Proposal #16-1

2016 NERA Planning Grants Program

Project Title: Planning for the Future: Ensuring Clean Water on Working Farms and Landscapes Subject to Climate Change and Natural Gas Development Perturbations

Team Members

Name	Discipline	Institution
James T. Anderson, Ph.D.	**Division of Forestry and Natural Resources** (Wetlands, Wildlife)	West Virginia University
Patrick Drohan, Ph.D.	**Department of Ecosystem Science and Management** (Pedology, Ecosystem Change)	Penn State University
Heather Gall, Ph.D.	**Department of Agricultural and Biological Engineering** (Ecosystem Science and Management (Contaminant Transport, Hydrology)	Penn State University
Magdeline Laba, Ph.D.	**Soil and Crop Sciences Section** (GIS, Remote Sensing, Climate Change)	Cornell University
Christopher M. Lituma, Ph.D.	**Division of Forestry and Natural Resources** (Avian Ecology, Grasslands)	West Virginia University
Jiuzhou "John" Song, Ph.D.	**Department of Animal and Avian Sciences** (Molecular Biology, Genetics)	University of Maryland

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Background

The northeastern U.S. is home to a diversity of forest systems and agricultural enterprises. Indeed, there are over 180,000 farms resulting in over $17 billion in annual sales (1). Agriculture, forest products and commercial fishing for 8 Northeast states provides $103 billion in economic activity (2). This diversity in commodities lends itself to great potential for adaptations and alternatives for farmers and forest owners, but also presents a number of management challenges for achieving sustainable forest and agricultural practices in relation to climate change and gas exploration.

Mean global air temperature has increased 0.74°C from 1906–2008 (3). In the Northeast temperature change has been greater, with an increase of 1.1°C from 1895–2011(4). From 1895–1997 mean temperature for the Mid-Atlantic Region (MAR) increased by 0.5°C (4). Future temperature projections vary based on global carbon emissions, but range from 1–5°C by 2100 (4–6). The freeze-free season is estimated to lengthen by ≥19 days by 2050, with increases of 3–4 weeks in many areas (8). From 1895–2011, precipitation increased by >10% (13 cm) for the Northeast (4). The occurrence of high intensity rainfall increased over the past 100 years and the Northeast has experienced a greater increase in extreme precipitation events than any other U.S. region from 1958–2010 (4,7). Future precipitation predictions are less certain than for temperature, but the frequency of heavy precipitation events is predicted to increase over the next 100 years (9).

Global demands for alternative and cleaner energy sources to mitigate climate change and carbon emissions continue to grow. Natural gas accounts for 24% of the global energy, but this is expected to increase with the development of contemporary cost-effective hydraulic fracturing (fracking) technologies (10). In 2001, unconventional gas (shale gas horizontal drilling and fracking) in the U.S. accounted for 2% of total natural gas production and currently it accounts for >23% of gas production (11). Marcellus Shale gas reserves in MD, NY, PA, OH, VA, and WV comprise 59% of the total estimated unconventional (shale gas) reserves in the U.S. (12). In PA during 2015, there were an estimated 9,000 active unconventional gas wells, and 16,000 active gas well permits (13). By 2030, PA is projected to have 60,000 unconventional gas wells.

Unconventional gas exploration can provide an alternative energy source for oil and coal, but gas extraction, in particular fracking, is not exempt from environmental concerns. The hydraulic fracturing process involves high-pressure injection of water and chemicals (slick-water) into the coal seams to allow the shale gas to escape and be harvested (14). Though water comprises 90% of the fracking fluid, chemicals representing the remaining 10% are proprietary and company specific. Mercury, selenium, and benzene are known toxic and carcinogenic compounds included in fracking liquid, and post-fracking flowback fluid is highly saline. Chemical products in fracking operations from 2005–2009 used >2500 products comprised of 750 chemicals (14). In PA, fracking produces >6 billion liters of flowback fluid (15). The challenges facing both the fracking industry itself (operational issues) and the associated potential environmental impacts (contaminant transport) are exacerbated by increasing temperatures and frequencies of heavy rainfall events.

Mission and Goals

There is increased concern about how the U.S. can ensure an adequate food and fiber supply under current and predicted climate change scenarios. For example, increasing temperatures in the Northeast are predicted to reduce milk production in dairy cattle (16). Forest composition is expected to change and invasive species may become more prominent (16). Changes in wetland hydroperiods are expected, including some scrub-shrub wetlands losing their entire summer inundation period (7), causing devastating impacts to amphibians that rely on these late spring/early summer inundations for breeding and metamorphosis. Birds are expected to shift their

ranges northward in latitude and elevation, and could suffer reduced reproductive success and survival as a result of phenological food resource disruptions (17).

