ARTICLE CASE

Shale Resources, Parks Conservation, and Contested Public Lands in North Dakota's Theodore Roosevelt National Park: Is Fracking Booming?

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ABSTRACT This case study analyzes the potential impacts of weakening the National Park Service's (NPS) "9B Regulations" enacted in 1978, which established a federal regulatory framework governing hydrocarbon rights and extraction to protect natural resources within the parks. We focus on potential risks to national parklands resulting from Executive Orders 13771—Reducing Regulation and Controlling Regulatory Costs [1]—and 13783—Promoting Energy Independence and Economic Growth [2]—and subsequent recent revisions and further deregulation. To establish context, we briefly overview the history of the United States NPS and other relevant federal agencies' roles and responsibilities in protecting federal lands that have been set aside due to their value as areas of natural beauty or historical or cultural significance [3]. We present a case study of Theodore Roosevelt National Park (TRNP) situated within the Bakken Shale Formation—a lucrative region of oil and gas deposits—to examine potential impacts if areas of TRNP, particularly areas designated as "wilderness," are opened to resource extraction, or if the development in other areas of the Bakken near or adjacent to the park's boundaries expands [4]. We have chosen TRNP because of its biodiversity and rich environmental resources and location in the hydrocarbon-rich Bakken Shale. We discuss where federal agencies' responsibility for the protection of these lands for future generations and their responsibility for oversight of mineral and petroleum resources development by private contractors have the potential for conflict.

"Of all the questions which can come before this nation, short of the actual preservation of its existence in a great war, there is none which compares in importance with the great central task of leaving this land even a better land for our descendants than it is for us."

—Theodore Roosevelt, The New Nationalism, Osawatomie, Kansas, August 31, 1910

"Where conflicting interests must be reconciled, the question shall always be answered from the standpoint of the greatest good of the greatest number in the long run."

—Gifford Pinchot, First Chief of the U.S. Forest Service, 1905

KEY MESSAGES

Readers of this case study will learn:

- about the historical development and significance of Theodore Roosevelt National Park (TRNP),
- about some current risks to the integrity and quality of TRNP as a result of adjacent oil and gas development,
- how conflicts between economic growth, energy demand, and environmental resource protection need to be managed,
- how federal and state regulations governing mineral development need to be reevaluated and possibly amended to keep up with current developments, and
- how human encroachment on—and risk to—natural resources, such as national parks, is increasing, particularly as energy usage and demand increases.

INTRODUCTION

The United States Energy Information Administration (EIA) projects that global energy use will rise by nearly 50%

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between 2018 and 2050 [5, 6]. The use of methods for unconventional oil and gas extraction, including hydraulic fracturing and horizontal or lateral drilling, are expected to double in the U.S. by 2040 [7]. Studies show that expanding energy development is one of the largest drivers of global land-use change, leading to a significant potential risk to biodiversity and ecosystem health [7–9, 83].

Energy producers are increasingly looking toward reserves situated in publicly owned lands, including those managed by the U.S. federal government. This rise in unconventional oil and gas development [84] has meant that extraction activities have expanded into new areas with little or no previous hydrocarbon development [10]. "[A]s riches from oil and gas grow, developers keenly eye the reserves sitting below public lands and water" ([11], p. 148; [12]).

Federal agencies, including the National Park Service (NPS), have an explicit legal obligation to protect and preserve the "unimpaired" quality of national parks and designated "wilderness" areas [13] that are publicly owned lands. However, with increasing pressure from both industry and state, and federal agendas for commercial development of resources on these lands, there is a potential for conflict of interest between energy development and extraction of mineral resources and the valuation and preservation of nature and public lands [10, 14, 15, 97]. Argued benefits of shale gas include the abundance of supply, particularly in the United States, affordability, as abundance may lead to reduced natural gas prices, potentially cleaner environmental footprints compared with other fossil fuels (coal and oil), replacing older and less efficient coal-fired power plants, and economic growth and job creation [16]. However, studies show that unconventional methods of shale gas extraction such as hydraulic fracturing combined with horizontal drilling pose potential risks to the environment, including loss of biodiversity and species habitats [100], contamination of air and water bodies [86, 92], and changes in the nature and quality of landscapes and ecosystems such as "fragmentation" [17–20, 71]. In light of these risks, it is important to understand the frameworks and regulations overseeing industrial development in national parks and surrounding areas.

