Energy Research & Social Science 62 (2020) 101384

Contents lists available at ScienceDirect

Energy Research & Social Science

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

Original research article

What do outdoor recreationists think of fracking? Politics, ideology, and perceptions of shale gas energy development in Pennsylvania State Forests

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ARTICLE INFO

Keywords:
Outdoor recreation
Visitor use management
Energy development
Political ideology
Recreation impact
Shale natural gas
Public lands

ABSTRACT

This study examined the influence of political ideology and perceptions of benefits and risks upon State Forest recreationists' support and opposition towards shale natural gas energy development (SGD) on public and private lands in Pennsylvania. Much of the ongoing and proposed Pennsylvania SGD infrastructure is either within or adjacent to public lands, waters, and protected areas, raising concerns about the potential environmental and social impacts upon recreation stakeholders. On-site face-to-face survey interviews were used to gather data from Pennsylvania State Forest recreationists from June to September of 2018 (n = 392). The predominantly local, educated, experienced, and politically moderate sample in this study demonstrated relatively low levels of support towards SGD on Pennsylvania public lands and relatively neutral stances towards support for SGD on private lands in Pennsylvania. Structural equation modeling results suggested that political ideology and perceptions of risks were significant predictors of support for SGD on both public and private lands in Pennsylvania. The relationship between political ideology and support for SGD on public and private lands was also partially mediated through the perceived risk of SGD in the model. Study findings contributed to previous research suggesting political attitudes may influence and supersede other factors when predicting support for SGD. A series of one-way analyses of variance further explored differences by political ideology in this study. In each of these analyses, a similar statistical trend prevailed. Those identifying themselves as conservative were significantly more likely than their moderate and liberal counterparts to support SGD on both public and private lands in Pennsylvania and perceive fewer risks from SGD on Pennsylvania State Forests. This research lent itself to the theory of landscape fit and construal level theory as State Forest recreationists may have perceived the 'fit' of SGD negatively and could have construed SGD abstractly, lending themselves to political ideology. From a policy and management standpoint, study findings highlight the importance of assessing and communicating State Forest recreationists' perceptions and subsequent opinions when planning, developing, and managing SGD and related decisions in the United States.

1. Introduction

Shale natural gas energy development (SGD) is the largest and most viable domestic energy sector in the United States [1]. Fueling this recent SGD boom is the combination of rising energy prices, large-scale capital investments, and cost-effective technological advances in unconventional hydraulic fracturing methods [2–4]. Unconventional hydraulic fracturing (commonly referred to as 'fracking') utilizes the high-pressure injection of water, sand, and chemicals into a wellbore to create cracks and fissures in deep-rock formations where natural gas and oil can flow more freely to the surface for collection [5,6]. The combined technological and geopolitical advances in SGD have allowed the United States to become the world's largest producer of natural gas, with Texas and Pennsylvania leading domestic production [3,6,7]. Pennsylvania has largely led domestic SGD production, with more than 25 trillion cubic feet of natural gas produced since 2005 [1]. A significant portion of this SGD production takes place ether within or adjacent to Pennsylvania State Forest lands [8,9].

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https://doi.org/10.1016/j.erss.2019.101384
Received 18 June 2019; Received in revised form 14 November 2019; Accepted 24 November 2019

This study examined State Forest recreationists' support and opposition towards SGD on both public and private lands in Pennsylvania. Outdoor recreation is an increasingly critical component of the Pennsylvania economy, generating $29.1 billion in annual consumer spending, $1.9 billion in state and local tax revenue, and employing more than three times as many individuals in Pennsylvania as the SGD industry in 2017 [10,11]. Pennsylvania lawmakers, natural resource managers, and SGD industry representatives must recognize and embrace State Forest recreationists as important and legitimate stakeholders within the SGD process due to their potential first-hand interaction with this form of energy development in Pennsylvania and around the world. This study found low levels of support towards SGD on public lands and relatively neutral stances towards support for SGD on private lands in Pennsylvania. Moreover, study respondents perceived limited benefits and limited risks towards SGD on Pennsylvania State Forests. This study highlights the perceived influence of SGD and political ideology upon State Forest recreationists as well as the importance of assessing and communicating recreationists' perceptions of SGD on public land private lands in the United States.

2. Literature review

2.1. Shale natural gas energy development

The Marcellus Shale is one of the largest shale gas 'plays' in the world, spanning 34 million acres and containing approximately 500 trillion cubic feet of natural gas [2,3]. The Marcellus Shale is a geological formation containing substantial natural gas deposits below sections of five Northeastern states: Pennsylvania, West Virginia, Virginia, Ohio, and New York [2]. Within the Marcellus Shale region, the rapid development and expansion of natural gas extraction is largely attributed to the combination of large scale capital investments, increasing domestic energy prices, and the development of cost-effective and efficient unconventional hydraulic fracturing extraction techniques (e.g., 'fracking') [2,3,10]. The Marcellus Shale natural gas extraction boom began in Pennsylvania in 2007 with fewer than 100 wells, but rapidly expanded to more than 9000 wells by 2015 [4,12]. The Pennsylvania portion of the Marcellus Shale lies beneath approximately 1.5 million acres of the 2.2 million-acre Pennsylvania State Forest system [13]. Pennsylvania State Forest lands contain some of the largest contiguous forests in the Eastern United States and are considered by many to be a priceless natural resource [12].

