LETTER FROM THE GUEST EDITORS

Hydrofracturing Special Issue of *Environmental Practice*

Development of unconventional natural gas reserves has been made possible by the combination of hydraulic fracturing (or hydrofracturing) and horizontal drilling technologies and has expanded at a feverish pace over the last several years in the United States (US) and around the world. *Hydrofracturing* involves injecting large volumes of fluid, including water, chemicals, and proppant, under high pressure into a deep geologic formation to open fissures that then allow natural gas to flow up the wellbore. Technically recoverable shale gas reserves are estimated to exceed 600 trillion cubic feet (tcf) in the US (US Department of Energy, 2009), and, given the increasing demand for domestic energy production, the extraction of unconventional shale plays will continue to expand and intensify. Research on the environmental and human-community impacts of unconventional shale gas development are beginning to emerge, and this special issue of *Environmental Practice* contributes to that growing body of knowledge.

In this special issue, we cover a variety of topics that fit into four general themes related to our current understanding of unconventional gas development: environmental impacts, waste materials, human community impacts, and management strategies. Two articles outline the potential environmental impacts. Clark et al. (2012) provide a general overview of the technology and policies involved in hydraulic fracturing and the potential consequences of shale gas development on air and water resources. Gillen and Kiviat (2012) offer a focused look at 15 species concentrated in the Marcellus and Utica Shales, assess their vulnerability to impacts of shale gas development, and highlight the need for more research to guide targeted management of these species.

Two articles focus on waste materials produced by shale gas extraction in Pennsylvania. Using data available from the Pennsylvania Department of Environmental Protection (PA DEP), Maloney and Yoxtheimer (2012) characterize waste-material disposal methods in Pennsylvania and analyze the frequency with which they are transported across state lines and major watersheds. In a more targeted look at the same PA DEP data sets, Wilson and VanBriesen (2012) examine how management decisions about *produced water* (water that flows to the surface over the life of a well) may have important implications for drinking-water sources.

Five articles in this volume explore changes experienced by human communities as a result of unconventional gas development. Perry (2012) presents a framework for addressing the societal costs associated with unconventional gas development by weighing aspects of risk and uncertainty using the US Environmental Protection Agency's study of hydraulic fracturing as a case study. Stedman et al. (2012) contribute to a new generation of boomtown research by surveying residents of northern Pennsylvania (where Marcellus Shale gas extraction has burgeoned) and southern New York (where a moratorium is in place) on their knowledge, attitudes, and perceived impacts of shale gas development. The authors found that residents' perspectives in the two sites diverged and converged in unexpected ways and suggest the need for increased information distribution to enhance residents' knowledge. One emerging tool for distributing information to the public is a participatory geographic information system (PGIS) that combines the accessibility of the World Wide Web with spatial information found in a GIS. Malone et al. (2012) assessed the utility and usability of FracTracker, a PGIS designed to inform the public about unconventional natural gas development.

Socioeconomic effects of gas development on local communities, such as issues related to housing, are beginning to receive more attention in the literature. In this special issue, Kolb and Williamson (2012) examine the connections among gas development, housing needs, and provisions of water and sewer infrastructure through case studies of two water and sewer providers in Lycoming County, Pennsylvania. Gehman et al. (2012) estimate the financial consequences to the Commonwealth of Pennsylvania and local communities resulting from underreporting of unconventional gas wells by the PA DEP under Pennsylvania's Act 13 of 2012.

Three articles in this special issue address potential management strategies for avoiding and minimizing environmental impacts from unconventional gas development. Exploring ways to reduce impacts to freshwater resources, Yoxtheimer, Blumsack, and Murphy (2012) describe a novel approach to a multifaceted issue, weighing the opportunities and challenges of using acidic mine drainage from former coal mines for hydraulic fracturing operations in the Appalachian Basin. Smith et al. (2012) examine best management practices (BMPs) at the watershed scale and propose a decision analysis approach to formulate BMPs and minimize impacts to sensitive species, such as the brook trout.

To better understand the integrity of BMPs, we and our colleagues at The Nature Conservancy conducted a scientific assessment of habitat and wildlife BMPs for shale gas development in the Appalachian Basin (Bearer et al., 2012). By combining over 400 existing BMPs with an extensive database of relevant scientific literature, we evaluate the scientific foundation of each BMP, identify research needs, and provide unconventional gas developers with information on practices that exceed regulatory requirements and reduce surface environmental impacts.

This volume closes with a Perspective from the Field piece by researchers and land managers at Pennsylvania State University, the US Forest Service, and the Pennsylvania Department of Conservation and Natural Resources (Drohan et al., 2012). They summarize research results and management

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recommendations presented at the 2012 Goddard Forum at Pennsylvania State University.

This special issue contributes to our understanding of the environmental, social, and political aspects of hydrofracturing, and we hope that it stimulates further discussion and research on the complex challenge of balancing environmental and human community needs with those of energy resource extraction around the globe.

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