National Parks and Wilderness

In 1872, President Ulysses S. Grant signed the Yellowstone National Park Protection Act [21] establishing Yellowstone as the nation's first national park [22]. The Organic Act of 1916 created the NPS, a bureau of the Department of the Interior (DOI), to protect all designated national parkland and "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" [13].

The Wilderness Act, signed by President Lyndon B. Johnson in 1964, designated protected status for wilderness areas that are parts of national parks, national forests, wildlife refuges, and the public domain [23]. The Act's legal definition of "wilderness" states:

> *"A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and community of life are untrammeled by man, where man himself is a visitor who does not remain."* [23]

Although logging, mining, and motorized vehicles are forbidden within designated wilderness areas, resource extraction and livestock grazing may continue in some areas where the activities began before its wilderness status. Wilderness areas must also contain a minimum of 5,000 acres and be in a "natural" state, devoid of detectable human presence, and provide opportunities for solitude, as well as contain environmentally, scientifically or historically significant features [24] to be designated as "wilderness" [78, 89, 98].

A majority of federal land is managed primarily by four major agencies: (1) the Forest Service (FS) within the Department of Agriculture, (2) the Bureau of Land Management (BLM), (3) the Fish and Wildlife Service (FWS), and (4) the NPS within the DOI [25]. Despite all acting as land managers, each of the four agencies has different responsibilities in the management of their various federal lands [101].

For example, BLM controls the largest portion of the federal lands, managing nearly 250 million acres of public land and roughly 700 million acres of federal subsurface mineral property [26]. On the other hand, the FS manages almost 200 million acres of forests and grasslands [27]. Both the BLM and the FS have responsibilities related to preserving water bodies, timber, wildlife habitats, conservation, and recreation, but the FS is primarily responsible for managing forest reserves, or national forests [27]. The FWS manages nearly 90

million acres, and its mission is specifically to conserve and protect animals and plants [28].

OIL AND GAS EXTRACTION IN U.S. NATIONAL PARKS

Despite these wilderness designations, there is increasing interest in expanding the development of unconventional hydrocarbons, such as shale oil and gas, for the sake of "energy independence" and "energy security." In fact, the United States is projected to become a net exporter of energy by 2020 [5, 6]. Currently, twelve national park sites have active oil and gas wells [29], while other national parks, including North Dakota's Theodore Roosevelt National Park (TRNP), experience impacts such as air pollution, noise, and land fragmentation [82, 83], from oil and gas development just outside the park boundaries [30–32]. Thirty additional NPS sites do not currently have active wells but are predicted to be at risk of future hydrocarbon development, based on current private ownership of subsurface rights [11, 29].

Federal control is complicated by the fact that some territory within national parks and national wildlife refuges may be subject to *split estates* where the federal government owns the surface properties but the mineral rights below the surface are privately held [10, 11]. The split estate may lead to a possible clash when a private company wants to extract its subsurface mineral resources yet the NPS wants to maintain its obligation to preserve park resources [33]. The subsurface of some of these federal lands contains vast mineral resources and, although the issue of leasing federal lands to extract hydrocarbon resources is not new, the use of fracking combined with horizontal drilling has both increased the interest in and added potential complexity to the issues of split estates [11, 34].

The expansion of hydrocarbon development—and particularly hydrofracking [35, 36]—has led the four main federal agencies, the NPS, the FS, the FWS, and the BLM, to re-evaluate current regulations to manage the goals of economic development with the risks resulting from resource exploitation.

