2019). Relatedly, maximum Arctic sea ice extent reached new lows every year between 2015 and 2019, and multiyear ice has exhibited a 60 percent loss in extent since the 1980s (Overland et al., 2019). The largest sea ice losses have come in the Chukchi and Beaufort Seas (National Research Council, 2014). With a summer sea-ice free Arctic projected for the end of the century and the Chukchi and Beaufort Seas already experiencing several ice-free summer months, Arctic offshore oil resources may become more accessible (National Snow and Ice Data Center, 2019). However, the loss of sea ice may in fact be more harmful than helpful to Arctic Alaskan operations. The associated rise in wave and iceberg-caused damage would increase production costs (Petrick et al., 2017). Further, most oil and gas operations occur in the middle of winter when the Arctic ecosystem is most stable. Due to the rising temperatures and loss of sea ice, the

Arctic winter operating window has steadily decreased over the last 25 years (Lilly, 2017). Ice roads take longer to construct and melt earlier, while thawing permafrost has the potential to damage the already limited infrastructure (Berman & Schmidt, 2019). An estimated 550km of the Trans-Alaska Pipeline System are also at risk (Hjort et al., 2018). These climate-related operational impacts all result in greater costs to oil and gas companies. Updating North Slope roads from ice to gravel would cost an estimated $10 to $20 million annually (Berman & Schmidt, 2019). Melvin et al. (2017) projected climate change could cause between $100 and $300 million in damages to North Slope public infrastructure under both the RCP8.5 and RCP4.5 emission scenarios. An analysis has not been conducted for oil and gas infrastructure, but the costs would likely be in a similar range. Perhaps of lesser concern to companies now, as warming continues into the future, climate change-related costs will only grow. Oil companies will be forced to adapt their operations to the rapidly changing environment, an added layer of difficulty they may increasingly be unwilling to endure.

Taken together, the harsh environment, unique ecosystem, and impacts of climate change, foreshadow serious ramifications for an accident in the region. An oil spill presents perhaps the most likely and most damaging of consequences. While many of the causes of oil spills are universal across drilling locations, the likelihood of any one of them occurring off the coast of northern Alaska is higher than anywhere else in the United States. The Arctic's extreme low temperatures and constrained daylight increase the likelihood of an oil spill due to equipment or mechanical failure or human error (ABSG Consulting Inc., 2018). Further, the lack of infrastructure makes a spill due to some operational impact more likely. Procedures typically completed on or by permanent stable structures are carried out by vessels instead (ABSG

Consulting Inc., 2018). Additionally, drilling for oil in the Arctic brings on another set of causal factors. Sea ice may puncture a ship's hull or damage an oil platform. Sufficiently thick sea ice also may gauge the seafloor and damage a pipeline. In Hilcorp's production plan for the Liberty Project, they were required to prepare for 100 and 1,000 year sea ice gauge depths (ABSG Consulting Inc., 2018). As previously discussed, climate change has caused rapid shifts in the region which increase the likelihood of spills. Permafrost thaw and subsequent land subsistence could cause pipeline spills (The Pew Charitable Trusts, 2013). Increased access to the Arctic due to the loss of sea ice may result in greater interference in the region, yet stakeholders remain largely unprepared to manage the associated risks.

Responding to an oil spill in the Arctic also proves harder than anywhere else in the world. Several knowledge gaps exist in ensuring safe operations. Limited research has been conducted regarding interactions between oil and ice, the feasibility of typical detection and response strategies in the Arctic, or the distribution of Arctic wildlife (National Research Council, 2014). Employing existing mitigation strategies in the Arctic would likely not be possible for significant portions of the year. Two figures from the Pew Charitable Trust's report on Arctic OCS oil spill responses illustrate the environmental barrier well:



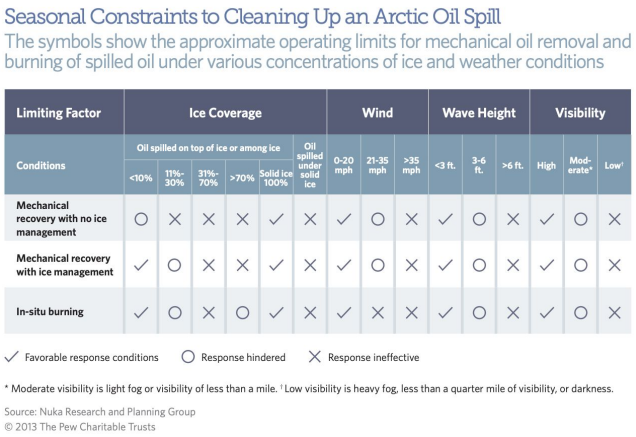
Environmental Factors That Determine Operational Limitations in the U.S. Arctic Ocean

