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**CHANGES IN RESIDENTS' VIEWS OF NATURAL GAS DRILLING
IN THE PENNSYLVANIA MARCELLUS SHALE, 2009-2012***

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ABSTRACT

Data from comparable surveys of residents in the Marcellus Shale region of Pennsylvania conducted in 2009 and 2012 are analyzed to ascertain changes in public views over time. The proportions of residents indicating they knew very little or nothing about the economic, social, and environmental impacts of gas drilling declined sharply. Further, residents increasingly formed opinions about the possible costs and benefits of developing the industry and whether they opposed or supported developing the gas industry. The proportions of respondents expressing various concerns about possible negative environmental impacts of drilling increased. However, most residents supported developing the industry and there was little change in that support over the survey period.

Rapid expansion of the natural gas industry in the Marcellus Shale region has brought change and controversy to numerous communities in Pennsylvania. Many regions affected are rural areas long beset by high unemployment, low wages, and declining populations. Such areas are precisely the places where gas-related development offers the promise of economic growth, job creation, and increased business opportunities (Ercolino 2013; Van Ryan 2010). However, optimism over these positive outcomes has been at least partially offset by heightened concerns over the possible negative social, economic, and environmental consequences associated with such development (Brasier et al. 2011; Kargbo, Wilhelm, and Campbell 2010).

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Media coverage, political activity, and public discourse both supporting and criticizing the industry have been widespread. Responding to these conflicting pressures, the Pennsylvania state government's official position has vacillated across time, from unequivocal support for industry development to reservations, selective monitoring, and the implementation of modest industrial impact fees (Adams, Weiss, and Wilkinson 2012). It is also possible that views of the general citizenry have changed as new experiences and evolving information became available. Documentation of the type and extent of such change is important both to policy makers responding to the concerns of their constituents and scholars interested in understanding the nature of stability and change in public opinion.

PREVIOUS RESEARCH

Studies spanning more than three decades have compared communities (usually two to four in number) at differing stages of industrial development to understand the nature of community change associated with rapid energy development (Albrecht 1978; Anderson and Theodori 2009; Brasier et al. 2011; Cortese and Jones 1977; Theodori 2009, 2013; Wilkinson et al. 1982). Such cross-sectional studies can be misleading, however, because effects of differing settings are confounded with different stages of development. Several longitudinal studies have analyzed how residents' responses change across time, but they have dealt with community satisfaction and patterns of social interactions rather than residents' positive or negative views of the industry itself (Brown, Dorius, and Krannich 2005; Brown, Geertsen, and Krannich 1989; Krannich and Luloff 2002; Smith, Krannich, and Hunter 2001). Moreover, the extent to which findings from these studies can be generalized to other locales and/or other times remains problematic. Indeed, one conclusion arising from comparative analysis is that impacts and community responses vary widely across different settings (Brasier et al. 2011; Jacquet 2009).

PURPOSE OF THIS ANALYSIS

The purpose of this analysis was to assess changes that occurred in the views of residents concerning natural gas development in Pennsylvania's Marcellus Shale region during a period of rapid growth. Although production at the first Pennsylvania Marcellus well began in 2005, growth of the industry remained slow for several years, with 11 wells statewide in 2006, 34 in 2007, 210 in 2008, and 768 in 2009 (Pifer 2011). Through the end of June 2012, the number of unconventional wells had increased to just more than 5,600 (DEP 2013). During that period, popular awareness of the developing industry and its potential impact also

expanded. Public meetings, informal interactions among citizens, and the media presented both glowing descriptions of increasing economic prosperity and frightening reports of environmental degradation. This study describes changes in public attitudes and support for/opposition to the industry that occurred among residents in the Marcellus Shale region during the three-year period between 2009 and 2012.

DATA

Comparable data dealing with public support for/opposition to and perceived benefits/threats of the natural gas industry were obtained from separate surveys of random samples of residents in the Pennsylvania Marcellus Shale area in 2009 and 2012. Study counties were located in the Central Core and Tier 1 of the Marcellus Shale area in terms of depth, thickness, porosity, thermal maturity, and silica content of the shale – all factors that contribute to the economics of the gas yield (Dell, Lockshin, and Gruber 2008). A total of 20 of the state's 67 counties were so defined. One additional county (Washington) was added because of the relatively high incidence of drilling that had occurred there by 2009. The sample counties stretched from the southwest to the northeast corner of the state.