TRNP RESOURCES AND FEATURES

In 1947, President Truman established Theodore Roosevelt National Memorial Park in North Dakota, in what is today the South Unit of TRNP [95]. Currently, it is separated into three distinct units: the South Unit, the North Unit, and the Elkhorn Ranch Unit in Billings and McKenzie counties in North Dakota [37] and spans 70,447 acres, including native Prairielands, badlands, juniper woodlands, and hardwood forests, and riparian areas, among other features [38]. The South and North Units are 60 miles apart; the Elkhorn Ranch Unit, a roughly one square mile area that was the second home of President Roosevelt, is located between the two units [37, 39] (see Figure 1). In 1978, Congress designated the area as TRNP—giving it national park status—and established the 29,920-acre Theodore Roosevelt Wilderness in the park's North and South Units, within the North Dakota badlands landscape [37].

Fundamental Resources and Values (FRVs) of TRNP

The NPS defines a park's FRVs as features, scenes, experiences, stories, sounds, and other attributes that are central to its significance/purpose and thus require consideration in planning and management to ensure they are maintained [37]. The FRVs are closely linked to its legislative purpose, as these attributes are part of the motivation and rationale for the original designation of the park [37, 40].

The FRVs for TRNP, per its Foundation Document [37], are as follows:

- *Native Wildlife and Habitat*: crucial habitat for Northern Great Plains wildlife, species diversity (including bison, bighorn sheep, elk, white-tailed deer, pronghorn, coyotes, prairie dogs, etc.), and a diverse landscape of plants (such as mixed-grass prairies and cottonwood forests).
- *Little Missouri River*: connects all three units of TRNP and is the park's primary water resource. The river is crucial to the landscape as it is carved from the sedimentary rock of the Badlands terrain and is critical to the park's ecosystem.
- *Outstanding Geologic and Paleontological Resources*: including aeolian deposits and other erosional surfaces, and many Paleocene fossils, as well as a large concentration of petrified wood.
- *Scenic Views and Clean Air*: The park's clean air and its dark night skies, as well as the Badlands terrain, provide access to "unspoiled nature" that first inspired President Roosevelt.



FIGURE 1. Theodore Roosevelt National Park (TRNP) Units. *Legend*: Regional map of TRNP showing the North and South Units, as well as the Elkhorn its location about major roads. *Image credit*: U.S. National Park Service (http://npmaps.com/wp-content/uploads/theodore-roosevelt-regional-map.jpg). *Permission (Wikimedia Commons)*: This file is licensed under the Creative Commons Attribution 2.0 Generic license.

- *Wilderness Qualities Throughout*: Protecting wilderness is a crucial goal of park preservation and provides visitors the opportunity to seek both solitude and adventure.

9B Regulations

In 1978, the NPS established specific regulations at Title 36 CFR Part 9[1] [41], Subpart B, referred to as "9B Regulations" to maintain the balance between the private rights to extract minerals and the obligation to protect national parks [42]. These Regulations govern the development of privately owned hydrocarbon rights in national parks to minimize the damage to park resources [11, 33, 93]. Therefore, the 9B Regulations provide a regulatory framework to manage issues related to split estates and to "[e]nsure that activities undertaken pursuant to [non-federal oil and gas rights] are conducted in a manner consistent with the purposes for which the National Park System and each unit thereof were created, to prevent or minimize damage to the environment and other resource values, and to [e]nsure to the extent feasible that all units of the National Park System are left unimpaired for the enjoyment of future generations" [43].

Specifically, the regulations stipulate that oil and gas operators must outline the proposed location, extraction processes to be used, and safety and protection measures [87]. Then, the NPS must evaluate if the proposed operations will impact national resources and visitors, incorporating public review and input [as required by the National Environmental Policy Act (NEPA)] [43].

As resource extraction technologies became more sophisticated, the NPS updated the 9B Regulations in 2016 [33, 44]. First, these revisions ended exemptions that allowed wells (approximately 60% of all those in

1. Code of Federal Regulations (CFR) Title 36. Parks, Forests, and Public Property Chapter I. NATIONAL PARK SERVICE, DEPARTMENT OF THE INTERIOR Part 9. MINERALS MANAGEMENT.

operation) to operate without NPS approval, which hindered safety and spill prevention oversight by the Park Service [29, 33]. Additional key updates to the regulations included raising the amount of money drillers were required to set aside in the event of a spill, establishing fees for drillers to use national parkland, allowing the NPS to charge fees for construction of infrastructure such as pipelines and roads that traverse national park habitats, providing funding for the NPS to restore parkland impacted by drilling companies, and providing NPS law enforcement officers enforcement "teeth" to hold operators accountable for failing to follow agreed upon safety standards [33].