Percentages of time when operating limits for response are reached because of the environment*

	Winter (Jan.-March)	Spring (April-June)	Summer (July-Sept.)	Fall (Oct.-Dec.)
Ice Condition	Solid (100%)	Solid (80%) Broken Ice (20%)	Broken Ice (60%) Open Water (40%)	Open Water (20%), Broken Ice (60%), Solid (20%)
Darkness	81%	21%	13%	77%
Wind	22%	13%	21%	33%
Fog	57%	58%	48%	55%
Temperature <-35 F	37%			4%

* Data are for Barrow and Wainwright, AK.

Source: Adapted from Nuka Research and Planning Group, Western Regional Climate Center, Alaska Clean Seas data



Seasonal Constraints to Cleaning Up an Arctic Oil Spill

The symbols show the approximate operating limits for mechanical oil removal and burning of spilled oil under various concentrations of ice and weather conditions

Limiting Factor	Ice Coverage						Wind			Wave Height			Visibility		
Conditions	Oil spilled on top of ice or among ice					Oil spilled under solid ice	0-20 mph	21-35 mph	>35 mph	<3 ft.	3-6 ft.	>6 ft.	High	Mod-erate*	Low†
	<10%	11%-30%	31%-70%	>70%	Solid ice 100%										
Mechanical recovery with no ice management	○	×	×	×	✓	×	✓	○	×	✓	○	×	✓	○	×
Mechanical recovery with ice management	✓	○	×	×	✓	×	✓	○	×	✓	○	×	✓	○	×
In-situ burning	✓	○	×	○	✓	×	✓	×	×	✓	○	×	✓	○	×

✓ Favorable response conditions ○ Response hindered × Response ineffective

* Moderate visibility is light fog or visibility of less than a mile. † Low visibility is heavy fog, less than a quarter mile of visibility, or darkness.

Source: Nuka Research and Planning Group

Figure 4. Percentage of time when operating limits for response are reached due to several environmental conditions. Figure 5. Impacts of environmental conditions on the feasibility of various oil spill response strategies.

Overall, all oil response strategies would face some level of difficulty all year round, with several strategies rendered completely ineffective at times. Even if a response were possible, the North Slope's remote location implies that emergency responders would take hours or days to arrive. The Arctic has no major highways or ports and only two airports with the capacity to handle cargo planes. In fact, the nearest U.S. Air Base is 950 miles away from the Arctic coast in Kodiak, Alaska, while the closest major port is 1,300 miles away at Dutch Harbor (The Pew Charitable Trusts, 2013). A report from the National Research Council (2014) suggests that the United States Coast Guard may not be fully prepared for a spill. The USCG in Alaska lacks the necessary personnel, equipment, transportation, communication, navigation, and safety resources. More locally, the North Slope's minimal onshore infrastructure and satellite coverage would likely hinder response coordination (ABSG Consulting Inc., 2018). There are few oil spill equipment caches on the North Slope, and building the necessary physical infrastructure and training a sufficient number of onsite personnel would almost certainly require a major

investment from the federal and state government and oil companies (National Research Council, 2014).

Reviewing the Exxon Valdez disaster offers a worrisome baseline for the potential impacts of an oil spill on the Alaskan Arctic ecosystem. When the Exxon Valdez ran aground in 1989, approximately 262,000 barrels of oil were spilled into Southern Alaska's Prince William Sound. Four hours passed and nearly 170,000 barrels spilled before the Coast Guard arrived, and a severe storm over the next several days prevented responders from initiating proper mitigation procedures. All told, the clean up required 10,000 workers, 1,000 boats, and 100 aircrafts. Despite a valiant clean up effort, pockets of oil can still be found along the coastline (Shigenaka, 2014). The alarmingly limited infrastructure in northern Alaska could not accommodate such a large response operation, while the notably harsher environment would jeopardize the safety of emergency personnel. According to a BOEM study, BP spent $4.2 billion, or $16,000 per barrel, on containing and cleaning up the Exxon Valdez spill. With no basis for which to quantify the cost per barrel of a spill in the Arctic, BOEM sets a range between $5,100, the cost per barrel of the Deepwater Horizon oil spill, and $16,000 per barrel (Industrial Economics, Inc. & SC&A, Inc., 2015). Given the many uncertainties surrounding Arctic oil spill response, $16,000 per barrel seems like a more realistic cost estimate, with the potential to be much higher. Consequently, the total clean up cost for a major spill in the Arctic would likely amount to several billion dollars.

