Response to REQUEST FOR APPLICATIONS – February 2012
Appalachian Landscape Conservation Cooperative
Top Science Need #3. Forecast Resource Extraction

Primary Investigator: Joseph Kiesecker, Lead Scientist, The Nature Conservancy

Organization's Background/Purpose: The mission of The Nature Conservancy is to protect the lands and waters on which all live depends.

Brief description of qualifications and statement of past performance (do not exceed 250 words): Dr. Joseph Kiesecker is a Lead Scientist for The Nature Conservancy's Conservation Lands Team. In this capacity his main responsibilities include developing new tools, methods, and techniques that improve conservation. He pioneered the Conservancy's *Development by Design* strategy, to improve impact mitigation through the incorporation of predictive modeling to provide solutions that benefits conservation goals and development. He is in a leadership role on several *Development by Design* pilot projects including work in oil and gas fields and renewable energy sites in the United States, and regions of Colombia, Australia, and Mongolia where energy and mining exploration is advancing rapidly. He also conducts his own research in areas ranging from disease ecology, to the effectiveness of new conservation tools such as conservation easements.

Dr. Kiesecker's training is in ecology, conservation biology and animal behavior, with a Ph.D. from Oregon State University in 1997. He has held faculty appointments at Yale University, Penn State University and currently holds a faculty appointment at the University of Wyoming. He has been a Donnelly Fellow, and has received funding for his research from National Institutes of Health, the National Science Foundation, the IUCN and numerous private foundations. Kiesecker has published over 100 articles, on topics ranging from climate change to the effectiveness of conservation strategies; examples of his work have been published in Nature, Proceedings of the National Academy of Sciences, Conservation Biology, Ecology, and American Scientist.

Background and Context

Question #1. Describe any current program, initiative, or goal of your organization that this SOW would complement or contribute directly toward.

This SOW complements and expands a landscape-level mitigation planning approach called *Development by Design*, which is currently being advanced by the Nature Conservancy in the Central Appalachians and intermountain west of the United States, as well as in regions of Colombia and Mongolia *Development by Design* balances the needs of planned development — such as oil and gas, mining, and infrastructure — with those of nature conservation, with the goal that projects will have a net beneficial impact on nature. The approach supports decision-making on how best to avoid conflicts between project impacts and conservation priorities, maintain biodiversity, and determine effective and transparent mitigation responses for the development, including compensating conservation actions known as "biodiversity offsets."

The application of *Development by Design* is one conservation strategy currently being implemented by The Nature Conservancy's Central Appalachians Whole System Program team. The Central Appalachians Whole System Program focuses on protecting important species, habitats, and ecological services that sustain the viability of nature and human communities. Our goal is to work with partners to conserve a network of large, representative and connected conservation areas, across political borders and boundaries that have been identified to have the resiliency and adaptive capacity in the face of large scale threats like climate change and forest fragmentation.

Question #2. Further describe any pre-existing infrastructure, activities or accomplishments, training, staff expertise, etc. that demonstrate your organization's readiness to successfully implement this SOW.

The first step of our *Development by Design* approach in the Central Appalachians involves GIS modeling to predictively map the future spatial footprint of wind development, natural gas extraction, and surface coal mining. The Central Appalachians Whole System Energy Team is already developing predictive GIS layers of the footprint of wind energy and Marcellus Shale gas in the region, within the boundaries shown in Figure 1.

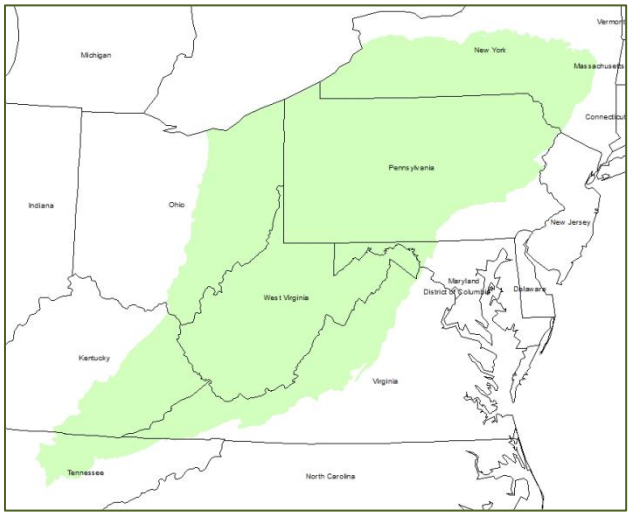

Figure 1: Boundary of Current Energy Analysis Project Area

We also plan to initiate coal mapping in partnership with a credible third party once resources are secured. We have a project team in place that is familiar with the region, has a proven track record of implementing a peer-reviewed modeling methodology, and we have strong working

relationships with industry leaders due to our long involvement in local conservation throughout the Appalachians, and our science based, solution-oriented approach.