Perceptions of the benefits and risks of SGD on both public and private lands have been shown to vary amongst Pennsylvania residents due in part to legal complexities arising from severed rights laws [2,6,12]. Pennsylvania is a severed rights state, meaning that surface rights and ownership may be separated from sub-surface rights and ownership [14]. The state of Pennsylvania has recognized that all surface and sub-surface owners have unique property rights. This presents a complex legal scenario where sub-surface or mineral owners have the right to extract said minerals, while surface or property owners have the right to protection from 'unreasonable' extraction related encroachment or damage [14].

The vast majority of public lands in Pennsylvania are managed by the Pennsylvania Department of Conservation and Natural Resources (DCNR) who owns approximately 80% of the sub-surface rights below the Pennsylvania State Forests system [8,9]. Since 2008, the DCNR has approved 1026 SGD wells on Pennsylvania State Forest lands, of which, 646 have been drilled to-date; generating approximately $545 million in state royalty revenue [8]. In 2015, Pennsylvania Governor Tom Wolf issued an executive order that established a moratorium on new SGD leases within Pennsylvania public lands, referencing among other topics, substantial recreation impacts on public lands [15]. The combination of complex legal scenarios, rapid SGD development, and political influence has resulted in various perceptions of the benefits, risks, and overall support towards SGD on Pennsylvania public and private lands.

2.2. Theory of landscape fit and construal level theory

Numerous studies have advanced the theory of landscape fit where individuals may gauge support or opposition based upon the perceived 'fit' between energy development and an individual's perception of both the community and the landscape [16–20]. 'Fit' refers to how an energy development project is interpreted within the symbolic meaning of a landscape, community, or location [16,19,20]. For example, the industrial aspects of some SGD projects may be perceived negatively among stakeholders who view SGD as disrupting the preservation, protection, and recreation opportunities of natural areas [17,18,21]. Thus, energy development 'fit' may be viewed as a measure of continuity or disruption to an area, which may be a driver of support or opposition for energy development projects [16,17].

Relatedly, construal level theory is a social-psychological concept which examines the relationship between perceived psychological distance and the extent to which an individual construes an issue as abstract or concrete [22,23]. Issues viewed as psychologically 'distant' may be construed in a more abstract or holistic manner (e.g., low construal), whereas issues viewed as psychologically 'close' may be construed in a more concrete or detailed manner (e.g., high construal) [22,23]. Perceptions of SGD are sometimes perceived as psychologically 'distant' and construed in an abstract manner [24,25]. In instances of abstract construal, individuals tend to reply upon broad ideological dispositions, such as political ideology, when deciding whether to support or oppose an issue [23]. Thus, the support and opposition of SGD, a relatively novel, abstract, and unfamiliar technology, may lend itself more readily to be influenced by factors such as political ideology as well as notions of landscape fit.

2.3. Political ideology and shale natural gas energy development

The debate over the use of non-renewable energy resources has recently intensified within the United States [6]. Non-renewable energy resources, such as oil, coal, and natural gas, are defined as energy sources that cannot be readily replaced by natural means at a pace consistent with consumption [26]. While non-renewable energy resources are widely utilized in the United States, perceptions of support and opposition regarding their development are often politically polarized [27,28]. These perceptions are often associated with conservative and liberal political ideologies, which have been shown to supersede other factors [29–31]. Research has demonstrated that conservatives are more likely to support the development of non-renewable resources and free market enterprise, whereas liberals are more likely to oppose the development of non-renewable resources and support practices associated with regulation [32–35].

Due to the rapid growth of SGD, recent research has focused on the general public's various perceptions associated with risks and benefits [6,10,36]. Perceptions of SGD can vary markedly based on factors such as political ideology, social class, age, gender, population density, exposure, proximity, direct benefit, and knowledge [2,6,37,38]. However, political ideology has been demonstrated to be a significant and robust predictor of support and opposition for SGD [27,32]. Thus, the rapid expansion of SGD has in many instances led to mixed perceptions and understandings toward the benefits and risks of SGD [39].

2.4. Perceived benefits of shale natural gas energy development

The primary positive benefits of SGD often revolve around notions of economic prosperity and energy independence [2,6,38]. For instance, Willits et al. [38] found that 84% of Pennsylvania residents felt SGD was essential to their state's economy and economic prosperity. Brown et al. [40] noted that economic stimulus and the concept of energy independence from foreign sources were viewed as the primary positive benefit of SGD amongst Pennsylvanians. Other perceived benefits include SGD acting as a low-carbon 'bridge fuel' between non-

renewable and renewable energy sources [41]. For instance, SGD may be perceived to burn cleaner, and reduce global pollution and emissions when compared to other non-renewable energy sources such as coal and oil [41–43]. These perceived benefits may lend themselves to general support for SGD [6,24,33]. Prior research asserts that individuals who perceive the more immediate benefits of SGD, such as economic and energy independence, are more likely to support SGD [6,33,44]

The benefits of SGD align well with long-held conservative political foundations related to free enterprise, economic independence, and minimal government interference and regulation [6,24,33,45,46]. These conservative principles lend support to overall practices associated with the expansion of domestic SGD on public and private lands [22,32,46,47]. Individuals with moderate political ideologies may align more with conservatism in their general support for SGD and may be more inclined to see the potential benefits of SGD [25]. Individuals with liberal ideologies, on the other hand, may lend support to environmental justice and regulation practices and may be less inclined to see the direct benefits associated with SGD [32,48].