In 2009, a sample of 4,496 cases was drawn at random from these 21 counties by a commercial sampling organization (GENESYS). Questionnaires, with a cover letter and postage-paid return envelope, were mailed to the addresses. Following a modified tailored design method (Dillman, Smyth, and Christian 2009), three subsequent mailings were used to increase the response rate. Of the total, 421 were vacant addresses and were returned as undeliverable. A total of 1,461 of the remaining 4,075 questionnaires were returned with usable data – a 36 percent response rate (Alter et al. 2010).

In 2012, residents in the same 21 counties were sampled for a survey that included a methodological experiment comparing responses to mail and telephone surveys (Theodori et al. 2013; Willits, Luloff, and Theodori 2013). The telephone survey was conducted from June 11, 2012, to August 30, 2012, using CATI software with repeated calls at various times of the day and days of week and callbacks to individuals who expressed interest in participating. Calls continued until 400 completed interviews were obtained. The overall completion rate was 27 percent. For the corresponding 2012 mail survey, 1,600 names and addresses of persons with listed telephone numbers were sampled. An initial mailing, including a cover letter and printed questionnaire, was sent to the sample members in July 2012, followed by three follow-up reminder letters with duplicate questionnaires

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over the next three months. A total of 95 questionnaires were returned as undeliverable. The first 400 replies received were included in the current analysis, resulting in an overall usable response rate of 27 percent.

The 2009 and 2012 surveys contained identical questions. Items included: whether respondents had leased land for natural gas development and whether drilling or pipeline development had actually taken place; whether they had attended a public meeting related to natural gas development; how much they felt they knew about the economic, social, and environmental impacts of gas drilling; how much “trust” they had in the natural gas industry; five Likert-type attitude items dealing with the benefits and/or consequences of development; and a summary question asking whether they were opposed to or supportive of natural gas extraction in the region (Table 1). Responses to these questions in the 2009 and 2012 surveys were compared to obtain information on changes in residents’ views across the three-year study period.

TABLE 1. ITEMS AND RESPONSE CATEGORIES FOR WHICH COMPARABLE DATA WERE AVAILABLE IN THE 2009 AND 2012 SAMPLES.

TOPICS AND ITEMS	RESPONSE CATEGORIES
Participated in activities related to natural gas:	0 = No
• leased land for natural gas development	1 = Yes
• has had drilling or pipeline development occur on land	
• attended a public meeting to get information or learn more about the drilling and production of natural gas	
Self-perceived knowledge of natural gas drilling:	0 = None or almost none
• economic impacts	1 = Very little
• social impacts	2 = Some but not much
• effects on natural environment	3 = A good bit
	4 = A great deal

TABLE 1. ITEMS AND RESPONSE CATEGORIES FOR WHICH COMPARABLE DATA WERE AVAILABLE IN THE 2009 AND 2012 SAMPLES. (*Continued*)

How much trust do you have in the natural gas industry?	0 = No trust 1 = Very little trust 2 = Some trust 3 = Great deal of trust
Attitudes about natural gas development	1 = Strongly disagree
• We already know enough about the potential impacts of natural gas extraction to move forward with development in the Marcellus Shale.	2 = Disagree
• All in all, the benefits of natural gas extraction from the Marcellus Shale will outweigh the costs.	3 = Neutral
• I worry that there will be some sort of catastrophic accident involving natural gas extraction in the Marcellus Shale.	4 = Agree
• Any negative impacts of natural gas extraction in the Marcellus Shale can be fixed.	5 = Strongly agree
• Development of natural gas in the Marcellus Shale will create long lasting environmental problems.	
Considering everything, how do you feel about natural gas extraction from the Marcellus Shale region?	1=Strongly support 2=Somewhat support 3=Neither oppose nor support 4=Somewhat oppose 5=Strongly oppose

ANALYSIS

Changes between the 2009 and 2012 survey responses to the three behavioral items (whether the respondent had leased land for drilling, whether drilling had occurred, and whether the person had attended a public meeting related to the natural gas industry) were assessed using logistic regression (Table 2). Following the social bases of environmental concern literature (Jones and Dunlap 1992; Klineberg, McKeever, and Rothenbach 1998; Van Liere and Dunlap 1980), as well as recent research on natural gas development (Jacquet 2012; Kriesky et al. 2013), four control factors (age, education, gender, and income) were included. Moreover, previous analysis of the 2012 data found differences between responses to the