Question #3. List potential partner(s) who might contribute expertise, other in-kind services or financial support to the activities under this SOW, and provide a Letter of Support from each partner(s) named. (Letters will not be viewed as an irrevocable commitment of resources or as formal match.)

We have attached formal letters of support from Triana Energy, Alpha Natural Resources, West Virginia University, and Audubon Pennsylvania.

Although we were unable to arrange for letters of support from all intended partners prior to submitting this proposal, we also intend to solicit ongoing peer review and feedback from an array of energy experts and potential end users, including - but not limited to - the USDA Forest Service, USEPA, the Appalachian Research Initiative for Environmental Science (ARIES) at Virginia Tech, and Dominion Energy.

Question #4. Describe your relationship to/with any key stakeholders (i.e. sponsors, participants, partners, host organizations, beneficiaries), including any stakeholder participation in the initial planning and development of this SOW. The Nature Conservancy routinely works with numerous federal and state agencies, NGO's and Universities throughout the Appalachian Region, and would expect to work closely in a variety of formal and informal capacities with all these partners in the implementation of this SOW.

Question #5. Describe how the completed project outcomes could be shared with the science community and other stakeholders at completion (e.g. tool deployed, training provided, outreach accomplished). As part of this project, the Conservancy is requesting funding to establish a basic web-based interface on which all data sets generated through this project would be made publicly available. Our explicit intention is to make the energy buildout scenaria available, as they are completed, to any individual or institution that would want to use them to estimate impacts to resources of importance to them.

In addition, the Conservancy would expect to publish this work in a peer reviewed journal.

Question #6. Are you aware of any impediments to the LCC's goal of accomplishing the project as described? The chief impediment to the full realization of this project will be availability of data. Specifically, we know that non-proprietary data availability on patterns of shale gas leases, severed ownership of gas and minerals on both private and public lands, coal resources, and indicators of Utica shale resources is extremely limited. The limitations on access to this data are universal and not unique to the Conservancy.

Some of the limitations on coal data are expected to be ameliorated within the next 2-3 years through OSM's Geomine project. TN, KY, WV, and VA are participating in this effort. We also expect additional data on Utica shale to become available within a similar timeframe.

Statement of Work (SOW) (***not to exceed 4 pages, line spacing at least 1.15***)

Title: Assessing Future Impacts of Energy Extraction in the Appalachian Mountains

Project Narrative: Here we propose to employ land use change build-out scenaria for future energy development demand to quantify future impacts on forest habitats across the Appalachian Landscape Conservation Cooperative. We propose to create maps of wind, oil and gas and coal development potential for the entire study area and then use these maps and published projections from federal and state land management agencies to model future build-out scenaria. We then propose to measure the impacts of the build-out scenaria on habitat fragmentation of forest resources, relating these impacts as a function of effects to biodiversity as well as effects to water production for human populations. Because a product of this type was not available, we propose to create a probabilistic classification model of energy resource potential to facilitate landscape-scale analysis. The predictive modeling will utilize a robust, non-parametric statistic called ensemble learning to estimate a probability surface of resource development potential. We will incorporate constraints (e.g., FAA distance to airport regulations) post hoc to modify our probability estimates. Thresholds of the probabilities will be used to generate various "intensities of development" in our scenario development. We will account for local regulatory frameworks when creating our development scenaria. Our projections will encompass a 25-year timespan. The analyses we propose here will complement our ongoing analysis within the Central Appalachians. Our Central Appalachians analysis focuses on wind and shale gas development. The requested funding will be used to expand our wind and shale gas modeling to the entirety of the Appalachians study area and allow funding to development similar models for potential coal development, something currently lacking in our ongoing study. Our analyses will be based upon available, appropriately scaled, credible geospatial data and relevant industry planning/development factors and assumptions. Similar projects undertaken in the US, Colombia, and Mongolia have included stakeholders from industry and government, and the output of these projects has been shared broadly, strategically, and transparently with industry, conservation organizations, and local, state, and federal agencies, and has been used to guide permitting and land use decisions. The results of ongoing analyses and the work completed under this proposal will be communicated, as they become available, to a comparable array of stakeholders in the Appalachians through a combination of in-person communications and web based mapping tools.

Important Background Information: The Central Appalachians are the energy resource hub of the eastern United States. Well known for the generations of families who have mined coal in the Appalachian Basin, the region has also historically yielded natural gas, and more recently coalbed methane. Now the region's long ridges offer seemingly ideal opportunities to provide wind energy to the heavily populated East coast, while miles beneath the surface formations of gas-rich shale laid down in deep anoxic waters around 400 million years ago are being tapped using hydraulic fracturing. The rapid pace of new energy development coupled with more aggressive methods for extracting traditional fuels pose substantial risks to some of our most cherished lands, waterways and wildlife. While these impacts have certainly not gone unnoticed, the focus of public concern has largely centered on water quality, with very little attention having yet been paid to the effect of energy development on the swaths of relatively intact, recovering forest habitat that define the Central Appalachian Region. In addition, each type of development is currently being considered within in its own regulatory sphere, with little or no assessment of cumulative impacts.