DEREGULATION OF OIL AND GAS EXTRACTION ON FEDERAL LANDS

Executive Orders

Article II, Section 1 of the U.S. Constitution states that "[t]he executive power shall be vested in a president of the United States of America," and means that the President has the power to issue legally binding Federal Orders without the approval of Congress (U.S. Const. Art. II, § 1) [96]. The result of this power is that Presidential Executive Orders can be used to weaken environmental regulations if Congress refuses to act or lacks the votes to pass a law requested by the President or members of his political party [91].

In January 2017, President Trump issued Executive Order 13771: Reducing Regulation and Controlling Regulatory Costs [1]. This Order compels all agencies to repeal at least two existing regulations for each new regulation issued in the fiscal year 2017 and thereafter. It further requires that "the total incremental costs of all regulations should be no greater than zero" for 2017, and places limits on future regulatory costs [1].

President Trump then issued Executive Order 13783: Promoting Energy Independence and Economic Growth [2], on March 28, 2017, which states that "It is in the national interest to promote clean and safe development of our Nation's vast energy resources, while at the same time avoiding regulatory burdens that unnecessarily encumber energy production, constrain economic growth, and prevent job creation." It calls for executive departments and agencies to review regulations that "potentially burden the development or use of domestically produced energy resources and appropriately suspend, revise, or rescind those that unduly burden the development of domestic energy resources beyond the degree necessary to protect the public interest or otherwise comply with the law," where "burden" is defined as "to unnecessarily obstruct, delay, curtail, or otherwise impose significant costs on the siting, permitting, production, utilization, transmission, or delivery of energy resources" [2].

On March 29, then-Secretary of the Interior Ryan Zinke issued Order No. 3349 on American Energy Independence [45], which called for a review of policies governing hydrocarbon extraction on federal lands including, among others, climate change and mitigation policies, the FWS regulations governing fracking in national wildlife refuges,[2] and the NPS's 9B regulations [44] governing fracking in national parks.

In light of deregulation following recent Executive Orders [72], energy developments may be allowed in the future [73, 74, 99]: within TRNP to extract state-owned mineral resources, on federal lands surrounding the park, on mineral estates owned by North Dakota, or on lands and mineral estates owned by the State of North Dakota and held in trust for the Common School Fund (Title IX Trust Lands) [46, 47].

And although TRNP is currently protected from drilling within its boundaries, the land outside the national park units' boundaries—visible from within the park—is at risk [30], and if the 9B regulations are significantly changed, drilling within the park may be possible as well.

HYDROFRACKING AND TRNP

Bakken Shale Development and Impacts on TRNP

A few years after the park's initial establishment in 1947, oil reserves were discovered in the Bakken shale upon which TRNP is located [30]. Oil and gas extraction activities have occurred in the Bakken shale basin, which covers parts of North Dakota, Montana, and the Canadian provinces of Manitoba and Saskatchewan, since the 1950s but began to intensify rapidly around 2008 due to emergent fracking and drilling technologies that enabled the extraction of previously unavailable deposits [4]. Much of this development in the Bakken is centered around Williston, North Dakota, located just over 50 miles from TRNP.

2. Management of Non-Federal Oil and Gas Rights, 81 Fed. Reg. 79,948 (Nov. 14, 2016).

AIR POLLUTION AND HAZE. Development is not allowed within the three units of the park itself. However, the NPS *does not* have regulatory authority over activities outside the boundaries, and park visitors may see signs of oil development in the surrounding areas, increased levels of pollution due to traffic and noise, dust, and light [30, 48]. Recent studies have shown significant concentrations of airborne particulate matter in and around the Bakken due to a wide range of polluting emissions from all stages of the unconventional hydrocarbon development lifecycle, including drilling, construction, transportation, flaring, and others [49].