A critical need exists to understand the impacts of unconventional gas drilling on forest resources, food contamination, wildlife populations, water quality, and other natural processes. Contemporary research is qualitative, opportunistic, and comparative at best, though negative impacts of unconventional gas fracking have been documented for birds, fish, crayfish and other macroinvertebrates, livestock and humans (15,18–19).

In keeping with the mission of NERA Planning Grants to address high priority research needs and facilitate the transfer of new research-based knowledge to audiences we will engage a working group who will focus on the food–water–energy nexus, particularly water, by developing a series of proposals to address this complex interdisciplinary issue of food and fiber security, water quality, climate change resilience, and fracking (all of which are addressed in the APLU Roadmaps (20, 21)) to address the following broad goal addressing research, outreach, and extension:

> *Our goal is to create a climate resilience framework on farms and watersheds that will conserve, create, and maintain clean water; promote biodiversity; and ensure a safe food and fiber supply in a landscape with significant active gas extraction.*

Justification and Potential for Sustained Funding

We believe this line of inquiry will result in significant, sustainable funding opportunities for pursuing grant funding centered on our research and outreach goal. Examples of research avenues stemming from this goal may include: 1) designing optimal placement of wetlands or buffer strips for storing and cleaning water; 2) evaluating impacts of fracking effluent on organic agricultural production; 3) assessing bioaccumulation of toxins in native songbirds and amphibians; and 4) based on climate change statistics, determining which areas should be obtained to best conserve natural resources in the future. Results of these and other related research questions will be of value to landowners and farmers in the northeast as they struggle to adapt to changing climate and perturbations from unconventional gas fracking and have significant implications for policy and management.

In 2016, the Agriculture and Food Research Initiative (AFRI) Competitive Grants Program advertised requests for proposals (RFPs) on Climate Variability, Water, and even the Foundational Program that fit our overall goals. The National Science Foundation (NSF) has funded related work under several different divisions. The National Oceanic and Atmospheric Administration (NOAA) Climate Programs has several water and climate related RFPs that may be suitable. Additionally, foundations, such as the Robert Wood Johnson Foundation, have invested onto this arena in recent years and we will investigate funding from these entities. We expect similar RFPs during 2017 for fiscal year 2018, although we will likely need to make adjustments in our logic for the submitted proposals, but we will still adhere to our theme of water on working landscapes as influenced by climate change and gas development. AFRI's water for agriculture program indicates that in coming years the program may expand to address "…mitigation, and adaptation; research and technology development for evaluating and mitigating the effects of chemicals and pathogens of emerging concern in freshwater…related to U.S. agriculture…., and the ability to provide incentives for behavior change/adoption of water use/conservation practices". Our group will be well positioned to respond to these RFPs.

Activities

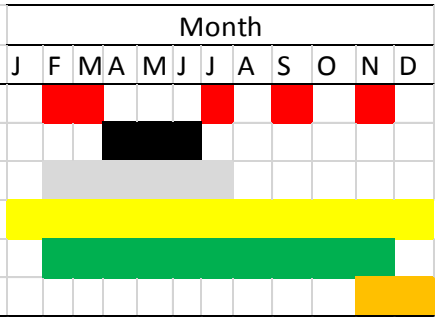
Activities will be standard practices that one would expect when working through a normal grant

submission process. We will meet to discuss ideas, recruit additional co-PIs and partners needed for specific grant applications, build and maintain an online shared library, search for RFPs, write proposals, and submit proposals to funding agencies. Our team will collaborate via regularly scheduled teleconferences and one multiple-day in-person meeting at a centralized location to solidify objectives and ideas for grant applications. We will enlist graduate and undergraduate student help for logistics and multistate proposal development. We will use Google Docs to share and edit proposals and Google Docs or Mendeley to house pdfs of articles. We will submit at least one $200K plus research and outreach application to AFRI or NSF for external funding during the grant period (and expect to submit several more during or after the 1-year grant period).

Roles of Team Members

Dr. Anderson will serve as the overall PI on the project and be responsible for scheduling meetings, ensuring that proposed activities and timelines are met, budgeting, and reporting. He will provide technical expertise on wetlands, wildlife, climate change and watersheds. Dr. Drohan will provide expertise on natural gas development, soil biogeochemistry, soil and water quality, climate change, and land use. Dr. Gall will provide expertise on environmental hydrology and contaminant fate and transport. Dr. Laba will provide expertise on geospatial modeling, wetlands, and agriculture/ environmental management. Dr. Lituma will organize the shared reference library and provide expertise on avian ecology, unconventional gas fracking, and statistics. Dr. Song will provide expertise on genetics, improving livestock performance, and reducing animal disease potential. All team members will search for grant opportunities, contribute to proposal writing, and participate in team-building activities. Several team members have successfully collaborated on past projects. Other researchers, from these or other institutions inside or outside the region, will be recruited as necessary as we identify specific missing expertise required for available RFPs.