Given the magnitude of these issues, it is challenging to understand the scale and complexity of addressing environmental impacts from energy development. Without a cumulative picture of how all energy development forms will impact the environment, industry, policy makers, and consumers are limited in their ability to evaluate potential tradeoffs among energy choices, and develop strategies that optimize the balance between energy development and environmental quality. As the Appalachian landscape is are once again exposed to the threat of direct loss, degradation, and fragmentation from improperly located wind energy facilities, gas wells, and large area surface mines, the Conservancy is uniquely positioned to contribute to a necessary dialogue on balanced solutions by bringing its *Development by Design* approach to create a science-based characterization of the potential energy footprint of the Appalachians.

Goal/Purpose Statement: To bring scientific information to the dialogue on balancing the needs of energy development with those of nature conservation, by providing individual projections of the coal, natural gas, and wind energy development footprints across the Appalachians LCC in a format that facilitates a cumulative assessment of impacts on an array of valued natural resources including intact forests and watersheds, species, and natural communities.

Specific Deliverables (products, services, etc.): The Nature Conservancy is seeking funding for the following activities:

1. Expand current analysis of wind energy buildout scenarios to Appalachian LCC boundary.
2. Map resource probability and develop projections for Utica Shale, subject to availability of data.
3. Contract external expertise to create a probability surface for land disturbance associated with large area surface coal mining throughout the Appalachian LCC.
4. Create a public web-based map server.

Models will be developed that depict the probability of energy development across the Appalachian Landscape Conservation Cooperative, and the potential cumulative impacts on valued natural resources. These models will use predictor variables appropriate to the energy resource. For natural gas these may include: geophysical data showing aeromagnetic, isostatic gravity, and Bouguer gravity anomalies, geology, topography and bedrock depth. Some of the critical data (thermal maturity, depth and thickness) necessary for the shale gas model will be generated utilizing gas-well monitoring data and geostatistical modeling (Kriging) techniques. Variables used to model wind within our current analysis boundary include: distance to transmission, elevation, slope, surface relief ratio, and surface texture. Predictor variables for probability of surface coal mining are yet to be determined.

Our intent in the scenario modeling is not to identify specific locations of a given impact but rather to address regional-level build-out intensities and impacts. We will use indicators such as forest fragmentation and ecosystem services (i.e., water availability) to assess regional impacts, and will report these impacts using metrics such as percent loss of important resource areas.

The output of these models will be reflected in a series of GIS layers representing anticipated footprints of coal, shale gas, wind generation projects, and associated supporting infrastructure across the Appalachian LCC throughout a 25 year window, across a range of probabilities. As requested, all GIS data shall conform to Federal Geographic Data Committee (FGDC) standards and be compatible with Web Feature Service (WFS) base mapping and suitable for creating a GIS service consumable by state and federal natural resource agencies, NGOs, industry, and the general public. In addition, we will create a web-

based map server for data access and simple mapping. An example of the type of interface we plan to create can be found at: http://50.18.62.210/DevByDesign/.

Staff Expertise Offered (specific scientific, technical and communication/coordination expertise): The Nature Conservancy (TNC) is a world leader in applying rigorous and systematic approaches to prioritizing sites for biodiversity conservation. TNC's *Development by Design* (DbyD) harnesses the science of systematic conservation planning looking at habitat conservation across a region and for a particular project site, to apply a science-based approach for identifying high priority mitigation opportunities. Drs. Joseph Kiesecker and Jeffrey Evans have extensive experience in predictive statistical modeling and have produced analyses of energy impacts at multiple sites in the U.S. and abroad and participated in stakeholder processes to achieve optimal impact mitigation. Ms. Tamara Gagnolet was the primary analyst who performed the energy buildout assessment for the Conservancy's Pennsylvania program. Ms. Judy Dunscomb has extensive experience with landscape scale planning in the east and southeast, and led a multi-stakeholder effort to develop a landscape classification system in Virginia to highlight conflicts between conservation and wind energy development. She also chaired the Natural Resource sub-committee of Virginia's Wind Energy Regulatory Advisory Panel which was tasked with developing regulatory and guidance language for the implementation of Virginia's Renewable Energy Permit by Rule. Mr. Brad Kreps and Ms. Angela Watland have extensive experience working with the coal industry and state and federal regulators in southwestern Virginia to improve conditions for the biological resources of the Clinch-Powell basin. Mr. Kreps currently leads the Clinch Valley Program (CVP) which operates in a 10-county region of southwestern Virginia and northeastern Tennessee. The CVP has worked with a diverse and divergent set of partners to protect more than 35,000 acres. He is responsible for multiple, concurrent projects including leadership of the Clinch Powell Clean Rivers Initiative, engagement with mining and energy companies, collaboration with regulatory agencies, land acquisition, conservation forestry, land and stream mitigation, government policy initiatives, grant administration, philanthropy, and community development initiatives. Ms. Watland has developed multiple tools to prioritize conservation zones for aquatic resources, and has assisted the Virginia Department of Mines, Minerals and Energy in the creation of a process for optimally allocating funds to abandoned mined-land clean up.