Yet, the response costs do not encompass the entire impact of an oil spill. An estimated 250,000 seabirds, 2,800 sea otters, 300 harbor seals, 250 bald eagles, 22 killer whales, and billions of salmon and herring eggs were killed as a result of the Exxon Valdez's grounding. The

Prince William Sound ecosystem has still not recovered (Shigenaka, 2014). BP paid $1.1 billion, or $4,200 per barrel, to compensate for the damage to ecological resources (Industrial Economics, Inc. & SC&A, Inc., 2015). The effects of a spill on the Arctic ecosystem would be considerably larger. The BOEM study suggests that an oil spill in the Beaufort Sea would have a 35 percent greater ecological impact than that of a spill in Cook Inlet, which lies just west of Prince William Sound, while a spill in the Chukchi Sea would have a 130 percent greater impact (Industrial Economics, Inc. & SC&A, Inc., 2015). Relatedly, the Arctic seas have demonstrated limited resiliency to high mortality events such as an oil spill (Dvorak, 2017). Ultimately, an oil spill could devastate an ecosystem already altered by the changing climate. Using Cook Inlet as a baseline, BOEM's study calculates the ecological cost of a spill in the Arctic at between $2,500 and $9,700/per barrel (Industrial Economics, Inc. & SC&A, Inc., 2015). As a result, an oil company may have to pay upwards of $2.5 billion to compensate for damages. The actual cost could be much higher given the Alaskan Arctic likely would never recover from a major oil spill.

Putting a price on the complete destruction of an ecosystem is a nearly impossible and perhaps unethical task. However, two studies have attempted to appraise Alaska's ecosystems using a U.S. citizen "willingness-to-pay" metric. A University of Alaska-Anchorage study estimated the total value of all of Alaska's ecosystems at $29.7 billion in 2001 dollars, or $43 billion today (Colt, 2001). The Alaska Department of Fish and Game denotes eight unique ecosystems in Alaska. Determining the value of one ecosystem over another presents an ethical dilemma, and thus, I divided the $43 billion equally between the eight. Consequently, the Arctic sea ice ecosystem could be valued at $5.4 billion. Carson et al. (2003) presented an alternative valuation, estimating the mean willingness to pay to avoid a second Exxon Valdez oil spill to be

$7.2 billion in 2003 dollars, equivalent to $10 billion today. A previous study conducted by Carson et al. suggested a high bound for willingness to pay of approximately $15 billion, or $25.5 billion today (Dvorak, 2017). Given the vulnerability and pristine nature of the Arctic OCS, the ecosystem value is likely closer to the high bound. When compared to ConocoPhillips's net income of $7.2 billion for 2019, the risk becomes quite clear (Brehmer, 2020). While an oil company would almost certainly not be required to pay the entire value of the Arctic OCS ecosystem, the exercise demonstrates the level of risk involved in drilling for oil.

Economic Risk

The many serious environmental risks associated with exploring for, developing, and producing oil in the Arctic translates into oil companies taking on a greater financial burden than for a project anywhere else in the world. As discussed, the harsh yet threatened environment, limited infrastructure, restricted operating time, and remote location require a willingness to take on considerable economic and technical risk. Arctic oil projects require large capital commitments in which any return is at least a decade away and extended project management characterized by complex engineering. (Pugliaresi, 2013). Without either, embarking on a new Arctic venture simply is not feasible. By comparing various cost and time metrics to other U.S. oil fields, the drawbacks of Arctic oil production both in the present and future become clear.