Timetable



The overall project runs from 1 Jan 2017–31 Dec 2017, but we will modify the start date as needed to match the grant notification date.

Budget Item	Amount	Justification
Airfare	$500	One round-trip ticket for team member to meet with program manager.
Car Rental and Gas/Mileage	$2,500	Average cost of $100/day @2.5 days for 10 trips
Lodging	$3,000	$150 average per night @ 2 nights/person for 10 persons
Per Diem	$1,020	$51/day @ 1 full day and two partial days (2 total) for 10 people
Room Rental for Meeting	$300	$150 average per day @ 2 days
Refreshments	$200	Snacks and drinks for refreshments breaks during the meeting so team stays energized
Total Travel	$7,520	

Appendix I. CV of Team Leader

Dr. James T. Anderson, Certified Wildlife Biologist
Professor of Wildlife and Fisheries Resources
Davis-Michael Professor of Forestry and Natural Resources
West Virginia University, Morgantown, WV 26506
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I have over 15 years of experience in developing interdisciplinary teams to address complex natural resource topics. I recently lead a successful 3 institution $10 million NSF EPSCoR water grant application. I possess extensive experience in grant writing, budgeting, conducting research, publishing results and otherwise disseminating information, and implementing demonstration practices.

EDUCATION

University of Wisconsin-Stevens Point	B.S.	1991	Wildlife
Texas A&M University-Kingsville	M.S.	1994	Range and Wildlife Management,
Texas Tech University	Ph.D.	1997	Wildlife Science

PROFESSIONAL EMPLOYMENT

July 2015 – Present: **Professor of Wildlife Ecology and Management; Program Coordinator Wildlife & Fisheries Resources Program**. Davis College of Agriculture, Natural Resources, and Design, West Virginia University, Morgantown, West Virginia.

September 2012 – July 2015: **Professor of Wildlife Ecology and Management; Director Environmental Research Center; Program Coordinator Wildlife & Fisheries Resources Program.** Davis College of Agriculture, Natural Resources, and Design, West Virginia University, Morgantown, West Virginia.

August 2009 – September 2012: **Professor of Wildlife Ecology and Management; Director Environmental Research Center**. Davis College of Agriculture, Natural Resources, and Design, West Virginia University, Morgantown, West Virginia.

August 2007 – August 2009: **Associate Professor of Wildlife Ecology and Management and Associate Director Natural Resource Analysis Center.** Wildlife & Fisheries Resources Program, Division of Forestry and Natural Resources, West Virginia University, Morgantown, West Virginia

August 2004 – August 2009: **Associate Professor of Wildlife Ecology and Management.** Wildlife & Fisheries Resources Program, Division of Forestry, West Virginia University, Morgantown, WV.

January 1999 – July 2004: Assist. Professor of Wildlife Ecology and Management. Wildlife & Fisheries Resources Program, Division of Forestry, West Virginia University, Morgantown, WV.

August 1997 – December 1998. Instructor/Post-doc. Texas Tech University, Lubbock, TX.

TEACHING EXPERIENCE

- WMAN 100 The Tradition of Hunting, 3 CR
- WMAN 200 Restoration Ecology, 3 CR
- WMAN 250 Big Game Ecology and Management, 3 CR
- WMAN 260 Waterfowl Ecology, 3 CR
- WMAN 421 Renewable Resource Policy and Governance, 3 CR
- WMAN 547 Applied Wetlands Ecology and Management, 3 CR

HONORS AND AWARDS

- Distinguished Alumni Award, College of Ag. Sciences & Nat. Res. 2016. Texas Tech University.

- Outstanding Faculty Award for Excellence in Service 2015, Forestry and Natural Resources (WVU)
- Davis-Michael Professor, Davis College of Agriculture, Natural Resource and Design, WVU 2012-
- Outstanding Faculty Award 2011, West Virginia University Forestry Alumni Association
- Outstanding Researcher 2011, Division of Forestry and Natural Resources (WVU)
- Cruiser Dedication, Division of Forestry and Natural Resources, WVU 2009
- Davis-Michael Mid-Career Award, Davis College, WVU 2006-2010
- Outstanding Researcher 2003 Davis College of Agriculture, Forestry, and Consumer Sciences (WVU)
- Outstanding Researcher 2003 Division of Forestry (WVU)
- Hoyt Outstanding Professor 2002 Division of Forestry (WVU)
- Outstanding Researcher 2000 Division of Forestry (WVU)