IMPACTS ON WILDERNESS AND WILDLIFE. According to the National Parks Conservation Association [31], recent research demonstrates that wildlife species can suffer various impacts due to unconventional hydrocarbon development including a change in movement to avoid areas with wells, less-frequent breeding displays adjacent to hydrocarbon fields and infrastructure, and decline in wildlife populations [31, 50]. Sawyer et al. [51]. showed that mule deer fled from drilling pad sites and were less likely to use lands with energy development within 2.4 miles, thus leading to isolation of wildlife populations within the boundaries of lands protected from drilling. Although the future effects of regional wildlife populations that occupy national parklands are unclear, biologists expect a decline in population size and diversity of wildlife in TRNP because of insulation and isolation of wildlife from surrounding areas as they avoid areas currently experiencing hydrocarbon development [50].

HABITAT LOSS AND ALTERATION. There is a potential for habitat loss and fragmentation due to resource extraction requiring clearing of significant areas of land and the development of new or updated roads and infrastructure to support the extraction sites [31, 52]. Operation of heavy machinery and increased traffic have the potential to destroy or crush vegetation and cause collisions with migratory wildlife such as small mammals as well as bears and deer, among others, that move in and out of national park boundaries [31].

Studies on areas adjacent to fracking sites in Pennsylvania have found that habitat loss and fragmentation due to energy development can impact wildlife including Neotropical migratory bird species [52]. Further evidence suggests that impacts on migratory bird species can in turn impact flora, including plant species that rely on birds for pollination [31, 52, 53]. Habitat loss and fragmentation can thus impact wildlife [88], and vegetation populations both *within* and *adjacent to* park boundaries: wildlife, plant seeds, and water and air move freely across national park borders, the conditions of resources within national park boundaries are inherently tied to the characteristics and quality of the wider surrounding landscape [50, 90]. In addition, effects of related activities such as mining of sand for fracking can impact national parks, as sand mining activities in the Midwest have been shown to have already led to sedimentation in the St. Croix National Scenic River [31].

OTHER TYPES OF POLLUTION: LIGHT AND NOISE. TRNP may be at risk from light and noise pollution associated with unconventional hydrocarbon development. Noise from the drilling of wells and construction of well pads and other infrastructure, high-pressure blasts from compressors pumping frack fluids (chemical mixtures injected at pressure to induce rock fracturing) underground, as well as traffic moving equipment and personnel to the drill pads [31] may create a soundscape more appropriate to an industrial setting than a natural park site. With energy development near national parks, we risk losing natural sounds—and natural silence—that can impact visitors' recreational experiences, cultural and spiritual benefits of park resources, and direct and indirect effects on wildlife and biodiversity [31]. Francis et al. [53] demonstrated in a study of land adjacent to natural gas wells in New Mexico that the steady noise from air compressors changed communities and diminished populations of both bird and mice species, and in turn, reduced the dispersal of piñon pine seeds [31].

In addition, energy development may result in increased light pollution. In TRNP, which previously offered some of the United States' "darkest, most pristine night skies," researchers and astronomers evidenced a new "constellation" due to methane flares from adjacent wells [31] (see Figure 2). Gas flaring can cause light pollution, preventing enjoyment of dark night skies, and can also confuse wildlife populations such as nocturnal animals [31, 54]. According to the NPS Final Environmental Impact Assessment (FEIS) on the 2016 revisions to the 9B regulations, artificial lighting has increased rapidly in recent decades in the United States [55]. A comparison of satellite imagery of the sky glow near the Bakken shale in 1997 and 2012 shows significantly increased artificial lighting of the night sky attributed to hydrocarbon production [55].