2.5. Perceived risks of shale natural gas energy development

There are numerous perceived social, environmental, and infrastructure risks associated with SGD [6]. The SGD literature cites social risks related to safety, crime, stress, and community health [2,6,49]. Several studies have shown that residents in SGD regions may perceive threats to their rural way of life, the rapid industrialization of small towns, and an inability to experience the natural beauty and amenities in their area [2,50]. Environmental risks associated with forest clearing, pollution, and water consumption and contamination are also common in the SGD literature. Large-scale water consumption has been shown to reduce regional surface water volume, leading to limited water supplies for rural residents and wildlife [2,5]. Moreover, infrastructure risks related to substantial heavy duty truck traffic are one of the most commonly perceived risks of SGD [2,49,51]. Numerous studies have found notable increases in vehicular accidents and fatalities involving heavy-duty trucks in areas proximate to SGD [2,5,37]. Perceptions of SGD risks are often perceived negatively and may lead to overall opposition [2,6,27,37,38,52].

The literature asserts that liberals, as opposed to conservatives, may be more likely to perceive the risks associated with SGD, which can ultimately lead to opposition [27,32]. Recent research has found political ideology, age, gender, and race to be predictors of SGD opposition [6,24,25,33]. For instance, opposition towards SGD is often related to concerns arising from environmental risk, aesthetic effects, and overall distrust associated with the SGD process [42,53]. Ultimately, the perceived risks and opposition of SGD align well with long-held liberal views associated with adherence to due process, economic regulation, environmental justice, and support for renewable energy practices [6,24,27,33,44,48].

2.6. Outdoor recreationists and shale natural gas energy development

Much of the ongoing and proposed SGD infrastructure in the United States is located either within or adjacent to public lands, waters, and protected areas, raising concerns about the potential environmental and social impacts upon recreation stakeholders. These perceived impacts are concerning for recreationists within the Pennsylvania public land systems. Studies have suggested that outdoor recreationists may be predisposed to pro-environmental values (often mimicking liberal sentiments) and that these values may lead recreationists to avoid or be displaced by industrialized energy development [10,16–21]. Further, many rural economies proximate to SGD have grown dependent upon the outdoor recreation and tourism economy, and SGD may negatively affect the scale and volume of visitors to these rural areas [18,51]. Research has demonstrated hunting and fishing difficulties due to wildlife dispersion, strains on camping, hotels, and accommodation availability due to the influx of SGD workers, and alterations to natural landscapes negatively influencing recreationists decisions to visit public lands [2,18,37,51,54].

There are numerous factors that may influence overall perceptions of SGD support and opposition, such as political ideology and perceptions of benefits and risks [6,24,27,33,44]. Moreover, political ideology may be the most important predictor of SGD support and opposition [27,32]. Outdoor recreationists' might bear positive and/or negative costs from SGD and the perceptions of said costs may drive overall opinion. Many of the aforementioned studies often treat outdoor recreation and recreationists' perceptions of SGD as a secondary pursuit or afterthought. Outdoor recreationists are an important and outspoken constituency within the SGD process due to potential face-to-face interaction with this form of energy development. Yet, no research has explicitly measured State Forest recreationists' perceptions of support and opposition towards SGD on public and private lands in Pennsylvania.

2.7. Research questions

The underlying purpose of this study was to explore the subsequent research questions in an effort to better understand and determine the nature of the problem. This study did not test specific theories or hypotheses, due to a lack of extant comparisons related to SGD and State Forest recreation populations. Rather, parallels were drawn between this study and the theory of landscape fit and construal level theory. The researchers expected recreationists' political ideologies and perceptions of SGD benefits and risks to play a role in shaping support or opposition, but sought to understand the extent and ways in which these factors operated. A better understanding of these relationships may help shape policies and strategies to communicate and engage recreationists in the SGD process.

R1: To what extent do Pennsylvania State Forest recreationists support SGD on public and private lands within Pennsylvania?
R2: Do Pennsylvania State Forest recreationists' perceptions of SGD benefits, perceptions of SGD risks, and political ideology relate to support for SGD on public and private lands within Pennsylvania?
R3: What is the relationship between political ideology and Pennsylvania State Forest recreationists' support for SGD on public and private lands within Pennsylvania?

3. Methods

3.1. Study context – Pennsylvania State Forests

The state of Pennsylvania manages a substantial number of public lands and protected areas that provide abundant outdoor recreation opportunities and access. The Pennsylvania Department of Conservation and Natural Resources-Bureau of Forestry (DCNR-BOF) manages a majority of these public-protected areas, presiding over 20 State Forest units encompassing approximately 2.2 million acres of forestland [8]. The Pennsylvania DCNR-BOF manages this forestland system under the guidance of the State Forest Resource Management Plan. This is a complex and adaptive multiple use land management framework that provides, among other things, simultaneous opportunities for outdoor recreation and SGD within State Forest units [8]. In recent years, outdoor recreation has become an increasingly critical component of the Pennsylvania economy, often displacing the prominence of boom and bust energy development that has historically dominated the landscape [50,51,55]. The combination of biological and geological diversity, high quality and informed natural resource management, in addition to an abundance of public access, makes the Pennsylvania State Forest system attractive to a wide range of local, regional, and international outdoor recreationists.