First, the lead time to production for an Arctic well is orders of magnitude higher than for wells elsewhere in the United States, most notably in tight oil fields. The U.S. Energy Information Agency projects that bringing an oil well in the ANWR into production, factoring in

the lease, exploration, and development processes, would take at least a decade (2018). Yet, Shell's debacle in the Chukchi and Beaufort Seas indicate the process could take much longer. Their ten year stint in the OCS only included leasing and unfinished exploration. To get to production, Shell may have required another costly decade. A tight oil well, which utilizes hydraulic fracturing and horizontal drilling practices, on the other hand, takes only months to plan, drill, and complete (Kleinberg et al., 2018). Even on a relatively fast ten-year timescale, an oil company could complete at least 20, and likely upwards of 60, tight oil wells before completing the one Arctic well. The drawn out lead time adds to the already more expensive initial cost of drilling in Alaska. A New York Times article estimated that drilling one well in Alaska costs $30 to $50 million, five times the cost of a shale well (McFarlane & Olson, 2019).

Incredibly high lifetime costs and decade-long lead times require low enough breakeven points to justify commencing an Arctic oil project. Yet, few, if any, projects in Alaska's OCS exhibit the necessary economic conditions to drill. Comparing the undiscovered economically recoverable oil in various places in the United States clearly illustrates the high profitability threshold for Alaskan production. Despite the estimated 23.6 Bbbls of oil in the Chukchi and Beaufort Seas combined, the total economically recoverable oil is negligible at low oil prices (Lasco, 2017). A BOEM study (2016) indicates that no recoverable oil occurs in the Chukchi Sea at $30/barrel, while a mere 70 MMbbls occurs in the Beaufort Sea. For comparison, BOEM estimates at least 3 Bbbls of recoverable oil anywhere else along the United States' OCS, including along the Atlantic and Pacific OCS where significantly less oil exists. Of the nearly 50 Bbbls of undiscovered technically recoverable oil in the Gulf of Mexico, over 31 Bbbls are recoverable at $30/barrel. The Chukchi and Beaufort Seas combined finally surpass the Atlantic

and Pacific OCS at $60/barrel. However, exploiting three quarters of the Arctic OCS technically recoverable oil would remain economically infeasible (Bureau of Ocean Energy Management, 2016). Producing solely the Chukchi Sea oil at $60/barrel would cost $72.9 billion and create net benefits totalling a slim $6.2 billion (Dvorak, 2017). The profit generated in the Gulf of Mexico due to the lower cost of production and much higher quantity of oil would dwarf that of Alaska's Arctic seas. Consequently, even if oil prices were to consistently reach heights where companies could turn a profit in the Arctic, other locations, both onshore and offshore, would offer better prospects. In looking elsewhere, oil companies incorporate less risk into their operations both economically and environmentally.

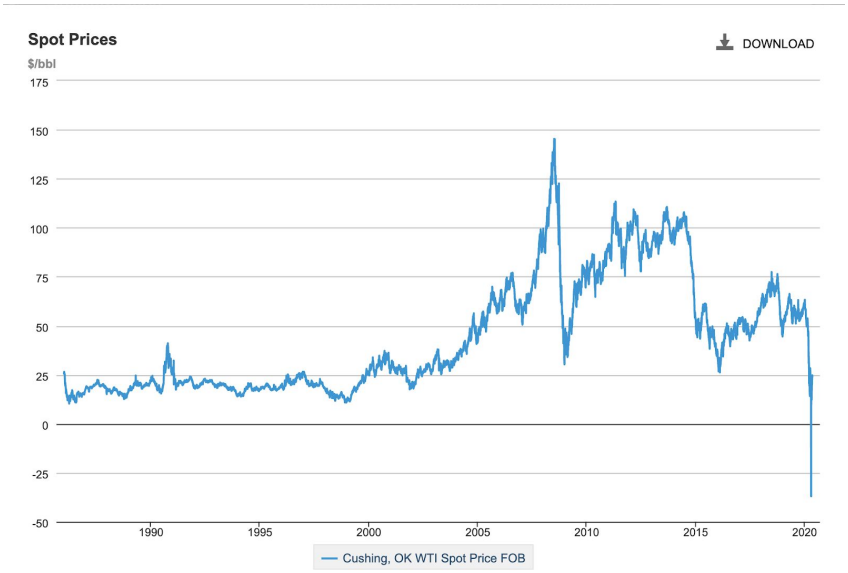


Figure 6. Daily WTI spot prices from 1986 to 2020 (U.S. Energy Information Agency, 2020b)