The dark night sky and absence of loud human-made sounds (such as drilling or traffic) are arguably a crucial

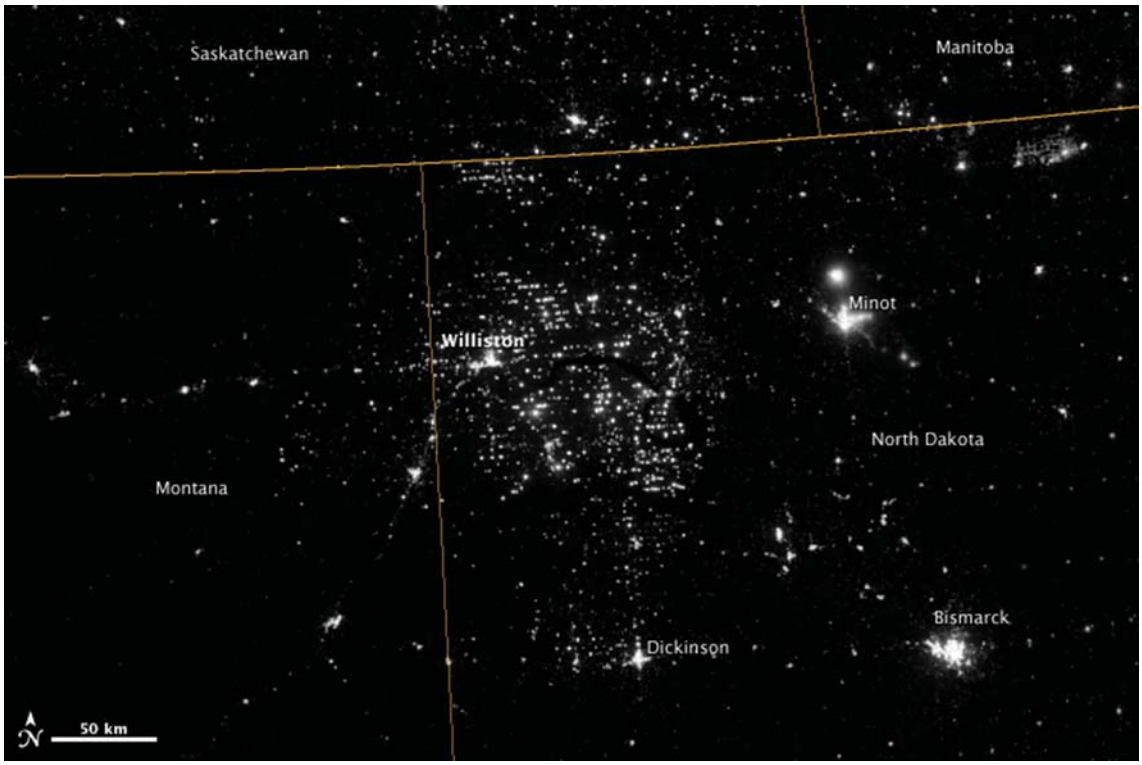


FIGURE 2. North Dakota gas drilling activity from the night sky. *Legend*: In November 2012, NASA's Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite captured this nighttime view of widespread gas flaring throughout the Bakken Shale area. Many of the scattered light specks are evidence of gas flaring, and others may be the bright lights surrounding drilling equipment. *Image credit*: NASA Earth Observatory (http://www.earthobservatory.nasa.gov/) and https://commons.m.wikimedia.org/wiki/File:Gas_Drilling,_North_Dakota_(8249377475).jpg. *Permission (Wikimedia Commons)*: This file is licensed under the Creative Commons Attribution 2.0 Generic license.

element of "wilderness," and a key feature that first inspired President Roosevelt's focus on conservation.

THREATS TO THE "VIEWSHED". Maintaining a national parks' viewshed—the area around the park visible to visitors both approaching and within the national park—is an important characteristic and goal of wilderness conservation [56]. However, current hydrocarbon developments are also impacting TRNP's viewshed, as flaring of gas from wells, visible signs of hydrocarbon development, increased truck traffic, and the addition of powerlines pose risks to the park's viewshed [56, 79].

IMPACTS ON WATER. Unconventional hydrocarbon extraction poses potential risks for contamination of water resources from fugitive gases and leaks and spills from inadequately treated fracking wastewater [35, 57, 70]. Recent studies show the increasing intensification of the water footprint of shale gas development: between 2011 and 2016, the water used per each shale well increased up to 770% [58], and there is evidence that the amount of water used in fracking may further increase in the future, exacerbating water resource impacts and water stress [75, 76].