This study focused on the Michaux and Tiadaghton State Forests. Located in South Central Pennsylvania, the Michaux State Forest covers more than 85,500 acres and provides abundant outdoor recreation opportunities ranging from hiking, camping, boating, mountain biking, and off-highway vehicle use [8]. The Michaux State Forest was specifically selected for this study as a 'control' site as there has never been SGD on the forest. Located in North Central Pennsylvania, the Tiadaghton State Forest covers more than 146,000 acres and also provides numerous outdoor recreation opportunities ranging from hiking, camping, canoeing, horseback riding, and off-highway vehicle use [8]. The Tiadaghton State Forest was also specifically selected for this study as a 'treatment' site as there has been significant SGD on the forest. Through conversations with natural resource managers, the researchers obtained permission to sample both Michaux and Tiadaghton State Forest recreationists at two of the most popular trailhead parking areas within each State Forest. Sampling within these two State Forests allowed for a design that assessed Pennsylvania State Forest recreationists' perceptions of SGD at locations without active SGD and locations with active SGD.

3.2. Data collection

On-site face-to-face survey interviews were used to gather data from recreationists throughout both State Forests from June to September of 2018. To gather a diverse and representative sample, a systematic sampling plan was developed in consultation with natural resource managers to coincide data collection with peak recreation use periods [56]. Researchers administered the survey via tablet computers using a commercially available offline data collection application. A trained research assistant approached potential respondents, described the purpose of the study, and solicited respondents to participate in the survey, which was read aloud and took between 10 and 15 min to complete. If potential respondents indicated they did not partake in any recreation activities that day, they were thanked for their time and excluded from the study. For systematic sampling purposes, interviewers contacted every second person or party observed and requested their participation [56]. Only consenting adults (18 years of age or older) were eligible to participate.

The topics within the first portion of the survey included trip visitation patterns and sociodemographic characteristics. Once this portion of the survey was completed, respondents received a laminated informational flashcard. The flashcard provided respondents with a brief informational narrative informing them of SGD in Pennsylvania. The narrative read, "Marcellus Shale natural gas development refers to a range of processes used to prepare for, extract, and transport natural gas that is tightly locked within rock formations deep in the earth." The flashcard did not identify any specific SGD sites, nor did it explain any benefits or risks of SGD. The purpose of this flashcard was to orient the respondent to the generalized concepts of SGD in an unbiased manner. Numerous energy development studies have deployed this flashcard technique [16,21,57,58]. After reviewing the flashcard, respondents were asked a series of questions pertaining to SGD. These items referred to the perceived benefits and risks of SGD and support and opposition for SGD on both public and private lands. Upon completion of the survey, respondents were thanked for their time and asked if they had any other questions. In total, 430 respondents were approached, yielding 392 completed surveys and a 91% response rate. Non-response bias was assessed using a single question evaluating primary activity. A chi-square analysis found no significant difference ($p < .05$) for primary activity type between respondents and non-respondents. Therefore, a lack of non-response bias was assumed.

4. Results

All data were analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0 and AMOS version 24.0. To address research question R1, frequencies, valid percentages, and measure of central tendency were used. To address research question R2, structural equation modeling (SEM) was used to assess the relationship between benefits, risks, political ideology, and support for SGD on public and private lands. Finally, to address research question R3, analysis of variance (ANOVA) procedures were used to analyze differences among group means, followed by Scheffe's post-hoc analysis.

Table 1
State forest recreationists' sociodemographic and trip visitation characteristics.

Variable	*N*	% or *M (SD)*
Gender		
Male	230	58.7%
Female	162	41.3%
Education		
Less than High school	2	>1.0%
High School Graduate	38	9.7%
Some College	48	12.2%
Four-year College Degree	261	66.6%
Graduate or Professional Degree	43	11.0%
Area Description		
Rural	211	53.8%
Suburban	162	41.3%
Urban	19	4.8%
Primary Activity		
Canoe/Kayak	129	30.0%
Hike/Walk	101	23.5%
Bicycle/Mountain Bike	99	23.0%
ATV/Off-Highway Vehicle Use	49	11.4%
First Time versus Repeat		
First time visitor	46	11.7%
Repeat visitor	346	88.3%
Residency		
Pennsylvania Resident	362	84.2%
Non-Pennsylvania Resident	68	15.8%
Experience Use History		
Average total years recreating	346	18.59 (33.20)
Distance Traveled from Home		
Median total distance traveled	233	25.0 miles (25.76)
Visitors traveling 15 miles or less	114	29.2%
Political Ideology[a]		
Mean		4.11 (1.42)
Liberal	59	15.2%
Moderate	254	65.3%
Conservative	76	19.5%

Note. Percentages may not equal 100 because of rounding.
[a] Note. Political Ideology (1= extreme liberal, 4= moderate, 7= extreme conservative).

4.1. Descriptive statistics

Of the 392 survey respondents, approximately 59% identified as male and 41% as female (Table 1). Over 10% of the sample had earned a high school diploma or less and two-thirds of respondents (66%) noted they had earned a four-year college degree; 11% of the sample had earned a graduate or professional degree. Respondents described where they lived as rural (54%), suburban (41%), or urban (5%). Respondents were asked to indicate which outdoor recreation activity was their primary activity on the day they were sampled (Table 1). Of the entire sample, canoers and kayakers represented nearly one-third (30%), hikers and walkers represented nearly one-quarter (24%), followed closely by bicyclists and mountain bikers (23%), and finally ATV and off-highway vehicle users (11%) represented the smallest proportion of visitors. In terms of trip visitation patterns, respondents were largely repeat (88%) visitors with the vast majority of respondents (84%) noting they were Pennsylvania residents. These experienced and largely localized visitors noted they had visited the State Forest an average of 19 times in their lifetime and traveled a median distance of 25 miles from their homes to the survey site. These sociodemographic and residency characteristic statistics closely resembled other similar

Table 2
State forest recreationists' perceptions and attitudes towards SGD.