Explain any information needs or coordination that must be accomplished first before work can begin, and estimate timeline for this (also include this estimate in Timeline attachment): There is a significant amount of data acquisition that is part of the scope of work for this project, and which will need to be accomplished prior to the initiation of any modeling efforts. In addition, we expect that the coal portion of this project – which requires the most detailed local knowledge – will be performed by an entity within the boundaries of the Apps LCC. The sub-award process will need to be completed before the coal work can begin.

Step-by-Step Process to Completion (proposed best approach, which may deviate from that suggested in the Project Description):

1) **Shale-gas development model (model resolution will be dependent on data availability)**
    a. Model definition – May 2012
        i. Define Model Outcome
        ii. What variables are driving the model?

b. Scoping and development – June 2012
    i. Define parameters for future development scenaria.
c. Draft model – Aug 2012
    i. Internal and External Model Assessment – Aug 2012
d. Full model – September 2012
    i. Internal and External Model Assessment – September 2012
e. Scenario development – October 2012

2) Wind development model

a. Model definition– Aug 2012
b. Scoping and development – Sep 2012
c. Draft model – Sep 2012
    i. Internal and External Model Assessment – Oct 2012
d. Full model – Nov 2012
e. Scenario development – Nov 2012

3) Coal model

a. Initiate Sub-Award Process – May 2012
b. July 2012 – Select sub-contractor
c. Model definition – August 2012
d. Scoping and development –September 2012
e. Draft model – December 2012
    i. Internal and External Model Assessment – January 2013
f. Full model – February 2013
g. Scenario development – May 2013

4) **Final project report –** July 31st 2013

Peer-reviewed publications that evaluate the efficacy or validity of the proposed approach (no more than 5, please):

Copeland HE, Doherty KE, Naugle DE, Pocewicz A, and Kiesecker JM (2009) Mapping Oil and Gas Development Potential in the US Intermountain West and Estimating Impacts to Species. PLoS ONE 4(10): e7400. doi:10.1371/journal.pone.0007400

Evans, J.S., M.A. Murphy, Z.A. Holden, S.A. Cushman (2011). Modeling species distribution and change using Random Forests *in Predictive species and habitat modeling in landscape ecology: concepts and applications*. eds Drew CA, YF Wiersma, F Huettmann. Springer, NY

Kiesecker, JM, H Copeland, A Pocewicz, and B McKenney 2010. *Development by Design*: Blending Landscape Level Planning with the Mitigation Hierarchy. Frontiers in Ecology and the Environment 8: 261-266

Kiesecker, JM, H Copeland, A Pocewicz, N Nibbelink, B McKenney, J Dahlke, M Holloran, and D Stroud 2009. A framework for implementing biodiversity offsets: selecting sites and determining scale. BioScience 59:77-84

Obermeyer B, Manes R, Kiesecker J, Fargione J, Sochi K (2011) *Development by Design*: Mitigating Wind Development's Impacts on Wildlife in Kansas. PLoS ONE 6(10): e26698. doi:10.1371/journal.pone.0026698

ATTACHMENT 1: PROJECT TIMELINE TABLE			
Project Start Date: May 15, 2012 **Project End Date:** July 31, 2013			
Milestone	**Initiation Date**	**Deliverable**	**Completion Date**
Request Payment of 25% of Award	May 1, 2012		
Utica Shale-gas development model (model resolution will be dependent on data availability)	May 15, 2012	GIS Layers of Model Output and assessment of resource impacts	October 31, 2012
Wind development model	August, 2012	GIS Layers of Model Output and assessment of resource impacts	November 30, 2012
Coal model Contract Awarded	May 31, 2012	Signed Contract	July 31, 2012
Draft Coal Model	August 1, 2012	GIS Layers of Model Output	December 31, 2012
Create Web-Map Server	November 1, 2012	Web-based server accessible	December 31, 2012
Full Coal Model	January 1, 2013	GIS Layers of Model Output, buildout scenaria, and assessment of resource impacts	May 31, 2013
Final Project Report	June 1, 2013	Technical report, Digital Data, and Key Findings for distribution to general public.	July 31st 2013