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TABLE 2. LOGISTIC REGRESSIONS TESTING THE RELATIONSHIPS OF YEAR OF SURVEY (0 = 2009, 1 = 2012) TO WHETHER RESPONDENT LEASED LAND FOR DRILLING, WHETHER DRILLING OCCURRED, AND WHETHER HE/SHE HAD ATTENDED A MEETING RELATED TO NATURAL GAS DEVELOPMENT, ADJUSTING FOR RESPONDENTS' GENDER, AGE, EDUCATION, INCOME, AND MODE OF DATA COLLECTION.

ACTIVITIES RELATED TO NATURAL GAS ^a	B	ODDS	
		RATIO	P-VALUE
Have you leased land for natural gas development?.....	.31	1.36	.088
Has drilling or pipeline development occurred on your land?.....	2.52	12.48	.000
Have you attended a public meeting to get information or learn more about the drilling and production of natural gas?.....	.38	1.46	.025

NOTE: ^aResponse categories were coded 0 = No, 1 = Yes.

telephone and mail surveys; as a result, mode of data collection (telephone vs. mail) was also incorporated as a control variable (Willits et al. 2013). Adjusting for differences between the two samples in terms of age, education, gender, income, and mode of data collection, the incidence of all three behaviors increased. However, the change in proportion of respondents reporting they had signed a lease was not statistically significant at the .05 level ($p = .088$), suggesting much of this activity had preceded the 2009 survey. The proportions of respondents reporting drilling activity increased by more than tenfold during this period. Attendance at public meetings also increased significantly, indicating greater information-seeking by the subjects as drilling increased.

Reported knowledge levels about the economic, social, and environmental impacts of natural gas drilling in 2009 were low, with 43 percent of the sample members reporting they knew very little or nothing about economic impacts, 46 percent reporting little knowledge about social impacts, and 39 percent saying they knew little or nothing about environmental impacts. In the 2012 sample, these figures were 23, 28, and 24 percent, respectively. Adjusting for differences in respondent characteristics and mode of data collection, scores measuring knowledge levels were significantly greater in 2012 than in 2009, with means of between “very little” and “some, but not much” in 2009 and between “some” and a “good bit” in 2012 (Table 3). The extent to which respondents expressed trust in the natural gas

TABLE 3. ADJUSTED MEAN SCORES RELATING YEAR OF SURVEY TO SELF-RATED KNOWLEDGE OF IMPACTS AND TRUST IN THE NATURAL GAS INDUSTRY, ADJUSTING FOR RESPONDENTS' AGE, EDUCATION, GENDER, INCOME, AND MODE OF DATA COLLECTION.

KNOWLEDGE AND TRUST ^a	YEAR		P-VALUE
	2009	2012	
How much do you know about the economic impacts of the natural gas industry?.....	1.79	2.27	.000
How much do you know about the social impacts of the natural gas industry?.....	1.70	2.18	.000
How much do you know about the environmental impacts of the natural gas industry?.....	1.96	2.24	.000
How much trust do you have in the natural gas industry?.....	1.59	1.64	.416

NOTE: ^aResponse categories for the three knowledge items were: 0 = none or almost none, 1 = very little, 2 = some, but not much, 3 = a good bit, and 4 = a great deal. Response categories for the trust item were: 0 = no trust, 1 = very little trust, 2 = some trust, 3 = great deal of trust.

industry did not change significantly between 2009 and 2012, with overall ratings between “very little” and “some” in both periods.

For each of the five items asking about respondents' attitudes concerning natural gas drilling, subjects expressed greater environmental concern in 2012 than in 2009. Four of these differences were statistically significant at the .001 level when the subjects' age, education, gender, income, and the mode of data collection were controlled (Table 4). Given these increases in expressed concern over the cost/benefit ratio of drilling, it was curious that when asked “Considering everything, how do you feel about natural gas extraction from the Marcellus Shale?” there was no measurable shift in overall response to this question.