Variable	*N*	*M (SD)*
Support for SGD		
On Pennsylvania private lands[a]	392	4.06 (2.49)
On Pennsylvania public lands[b]	392	3.34 (2.42)
Attitudes Towards SGD		
Benefits of SGD on Pennsylvania State Forest lands[c]	393	3.82 (2.05)
Risks of SGD on Pennsylvania State Forest lands[d]	391	4.18 (2.02)

[a] Note. Support for SGD on PA private lands (1 = strongly oppose, 7 = strongly support).
[b] Note. Support for SGD on PA public lands (1 = strongly oppose, 7 = strongly support).
[c] Note. Benefits of SGD on PA State Forest lands (1 = completely disagree, 7 = completely agree).
[d] Note. Risks of SGD on PA State Forest lands (1 = completely disagree, 7 = completely agree).

research in the study area [59–61].

To assess visitors' overall perceptions towards SGD, respondents evaluated the extent to which they supported or opposed SGD on both private and public lands in Pennsylvania (Table 2). This was performed through the use of two single-item seven-point Likert scales (1 = strongly oppose, 7 = strongly support). Overall, visitors noted low levels of support (M = 3.34) towards SGD on public lands in Pennsylvania and relatively neutral stances towards support (M = 4.06) for SGD on private lands in Pennsylvania. These overall support and opposition items were created based on previous energy development literature and conversations with natural resource managers [6,17,27,62].

To measure visitors' perceptions towards SGD benefits and risks, respondents were asked to indicate the extent to which they agreed with seven benefit statements and seven risk statements related to SGD in Pennsylvania State Forests using a seven-point Likert scale (1 = completely disagree, 7 = completely agree) (Tables 2 and 3). Both the benefit and risk constructs have been previously validated to assess visitors' perceptions towards energy development [6,16,63,64]. Overall, visitors perceived limited benefits (M = 3.82) and limited risks (M = 4.18) towards SGD on Pennsylvania State Forests.

Finally, respondents were asked to indicate their political ideology using a single-item seven-point Likert scale (1 = extreme liberal, 4 = moderate, 7 = extreme conservative) which was developed based on previous literature [6,16,28,65] (Table 1). The political ideology distribution was fairly symmetric, with approximately 15% of respondents identifying as liberal, approximately 65% of respondents identifying as moderate, and approximately 20% of respondents identifying as conservative. The mean for political ideology was 4.11, suggesting the sample was fairly moderate, although leaning toward the conservative side of moderate.

4.2. Structural equation model for support for shale natural gas energy development

Structural equation modeling (SEM) examined the relationships between SGD benefits, SGD risks, political ideology, and support for SGD on public and private lands. SEM was used in this study as it has been demonstrated to create stronger predictive models, provide additional indicators of goodness of fit, and offers direct and instantaneous model comparisons [66]. It should be noted that cases with missing data were removed from the dataset, as maximum likelihood estimation in AMOS requires no missing data. Missing cases were removed, instead of imputing data, in an effort to be as conservative as possible. First, a measurement model for SGD benefits and risks was established via a confirmatory factor analysis (CFA). The initial model did not show sufficient fit. After consulting modification indices, three benefit items and four risk items were removed until a final model was reached (Table 3). Both the SGD benefit (a = 0.95) and the SGD risk (a = 0.98) constructs showed sufficient reliability and the overall model showed good fit (χ^2:37.572; df = 13; p < .001; CFI = 0.993; TLI = 0.989; RMSEA = 0.075; SRMR = 0.0133) with sufficient factor loadings (>0.40). The CFA informed a series of SEMs to assess the assumptions of mediation [66]. This process found no significant relationship between political ideology and the perceived benefits of SGD. These findings suggested the removal of the SGD benefits construct from the analysis because it did not meet the assumptions of mediation [66]. Thus, the SGD benefits construct was removed from all future analyses.

The final mediation SEM is displayed in Fig 1. The SEM showed a

Table 3
Confirmatory factor analysis of perceived risks and benefits associated with SGD[a].

Variable code[b]	Item	Loading[c]	*M (SD)*
Perceived Risks[d] (α = 0.98)			
V1	Drive visitors and residents away from the area	0.94	3.69 (2.19)
V2	Harm the area's economy	0.98	3.73 (2.20)
V3	Bring too many new people to the area to live or work	0.98	3.68 (2.15)
V4	Harm the local infrastructure	0.98	3.80 (2.16)
Items removed from CFA measurement model			
–	Negatively influence the environment[f]	–	5.24 (2.10)
–	Ultimately, not be as productive as promised[f]	–	3.95 (2.50)
–	Decrease the scenic and natural beauty[f]	–	5.16 (2.11)
Perceived Benefits[e] (α = .095)			
–	Improve local services	0.86	3.12 (2.18)
–	Improve the local economy	0.97	3.97 (2.24)
–	Benefit future generations	0.97	4.07 (2.24)
Items removed from CFA measurement model			
–	Increase energy independence[f]	–	4.56 (2.19)
–	Help the environment[f]	–	4.46 (2.20)
–	Give the area a positive reputation[f]	–	2.81 (2.21)
–	Bring new people to the area to live and/or visit[f]	–	3.74 (2.24)

[a] Note: χ^2 = 37.572, df = 13, p < .001; CFI = .993; TLI = .989; RMSEA = 0.075; SRMR = 0.0133.
[b] Note: Variable code refers to SEM model, see Fig. 1.
[c] Note: Standardized factor loading. All loadings were significant at p < .05.
[d] Note. Benefits of SGD on PA State Forest lands (1 = completely disagree, 7 = completely agree).
[e] Note. Risks of SGD on PA State Forest lands (1 = completely disagree, 7 = completely agree).
[f] Note. Item removed during the SEM CFA process.