Alaskan oil's dependency on consistently high oil prices makes projecting profitability nearly impossible. Any estimate of future oil prices incorporates a significant amount of

uncertainty, especially when attempting to forecast over a decade out. As a result, oil companies should only tap the most productive of resources (Kleinberg et al., 2018). Even then, profit is not guaranteed. When Shell and others bid billions on Chukchi and Beaufort Sea leases in the mid-2000s, oil prices were consistently over $70/barrel, reaching a high of $140/barrel in late June of 2008 (Figure 6). The promise of considerable revenue justified their lease bids and initial costs. Shell was willing to endure setbacks and delays as oil prices remained between $80 and $100/barrel for most of the early 2010s (Figure 6). However, oil prices plummeted from late 2014 to early 2016. When Shell relinquished their leases in September 2015, oil was trading for $45/barrel (Figure 6). Dvorak estimated at $40/barrel, production of Chukchi Sea oil would generate a net loss of $1.9 billion (2017). No oil company saw benefit in further project development, and rather than hope for a price revival, they terminated their projects and cut their losses.

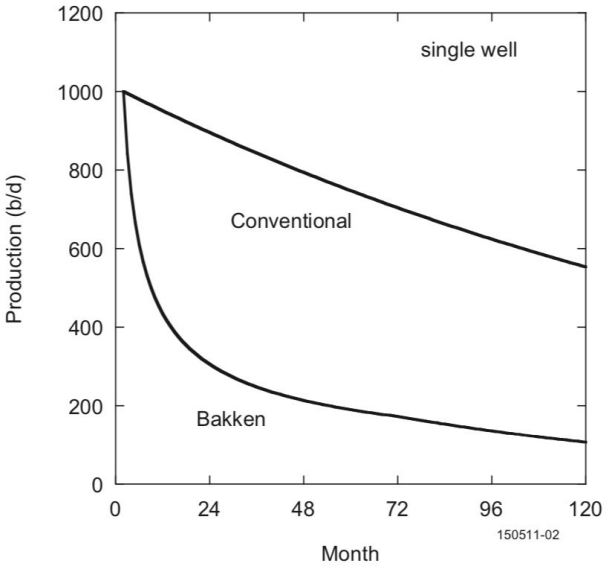


Figure 7. Rates of decline for oil wells. Conventional wells decline at an average rate of -6 percent annually. (Kleinberg et al., 2018)

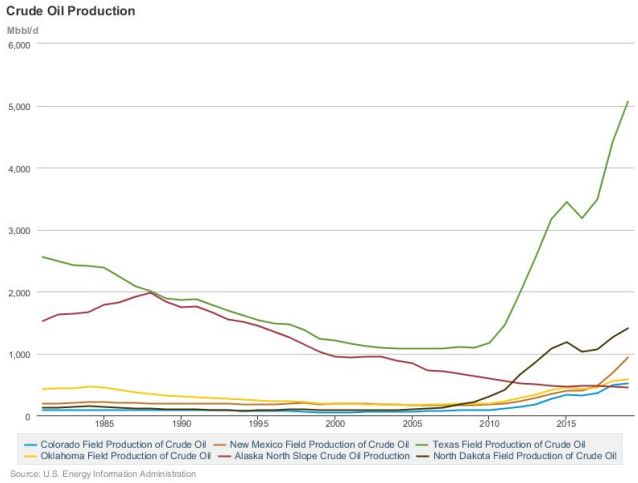


Figure 8. Crude Oil production for selected states (U.S. Energy Information Agency, 2020c)

Heavy reliance on oil prices further distinguishes Arctic oil from tight oil in the contiguous United States. Conventional wells such as those drilled in Prudhoe Bay and other massive North Slope oil fields stay in use for decades (Figure 7). Since production costs remain high throughout a well's lifetime, in order to ensure continued profitability so too must oil prices. In contrast, tight oil wells, such as those drilled in North Dakota and Montana's Bakken Formation, rapidly decline, only producing meaningful amounts of oil for a couple of years. A typical tight oil well will decline by 60 percent in the first year and 25 percent in the second (Kleinberg et al., 2018). Added to the short time for well completion, a company may cap a tight oil well two or three years after commencing the drilling process. Consequently, tight oil wells are less vulnerable to fluctuations in price. The ability to quickly add to or decrease oil supply offers U.S. tight oil the additional advantage of influencing oil prices while Arctic oil falls victim to them (Kleinberg et al., 2018). Since the price drop in 2014, oil prices have rarely been sufficiently high to warrant offshore drilling in the Arctic, and the North Slope's oil production has continued to decline. Meanwhile, states with tight oil accumulations have experienced sustained production booms throughout the last decade (Figure 8).