It would, however, be premature to conclude that responses to the “support/opposition question” did not change between 2009 and 2012. This question (like the five Likert-type attitude items) presented five bipolar answer categories. That is, the knowledge and trust items each employed a unipolar scale in which the degree or extent of a single dimension was assessed. For the bipolar items, the first and last categories specified opposite positions, with a “neutral” or “neither” response in the middle. Previous analysis of the 2009 data found that the factors associated with failing to specify an opinion (i.e., choosing the middle category in a bipolar item) differed from those associated with choosing between the polar or directional positions (Willits et al. 2012). Based on this earlier work, the

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TABLE 4. ADJUSTED MEAN SCORES RELATING YEAR OF SURVEY TO RESPONDENTS' VIEWS ABOUT NATURAL GAS DEVELOPMENT, ADJUSTING FOR RESPONDENTS' AGE, EDUCATION, GENDER, INCOME, AND MODE OF DATA COLLECTION.

ATTITUDINAL ITEMS ^a	YEAR		P-VALUE
	2009	2012	
We already know enough about the potential impacts of natural gas extraction to move forward with development in the Marcellus Shale.....	3.11	2.77	.000
All in all, the benefits of natural gas extraction from the Marcellus Shale will outweigh to costs.....	3.22	3.00	.000
I worry that there will be some sort of catastrophic accident involving natural gas extraction in the Marcellus Shale..	2.86	3.19	.000
Any negative impacts of natural gas extraction in the Marcellus Shale can be fixed..	2.92	2.65	.000
Development of natural gas in the Marcellus Shale will create long lasting environmental problems..	3.00	3.09	.141
Considering everything, how do you feel about natural gas extraction from the Marcellus Shale region?.	2.53	2.52	.903

NOTE: ^aResponse categories for the five attitudinal items were: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Response categories for the opposition/support item were: 1 = strongly support, 2 = support, 3 = neither oppose nor support, 4 = oppose, and 5 = strongly oppose.

data were recast for this item (and the other bipolar items) to address two separate questions:

- Did respondents in the two periods (2009 and 2012) differ in the extent to which they chose a directional response (oppose/support, or agree/disagree); rather than the middle, neutral, or neither category?
- Of those who gave an opinion (i.e., who did *not* choose the middle category), did respondents in 2009 differ from those in 2012 in terms of the directional position they chose?

To address the first of these questions, responses to each of the five attitude items and the “support/opposition item” were divided into two categories: “no

opinion specified" (i.e., respondent chose the middle response category, coded "1") or "opinion reported" (any other response, all coded "0"). Binary logistic regression was used to ascertain whether the 2009 sample (coded "0") differed from the 2012 sample (coded "1") with respect to the incidence of reporting no opinion. As in the previous analyses, age, education, gender, income, and data collection mode were statistically controlled to focus on the difference between the two times *per se* (Table 5).

Respondents in the 2012 sample were significantly less likely than those surveyed in 2009 to have "neutral" responses to each of the five attitude items. Similarly, the incidence of "neither oppose nor support" answers declined significantly during the period in response to the question dealing with feelings of support or opposition concerning natural gas extraction in the Marcellus Shale region.

To address the second question, respondents with "no opinion" (i.e., those answering the middle category) were excluded before analyses. Logistic regression was again used to assess differences between the two survey years in terms of the incidence of agree/strongly agree responses (coded 1) and disagree/strongly disagree answers (coded 0). A similar analysis focusing on responses to the "support/opposition" question was carried out with "support/strongly support" coded 0 and "oppose/strongly oppose" coded 1 (Table 6).

Among respondents who expressed an opinion, those answering in 2012 were more likely to express concerns about environmental issues than those in 2009. Thus, the 2012 respondents were significantly more likely than those participating in the 2009 survey to *disagree* that "we know enough to proceed," "benefits outweigh costs," and "negative impacts can be fixed." Concomitantly, they were more likely to *agree* that they "worry about a catastrophic accident involving natural gas" than were those subjects in the 2009 survey. Although the difference did not reach statistical significance at the .05 level ($p = .065$), among those who did express an opinion, the proportion who opposed (or strongly opposed) drilling was slightly greater in 2012 than in 2009.