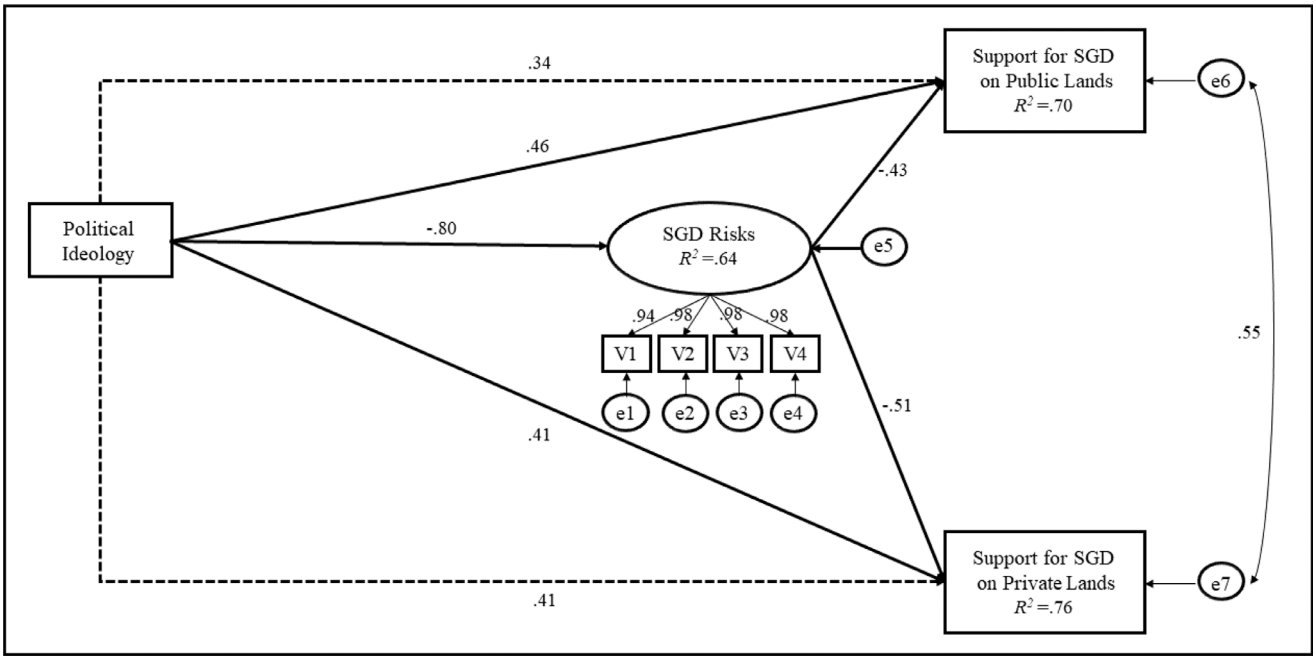

Fig. 1. Final Mediation SEM[a]. [a]Note: χ^2:40.236, df = 11, $p < .001$; CFI = 0.992; TLI = 0.985; RMSEA = 0.089; SRMR = .0088. [b]Note: Solid arrows indicate standardized direct effects. [c]Note: Dashed arrows indicate standardized indirect effects. Note: All relationships were significant at $p < .05$

good fit to the data (χ^2:40.236; $df = 11$; $p < .001$; CFI = 0.992; TLI = 0.985; RMSEA = 0.089; SRMR = 0.0088). Overall, SEM results indicated that political ideology and perceived risks of SGD explained a significant amount of the variance in support for SGD on both public (70%) and private lands (76%) in Pennsylvania. Political ideology had a strong, negative relationship with perceived SGD risks (−0.80), inferring that increasing conservatism led to decreased perceptions of SGD risks. Additionally, increased perceived risks of SGD had a strong, negative relationship with support for SGD on both public (−0.43) and private lands (−0.51). Political ideology also had a strong, positive relationship with support for SGD on both public (0.46) and private lands (0.41). Lastly, bootstrapping with bias-corrected confidence intervals (95%) was used to further assess the indirect effects of political ideology on support for SGD on public and private lands as mediated by perceived SGD risks. A significant and strong indirect effect was found between political ideology and the support of SGD on both public lands (0.34) and private lands (0.41) [56]. Thus, the perceived risks of SGD partially mediated the relationship between political ideology and support for SGD on both public and private lands.