Recognizing the high level of environmental and economic risk, banks have made smart economic decisions in no longer financing new Arctic oil and gas projects. Touted as part of stronger environmental policies, in reality the commitments mean banks no longer believe they can turn a profit in Alaska. As Goldman Sachs CEO David Solomon explained in an op-ed released alongside their recent sustainability guideline changes, "profitability will always matter" (2019). However, as the world demands greater sustainability, many fossil fuel ventures no longer appeal to investors. Unsurprisingly, the recent announcements have come alongside

commitments to no longer finance much of the coal industry, which has also been in decline for over a decade (JPMorgan Chase, 2020; Morgan Stanley, 2020; Wells Fargo, 2020; Citi, 2020). Banks came to these resolutions relatively easily. With lower oil prices and increased environmental awareness, Arctic oil no longer represents "a top ten oil project to finance," according to Eurasia Group senior analyst David Livingston. Further, Livingston calls the decisions a "lagging indicator" of Arctic oil's declining importance (Geman & Harder, 2020).

While not indicative of a sharp turn toward environmentalism, the new investment policies still will have an impact on the Arctic. The region's production likely will face a more rapid fall without key sources of financing. Oil companies will have a harder time investing in new projects, especially smaller companies such as Hilcorp (Dlouhy, 2020). More specifically, the commitments could quell interest in the Coastal Plain's oil and gas resources. Goldman Sachs, JPMorgan Chase, Morgan Stanley, and Wells Fargo each indicate in their updated environmental policies that by refusing to finance new Arctic oil projects they will not aid in any development in the Arctic Refuge. The distinction looms large as President Trump continues to push for a lease sale. Contrary to the Arctic OCS, development in the 1002 Area could produce large net benefits even at somewhat lower oil prices. Kotchen and Burger (2007) estimate 7.07 Bbbls of economically recoverable oil, nearly all of the 7.7 Bbbls in the Coastal Plain, with prices at $53/barrel, resulting in net benefits totalling $251 billion. Hahn and Passell (2010) similarly predict net benefits of $203 billion for oil valued at $50/barrel. Without a key source of funding, however, oil companies may not be able to exploit the ample resources.

Reputational Risk

In addition to the loss of financial support from banks, developing the ANWR for oil has potentially severe reputational ramifications. The ANWR, as with the Arctic OCS, holds value for simply existing. In his 1967 paper entitled *Conservation Reconsidered*, John Krutilla argued that "there are many persons who obtain satisfaction from mere knowledge that part of the wilderness of North America remains even though they would be appalled by the prospect of being exposed to it" (p.781). The contamination of the largest protected terrestrial area in the United States would not sit well with most Americans. A 2019 Yale University poll indicated that 67 percent of registered voters oppose drilling in the ANWR. While Democrats overwhelmingly opposed drilling, 50 percent of Republicans also would prefer to leave the landscape undisturbed, demonstrating the Arctic Refuge's value to all Americans (Ballew et al., 2019). Relatedly, in 2018, institutional investors with assets totally over $2.5 trillion, including groups varying from BNP Paribas, to the New York State Common Retirement Fund, to The Episcopal Church, penned an open letter to oil and gas companies and banks urging them to not pursue development in the refuge (Brown, 2018). Ignoring these requests would represent a complete disregard for the environment and the indigenous communities that rely on the refuge's resources. Of course, oil companies and the United States government are no strangers to abusing the planet or native people.