The potential for water stress is significant in North Dakota, a semi-arid state. Data and maps from the United States Drought Monitor showed that all of North Dakota is currently affected by some degree of water stress, with a significant portion of the state under extreme drought conditions [59]. The rapid growth in demand for water and shift in water demand patterns that accompanied the Bakken shale boom has further stressed water delivery services, leading to such emergency measures as the temporary sale of water intended for irrigation to the oil and gas industry as well as the introduction of temporary permits to allow extraction from limited groundwater sources [60, 94].

CULTURAL IMPACTS. The negative impacts of increased hydrocarbon development within and adjacent to national parks highlighted so far only relate to impacts on

ecosystems and visitor experiences, overlooking the potential impacts of development on the *cultural* values that also exist within TRNP and other wilderness areas. The future impact assessment should also evaluate the risk to human rights, traditional rights, environmental rights, and cultural rights to understand the implications of hydrocarbon development on indigenous populations and important traditional or cultural heritages.

With the increased interest in the hydrocarbon deposits located under TRNP [85], there has been a gradual encroachment on protected federal lands—and importantly, designated Wilderness areas—to access these resources for commercial development [81]. Deregulation by Executive and Federal Orders, among others, has the purpose of making energy development easier [80]. Evidence of encroachment includes increasing development in proximity to TRNP with noticeable changes to viewscape and soundscape, increased traffic near park boundaries, and elevated levels of pollution and others. We can argue that the current administration's move to weaken regulations and prioritize energy development over environmental conservation conflicts with the original intent to set aside TRNP and other federal parklands for current and future generations.

MOVING FORWARD: THE CASE FOR PRECAUTION?

The Wilderness Act intends to preserve designated areas from the impact of human development for current and future generations—yet there is a clear risk that legislation promoting energy interests and hydrocarbon development may undermine this intent. Moreover, there remains uncertainty regarding the potential negative impacts on wilderness and other protected areas if oil and gas extraction is permitted on these lands.

As an inherent responsibility of the Park Service and agencies charged with the protection of natural resources is ensuring the viability and enjoyment of parklands for current and future generations (principle of inter- and intra-generational equity), a case for a precautionary approach toward shale oil and gas extraction adjacent to or near parks can be argued. This is because the *future* impacts of hydrocarbon development on protected lands, with risk to ecosystem quality and biodiversity, are harder to measure. Therefore, a precautionary approach is a logical recommendation to ensure that the energy footprint and potential effects do not harm or negatively impact natural resources—either at present or in the future—by halting fracking until it can be proven that a certain predetermined standard of harm will not occur.

When faced with competing needs and goals—the rising demand for energy and availability of fossil resources on federal lands and the importance of conservation—the precautionary principle may serve as a useful decision-making tool and framework. Principle 15 of the 1992 Rio Declaration on Environment and Development ("Rio Declaration[3]") defines the purpose of the "precautionary principle" applied to environmental issues, saying "[i]n order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" [61]. The rationale behind the application of the precautionary principle is that populations have a right to a safe and sound environment. This means that even if we lack scientific certainty about an environmental or health threat, policymakers should create regulatory protections and cannot cite a lack of certainty as a reason for inaction against an environmental risk [62]. This approach can arguably help to prevent degradation of national parks' critical resources, particularly within designated wilderness areas. In addition, the principle means that if a certain action has the potential for "serious or irreversible damage," the burden of proof that the action is *not* harmful falls upon the polluter [63].