SELECTED GRANTS RECEIVED (>$16 million total)

1. PI, Cacapon River Watershed Stream and Riparian Restoration Collaborative. National Fish and Wildlife Foundation $650,000.
2. PI, Development of an Environmental Center of Excellence for the Mid-Atlantic Highlands. National Oceanic and Atmospheric Administration $1,705,250.
3. PI, Pilot test the ecological approaches to environmental protection developed in capacity research projects CO6A and CO6B. National Academy of Sciences, $360,628.
4. PI, Creation and assessment of a wetland on the Pleasant Creek Wildlife Management Area. West Virginia Division of Natural Resources. $46,220.50
5. Co-PI. R11 Track 1: Gravitational wave astronomy and the Appalachian Freshwater Initiative (Waves of the future: Capacity building for the Rising Tide of STEM in West Virginia (EPSCOR). WV-HEPC-Div Science and Research. US National Science Foundation $1,943,548.
6. Co-PI, Stream monitoring study for Appalachian Corridor H, Elkins, West Virginia to Virginia State line. West Virginia Department of Transportation, Division of Highways. $1,164,104.

GRADUATE STUDENTS MENTORED OR TRAINED (Total Graduate Advisees as Chair = 34)

Graduated as Chair: 8 PhD, 26 MS Current Students as Chair; 5 PhD, 5 MS

SELECTED PUBLICATIONS (>130)

Anderson, J. T., and C. A. Davis, editors. 2013. Wetland Techniques. Volumes 1-3. Springer, New York, New York. 1,061pp.

Balcombe, C. K., **J. T. Anderson**, R. H. Fortney, and W. S. Kordek. 2005. Aquatic macroinvertebrate assemblages in mitigated and natural wetlands. Hydrobiologia 541:175-188.

Chen, Y., R. C. Viadero, Jr., X. Wei, L. B. Hedrick, S. A. Welsh, **J. T. Anderson**, and L. Lin. 2009. Effects of highway construction on stream water quality and macroinvertebrate condition in a Mid-Atlantic highlands watershed, USA. Journal of Environmental Quality 38:1672-1682.

Gingerich, R. T., and **J. T. Anderson**. 2011. Decomposition trends of five plant litter types in mitigated and reference wetlands in West Virginia, USA. Wetlands 31:653-662.

Pitchford, J. L., C, Wu, L. Lin, J. T. Petty, R. Thomas, W. E. Veselka, D. Welsch, N. Zegre, and **J. T. Anderson**. 2012. Climate change effects on hydrology and ecology of wetlands in the mid-Atlantic Highlands. Wetlands 32:21-33.

Appendix II. Literature Cited

1. USDA, 2009: United States Summary and State Data. In 2007 Census of Agriculture, Vol. 1, Geographic Area Series, Part 51. AC- 07-A-51., 739 pp., U.S. Department of Agriculture, Washington, D.C. Accessed 5 Aug 2016 http://www.agcensus.usda.gov/Publications/2007/Full_Report/usv1.pdf

2. Lopez, R., N. Plesha, B. Campbell, and C. Laughton. 2016. Northeast economic engine: Agriculture, Forest products, and commercial fishing. Second edition. Farm Credit East Report. Accessed 2 Aug 2016 https://issuu.com/farmcrediteast/docs/fce_econimpact_final/1

3. Bates B.C., Z.W. Kundzewicz, J. Palutikof J, S. Wu. 2008. Climate change and water. Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva. Accessed 5 Aug 2016 http://www.ipcc.ch/publications_and_data/publications_and_data_technical_papers.htm

4. Horton, R., G. Yohe, W. Easterling, R. Kates, M. Ruth, E. Sussman, A. Whelchel, D. Wolfe, and F. Lipschultz, 2014: Ch. 16: Northeast. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 16-1-nn. Accessed 2 Aug 2016 http://nca2014.globalchange.gov/report/regions/northeast

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8. National Oceanic and Atmospheric Administration (NOAA) 2013. Regional climate Trends and Scenarios for the U.S. National climate Assessment. Part 1. Climate of the Northeast U.S. NOAA Technical Report NESDIS 142-1. Accessed 3 Aug 2016 http://www.nesdis.noaa.gov/technical_reports/NOAA_NESDIS_Tech_Report_142-1-Climate_of_the_Northeast_U.S.pdf

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13. Penn State Marcellus Center for Outreach and Development. 2015. Map of issued permits for unconventional wells. Penn State University: University Park, PA. Accessed 4 Aug 2016 http://www.marcellus.psu.edu/resources/maps.php

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