4.3. Bivariate analysis by political ideology

A series of one-way analyses of variance (ANOVA) were performed to further explore the influence of political ideology amongst the sample (Table 4). For data segmentation purposes, the single-item political ideology scale was recoded within these bivariate analyses to reflect the three most commonly referenced political ideologies in the United States: 1) liberals, 2) moderates, and 3) conservatives [67–69]. Within this recode, a response of 1–2 represented a 'liberal' political ideology, a response of 3–5 represented a 'moderate' political ideology, and responses of 6–7 represented a 'conservative' political ideology.

ANOVA results found significant differences by political ideology in support for SGD on public and private lands in Pennsylvania. Those identifying as conservative averaged significantly higher mean scores for support of SGD on both public lands ($M_{conservative}$ = 6.36; $M_{moderate}$ = 2.95; $M_{liberal}$ = 1.07) and private lands ($M_{conservative}$ = 6.88; $M_{moderate}$ = 3.85; $M_{liberal}$ = 1.37) in Pennsylvania than those identifying as moderate or liberal (Table 4). Study results also suggested significant differences by political ideology regarding the perceived risks of SGD in Pennsylvania State Forests ($M_{conservative}$ = 1.47; $M_{moderate}$ = 3.83 $M_{liberal}$ = 6.26). Results of a Scheffe's post-hoc analyses determined further significant differences between both liberals, moderates, and conservatives. Within each of these analyses, a similar statistical trend prevailed. Those identifying themselves as conservative were significantly more likely than their moderate and liberal counterparts to support SGD on both public and private lands in Pennsylvania and perceive fewer risks from SGD on Pennsylvania State Forests.

5. Discussion

SGD has rapidly expanded in the United States for various

Table 4
One-Way Analysis of Variance Comparing Political Ideology to Perceptions of SGD

Variable	Liberal mean (*SD*)	Moderate mean (*SD*)	Conservative mean (*SD*)	*F* value[a]
Support SGD on PA public lands[b]	1.07^1 (0.31)	2.95^2 (2.08)	6.36^3 (1.23)	154.75
Support SGD on PA private lands[c]	1.31^1 (0.81)	3.85^2 (2.25)	6.88^3 (0.32)	163.98
Risks of SGD on PA State Forests[d]	6.26^1 (1.11)	3.83^2 (1.83)	1.47^3 (0.89)	150.35

Note. For Liberal respondents: n = 59, For Moderate respondents: n = 254, For Conservative respondents: n = 76.
[a] Note: All relationships were significant at $p < .001$.
[b] Note. Support for SGD on PA public lands (1 = strongly oppose, 7 = strongly support).
[c] Note. Support for SGD on PA private lands (1 = strongly oppose, 7 = strongly support).
[d] Note. Risks of SGD on PA State Forest lands (1 = completely disagree, 7 = completely agree).

technological, economic, and geopolitical reasons, with production expected to more than double by 2050 [7]. This study examined the influence of political ideology and perceptions of benefits and risks upon State Forest recreationists' support and opposition towards SGD on public and private lands in Pennsylvania. The predominantly local, educated, experienced, and politically moderate sample in this study exhibited low levels of support towards SGD on public lands and relatively neutral stances towards support for SGD on private lands in Pennsylvania. Moreover, respondents perceived limited benefits and limited risks towards SGD on Pennsylvania State Forests. For instance, respondents identified specific recreation and community risks such as resident and visitor displacement, infrastructure degradation, and economic harm; all of which may ultimately affect the overall recreation experience within Pennsylvania public lands.

This study found that political ideology and the perceived risks of SGD had a significant influence upon support for SGD on both public and private lands in Pennsylvania. The perceived risks of SGD also partially mediated the relationship between political ideology and support for SGD. While these notions have been suggested in the literature, to our knowledge, no research has attempted to empirically validate these concepts amongst an outdoor recreation population. More importantly, this study found that political ideology was a stronger predictor of support for SGD on public lands as opposed to the perceived risks of SGD. Said another way, while perceptions of risks were important, they were not as robust as political ideology in the prediction of support for SGD on public lands. These findings further contribute to the literature emphasizing both the individual and combined importance of including political ideology in energy development research [18,23].

From a theoretical standpoint, parallels were drawn between study finding and the theory of landscape fit and construal level theory. To be clear, this study did not test specific theories or hypotheses, but sought to understand the ways in which various factors operated. For instance, study findings offered insights for construal level theory. In cases of abstract construal, individuals may fall back upon broad ideological dispositions, such as political ideology, when gauging support [23,41]. Study findings suggested the political polarization of respondents was influential in shaping overall perceptions of support towards SGD. Conservative respondents were more supportive of SGD and less likely to perceive risks. These finding lend themselves to conservative foundations related to economic freedom, free market enterprise, and minimal regulation [23,25,33,35]. Liberal respondents were less supportive of SGD and more likely to perceive risks. These finding resonate with liberal principles related to environmental justice and regulation [23,25,33,35]. Moreover, political ideology superseded perceptions of risk in this study, when predicting support for SGD on public lands [30,31,47]. Thus, the support and opposition of SGD, a relatively abstract and unfamiliar technology, may lend itself more readily to broad ideological influences such as political ideology.

Study findings also shed light on the theory of landscape fit and suggested State Forest recreationists may not have perceived the 'fit' of SGD amongst their community and landscape [17,19,20]. Many of the perceived risks of SGD often stem from a lack of 'fit' between energy development and an individual's perception of both the landscape and community [17,19,54]. The respondents in this study may have perceived not only recreation related risks, but also the broader landscape and community risks of SGD upon the area. When assessing support and opposition for SGD, State Forest recreationists may have perceived a disruption to their recreation experience rather than an enhancement. These findings support the literature as outdoor recreationists often oppose industrialization and energy development within otherwise natural outdoor recreation settings [17,19–21,51].