In the United States, approaches to health, safety, and environmental regulation tend to use cost-benefit and risk-based strategies arguably to accommodate industrial and business interests [64]. Applegate [65] explains that "[w]ith rare exceptions, U.S. law balances precaution against other considerations, most importantly cost. Therefore, while precautionary elements are firmly entrenched in U.S. environmental law, it is more accurate to say that it reflects a precautionary preference rather than the precautionary principle." However, there have been some cases where the precautionary principle has been applied in one form in decision making in the United States. For example, New York State implemented a ban

3. Agreed by the U.S. in 1992 in Rio and adopted by "Conference of the Parties" at The United Nations Conference on Environment and Development (UNCED).

on hydraulic fracturing on the grounds of "significant uncertainty" regarding public health risks [66, 67]. More recently, arguments have been made toward applying the precautionary principle when faced with potential uncertainty regarding electronic cigarettes [68].

In light of the recent rollback of regulations designed to govern resource extraction on federal lands, taking a cost-benefit and risk-based approach may place too great a burden on the evidence of risk. This may pose a threat of irreversible damage to vulnerable park resources as there may be a time lag for evidence of damage to manifest itself. This is due to the prevalence of requirements that regulations be based on an "increased level of scientific evidence or justification," in addition to requirements that the benefits of regulation outweigh or justify the imposition of costs ([64], p. 353).

The rationale behind the application of the precautionary principle is that populations have a right to an environmentally safe environment. This means that even if scientific certainty about an environmental or health threat is lacking, policymakers should arguably create regulatory protections and cannot cite lack of certainty as a reason for inaction against an environmental threat [62], and this approach can arguably help to prevent degradation of the parks' critical resources, particularly within the wilderness area. In addition, the principle means that if a certain action has the potential for "serious or irreversible damage," the burden of proof that the action is not harmful falls upon the polluter [63].

CONCLUSION

In conclusion, this case study identified the potential misalignment of conservation objectives by examining the observed detrimental effects of hydraulic fracturing in the Bakken shale on North Dakota's TRNP. The case study of TRNP illustrates the potential for conflict between federal agencies' oversight of energy development, including unconventional oil and gas reserves, with their obligation to preserve designated areas of "wilderness," as well as protect social and cultural significance, ecosystem services, recreational benefits, and inherent beauty. We argue that to minimize risk, the NPS should view and regulate potential hydrocarbon development within the framework of the current 9B Regulations. Weakening or erosion of the 9B Regulations both contradicts the NPS's role as initially established and may set a precedent for economic development as overriding the need for maintaining natural resources for future generations.

There is a need for further research into the growing energy footprint—particularly impacts of unconventional hydrocarbon extraction—on natural resources, their ecosystem service provisioning, cultural and heritage assets, and the viability of wildlife and park resources for future generations. Taking a precautionary approach may help to balance rising energy production and consumption demands with responsibilities to ensure viable natural resources and ecosystem services for future generations.

> *"There is a delight in the hardy life of the open. There are no words that can tell the hidden spirit of the wilderness that can reveal its mystery, its melancholy and its charm. The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value."*
>
> —Speech by Theodore Roosevelt, August 31, 1910, Roosevelt [69].

CASE STUDY QUESTIONS

1. Think broadly about the 1964 Wilderness Act. Why is this legislation important for humans and ecosystems?
2. How should decisions relating to conservation versus fracking be made? Who should be included in this process and why?
3. How would the "precautionary principle" alter a regulatory approach to hydraulic fracking in or near wilderness areas and national parks?
4. What is the "endpoint" of wilderness? What might be the consequences of piecemeal fracking approvals, here and there, that encroach on natural areas?
5. In regulating fracking and conservation, can the federal government be both the gamekeeper and the poacher? [As Geltman explains, "by both statute and as owner of land," the United States federal government is responsible for maintaining a balance between natural resource conservation and land stewardship with the exploitation of federal resources ([11], p. 152)].

6. Consider the "split estate" issue. Ought the interests of the majority outweigh the interests of the few? How do we decide here as to who are the majority and who are the few?

AUTHOR CONTRIBUTIONS

MA and KM contributed to the scoping of the research and the analysis of the case study and writing of the manuscript. MA developed the initial draft (in discussion with KM) and KM contributed to writing, editing, and analysis of the draft and subsequent revisions. The authors worked in tandem to shape the final submission.

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COMPETING INTERESTS

The authors declare that no competing interests exist.

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