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TABLE 5. LOGISTIC REGRESSIONS TESTING THE RELATIONSHIPS OF YEAR OF SURVEY (0 = 2009, 1 = 2012) TO WHETHER RESPONDENTS DID OR DID NOT SPECIFY AN OPINION FOR THE OPPOSE/SUPPORT ITEM AND FOR FIVE ATTITUDE QUESTIONS, ADJUSTING FOR AGE, EDUCATION, GENDER, INCOME, AND MODE OF DATA COLLECTION.^a

ITEMS	AN OPINION VS. NO OPINION (0 = RESPONSES 1,2,4,5) VS. (1 = RESPONSE 3)		
	B	ODDS RATIO	P-VALUE
We already know enough about the potential impacts of natural gas extraction to move forward with development of the Marcellus Shale.	-.83	.43	.000
All in all, the benefits of natural gas extraction from the Marcellus Shale will outweigh the costs.	-.51	.60	.000
I worry that there will be some sort of catastrophic accident involving natural gas extraction in the Marcellus Shale.	-.47	.63	.001
Any negative impacts of natural gas extraction in the Marcellus Shale can be fixed.	-.65	.52	.000
Development of natural gas in the Marcellus Shale will create long lasting environmental problems.	-.60	.55	.000
Considering everything, how do you feel about natural gas extraction in the Marcellus Shale Region?.	-.91	.40	.000

NOTE: ^aResponses for the five attitudinal items were: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Responses for the opposition/support item were: 1 = strongly support, 2 = support, 3 = neither oppose nor support, 4 = oppose, 5 = strongly oppose.

TABLE 6. LOGISTIC REGRESSION TESTING THE RELATIONSHIP OF YEAR OF SURVEY (0 = 2009, 1 = 2012) TO THE SPECIFIED OPINIONS FOR THE OPPOSE/SUPPORT ITEM AND FIVE ATTITUDE QUESTIONS, ADJUSTING FOR AGE, EDUCATION, GENDER, INCOME, AND MODE OF DATA COLLECTION.^a

ITEMS	SPECIFIED OPINION (0 = RESPONSES 1,2) VS. (1 = RESPONSES 4,5)		
	B	ODDS RATIO	P-VALUE
We already know enough about the potential impacts of natural gas extraction to move forward with development of the Marcellus Shale.	-.77	.46	.000
All in all, the benefits of natural gas extraction from the Marcellus Shale will outweigh the costs.	-.55	.58	.000
I worry that there will be some sort of catastrophic accident involving natural gas extraction in the Marcellus Shale.71	2.04	.000
Any negative impacts of natural gas extraction in the Marcellus Shale can be fixed.	-.51	.60	.002
Development of natural gas in the Marcellus Shale will create long lasting environmental problems.28	1.32	.082
Considering everything, how do you feel about natural gas extraction in the Marcellus Shale Region?.29	1.34	.065

NOTE: ^aResponses for the five attitudinal items were 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. Responses for the opposition/support item were: 1 = strongly support, 2 = support, 3 = neither oppose nor support, 4 = oppose, and 5 = strongly oppose.

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CONCLUSIONS

Despite the relatively small period between the two surveys, some rather substantive and significant changes emerged. The most obvious changes in public response to Marcellus Shale drilling over the three years of this study were the increases in the extent to which residents felt they had at least some knowledge concerning the economic, social, and environment impacts of drilling. Given media coverage, political posturing, and formal and informal discussions surrounding these issues, such increases were not surprising. Moreover, concurrent with the increase in perceived knowledge, respondents in 2012 were less likely than 2009 respondents to report they were undecided or neutral with respect to the environmental costs associated with drilling and more likely to have an opinion regarding their opposition to/support for natural gas development. Further, respondents in 2012 who offered an opinion were significantly more likely than those in 2009 to express concerns about environmental issues. Although failing to reach statistical significance at the .05 level, the results also suggested that the 2012 respondents indicated greater opposition to Marcellus Shale drilling. However, in each time, support for drilling was more widespread than was opposition; more than 70 percent of residents with an opinion expressed support for developing the industry, whereas fewer than 30 percent reported opposition. Moreover, from a methodological perspective, it was noteworthy that scoring the bipolar response categories on a single continuum from 1 to 5 failed to highlight the most substantive change – the decline across time in the likelihood of residents having no opinion or being neutral concerning these issues.

That these changes occurred and were documented in such a short time indicate, at a minimum, social scientists need to begin paying more attention to change analyses. In the natural resource arena, researchers have too often focused on timely but narrowly defined cross-sectional studies. If we are to be relevant and capable of participating in important natural resource policy decisions, we must begin a systematic effort to monitor the patterns of our studies *over time*. Shale-related drilling studies provide one ideal opportunity for such efforts.

AUTHOR BIOGRAPHIES

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