This study also informed natural resource management and policy. SGD, politics, and outdoor recreation have been intimately intertwined throughout Pennsylvania's history. While the boom and bust legacy of resource extraction continues to play out in Pennsylvania, the outdoor recreation industry has quietly positioned itself as an increasingly critical component of the state's economy. For instance, in 2017 the Pennsylvania outdoor recreation economy generated $29.1 billion in annual consumer spending, $1.9 billion in state and local tax revenue, and employed more than three times as many individuals in Pennsylvania as the SGD industry [10,11]. Many rural Pennsylvania economies proximate to SGD have grown dependent upon the outdoor recreation economy and SGD may negatively affect the scale and volume of visitors to these areas [18,51].

This tension between traditional extractive industries and emerging rural recreation economies presents a unique scenario for natural resource managers who are challenged to manage Pennsylvania public lands under a complex multiple use land management framework that provides simultaneous opportunities for outdoor recreation and SGD [8]. Resource managers and industry representatives should consider prioritizing strategies to accurately monitor and communicate the risks and benefits of SGD within Pennsylvania public lands. The goal of these strategies could be to increase the transparency of policies and information within the SGD process and collaboratively mitigate impacts between resource managers, recreationists, and the SGD industry. These strategies could aim to inform recreation stakeholders of the benefits and risks of SGD and provide individuals the opportunity to construe SGD in a more concrete and detailed manner, lessening their reliance upon political ideology, and ultimately fostering well informed and accurate decision making.

Implications for future research include examining the recreation impacts of SGD across multi-item constructs, refining the measurement of perceived risks and benefits, segmenting State Forest recreationists, investigating the influence of demographic variables, and examining both cross-sectional and longitudinal population samples. This study employed two separate single-item indicators to measure State Forest recreationists' overall support and opposition toward SGD on both private and public lands. These single-item indicators were successful, but future research should consider including other multi-item support and opposition measures with various unidirectional scaling along with these variables in an effort to corroborate study findings. Another study limitation was the measurement model developed in this research. The fact that numerous variables were removed when developing the scales in the SEM/CFA indicates there needs to be a refinement in the measurement of perceived benefits and risks. Additional variables could also be explanatory among the relationships explored in this research, and future research should work to expand and refine study measures. While the focus of the study was to assess State Forest recreationists, there is merit in examining differential effects for specific outdoor recreation activities. Future studies should consider segmenting and analyzing recreationists by public land classifications (e.g., State Forests, State Parks, Game Lands), by well-defined activity types, and consider the direct and indirect effects of demographic variables (e.g., gender and education). These segmentations and analyses could aid in further understanding support and opposition for SGD amongst both broad and specific user segments. It should be noted that initial analyses of these data tested for these interactions (e.g., activity type and demographics) but found no significant relationships. Further, given the study sample was over-represented by college educated individuals, compared to the national population, study findings should not be generalized. Future research should also consider assessing SGD projects throughout the various stages of development (e.g., proposal, construction, operation, reclamation). Finally, researchers must also recognize that State Forest recreationists are not the only relevant stakeholders within the SGD domain. This cross-sectional study approach was cost- and time-effective and successful in validating the underlying assumptions of this research. However, the cross-sectional study design did not determine cause and effect and was not used to analyze behavior over time. Future research should assess not only cross-sectional recreation populations within an area, but also longitudinally assess recreation and general population samples within the

surrounding area(s) for comparative purposes.

6. Conclusion

The results of this study suggested relatively low support for SGD on Pennsylvania public lands among State Forest recreationists. However, when integrating political ideology, study results found that State Forest recreationists identifying themselves as conservative were significantly more likely than their moderate and liberal counterparts to support SGD on Pennsylvania public lands. Political ideology proved to be a robust variable in the study and surpassed perceived risk when predicting support for SGD on Pennsylvania public lands. Recognizing that outdoor recreation is an increasingly critical component of the Pennsylvania economy, lawmakers, natural resource managers, and the SGD industry should consider recreationists as a legitimate, vocal, and politically charged stakeholder within the SGD process. From a policy perspective, each development phase of SGD in Pennsylvania (e.g., proposal, construction, operation, reclamation) warrants particular input from this important constituency. This is especially true as SGD companies attempt to gain public support. Engagement and communication with recreation stakeholders will be critical to the continued success of SGD in the United States. When understanding support and opposition for SGD, this study demonstrated the importance of understanding State Forest recreationists' political ideologies in addition to their perceptions of benefits and risks. This study corroborated previous energy research and highlighted the importance of considering and assessing outdoor recreation stakeholder perceptions and subsequent opinions when planning, developing, and managing SGD and related policy in the United States.

Declaration of Competing Interest

None.

Acknowledgments

All study design, data collection, analyses, interpretation, and decisions to submit this article for publication were made by The University of New Hampshire Department of Recreation Management and Policy and The Pennsylvania State University Department of Recreation, Parks, and Tourism Management. Funding for this research was supported by the Pennsylvania Department of Conservation and Natural Resources (Grant no. 4400015622). The cooperation provided by the Pennsylvania Department of Conservation and Natural Resources as well as the outdoor recreationists within Pennsylvania's State Forests were instrumental in the successful completion of this research.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.erss.2019.101384.

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