Oil companies and banks have cited purely economic reasons for ending Arctic operations, but there is reason to believe growing public opposition also played a role. In Wells Fargo's press release regarding Arctic financing, they stated they did not believe in "[limiting]

credit or financing to legally operating companies based solely on public opposition" (2020). However, they accounted for both reputational risk and social and environmental considerations when making the decision. The mere necessity for banks to update their environmental policies and angle toward more sustainable practices sheds light on the influence of greater public recognition of environmental issues. Shell's Arctic operations were met with relentless opposition from activists. The robust and well-organized "Shell No" campaign used every means they could to inconvenience Shell and bring awareness to the risks of drilling in the Arctic (Schuler, 2019). While there may not be a way to determine the activists' exact influence, other oil companies surely followed Shell's struggles and chose not to continue with their equally contentious endeavours. Tainting one of the last pristine places in the nation and one of the most vulnerable to climate change would result in backlash most companies would rather avoid.

Conclusion

In my paper I outlined Alaska's controversial history of oil exploitation. I detailed production in the North Slope and OCS, highlighting key moments in the region's development. I explained the recent decisions by oil companies and banks to distance themselves from the Arctic by analyzing the environmental, economic, and reputational risk factors associated with drilling for oil and demonstrated that, despite the ample fossil resources, the limited potential benefits do not justify their production.

The decisions are indicative of the Alaskan oil industry's extended decline. In 2017, the Alaskan government projected that without new additions to the sector, another 120,000 barrels

per day of oil production could be lost by 2026. New projects such as the development of Repsol's large Horseshoe discovery and the approval of the Liberty oil field would only serve to prolong the decline by a few decades (Munisteri, 2017). The EIA similarly views these new projects, along with production in the ANWR, as the state's last lifeline. They predict new production in the NPRA and Arctic Refuge would only delay a return to a steady decline until 2041. However, the EIA's low oil price projection sees no development occurring in the ANWR, sending the state's oil production to near irrelevance on a national scale much sooner (U.S. Energy Information Agency, 2020d). Further, as oil stops flowing, continuing to operate TAPS will become a greater economic and technical challenge, putting greater strain on the already faltering industry. With a minimum operating capacity estimated somewhere between 75,000 and 350,000 barrels per day, the pipeline could hit the threshold as early as 2025 (Munisteri, 2017). Lacking a means of transportation and failing to turn a profit, the once backbone of national energy production could cease producing oil in a matter of years.

The International Energy Agency's World Energy Outlook and the recent collapse of the oil market offer little hope for a revival of the Alaskan oil industry. Echoing the EIA's projection, the IEA sees U.S. tight oil not only dominating the country's production but also spurring any growth globally for the next few decades (IEA, 2019). The cheaper and more readily exploited oil should continue to pull interest away from the Arctic. While the long term effects of COVID-19 on oil markets are far from certain, the cratered demand and subsequent glut in supply will likely accelerate the shifting preference for tight oil and perhaps put the entire industry into decline much sooner than the EIA, IEA, or any other forecasts expected. The pandemic may bring or have already brought about peak oil, a sentiment the CEOs of BP and

Shell, among others, have echoed (Edwards & Hurst, 2020; Raval, 2020). Regardless of whether or not the world has hit peak oil, the industry will remain in disarray for some time. With oil prices at historically low levels, Alaska's oil future has only become cloudier.

Even if oil markets recover, one final and critical factor warrants discussion. A national climate change policy could have the greatest impact on Alaska's oil production. Should former Vice President Joe Biden prevail in the upcoming presidential election, he would reverse course on President Trump's irresponsible stance on climate action. Biden has called drilling in the Arctic a "disaster," and his proposed climate policies include permanently closing the ANWR to oil and gas development along with calling for a global moratorium on Arctic offshore drilling (*Climate*, 2020; *Joe Biden on the Arctic Refuge*, 2020). Further, he would reenter the United States into the Paris Climate Agreement and push for even greater emissions reductions (*Climate*, 2020). In order to most economically meet the 2ºC warming goal set in Paris, a study by McGlade and Ekins found that all Arctic oil and gas must be considered "unburnable" (2015). As a result, a shift in political leadership may have the most immediate and drastic effect on the Arctic's energy future.

The considerable uncertainty surrounding our future energy production and consumption leaves Alaska and the oil industry in a precarious position. The state will have to reshape its economy. Oil companies have already begun repositioning and rebranding themselves for a low carbon future. Risky Arctic oil projects no longer bring about lucrative returns. Rather they entail unnecessary environmental, economic, and reputational risk. In the global transition away from fossil fuels, ending oil development in the Arctic is just the tip of the iceberg.

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