

Appalachian Landscape Conservation Cooperative

Science Needs Portfolio

Developed through the
Priority Conservation Science Needs Workshop
November 29-30, 2011

[Restructured version August 2013]

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Introduction

The Science Needs Portfolio as a Major Tool of the Appalachian LCC Science Program:

The Appalachian Landscape Conservation Cooperative's (LCC) first Conservation Priorities Science Needs Workshop took place on November 29-30, 2011 in Blacksburg, VA. A group of over 150 invited researchers and managers representing a diverse cross-section of expertise and affiliations were assembled to identify the science information needs of Appalachia in order to effectively address the conservation challenges and opportunities across the landscape. The resulting comprehensive cataloging or "Science Needs Portfolio" was developed to serve as a guiding framework, critical to help facilitate and support conservation planning, delivery, and applied research as well as monitoring efforts across the Appalachian LCC.

The Science Needs Portfolio is the cornerstone of the Appalachian LCC Science Program. It is organized by thematic areas (Aquatics, Human Dimensions, Forests, Climate Change, etc.) and structured to identify the highest-level of "MISSION: SCIENCE and MANAGEMENT OBJECTIVES," sub-divided and described by "PROGRAM" and identifies initial thinking on the type of activities or "PROJECTS" that would, in total, combine to make up the Program elements. The initial drafting of the Portfolio followed one-year of consultations with partners and culminated in the working draft that served as the starting materials for further refinement and revision through a 3-day Conservation Priorities Science Needs Workshop held in November of 2011.

The Workshop Participants began their work toward creating a working Portfolio (a "living document"), based on the guidance provided by the Appalachian LCC Steering Committee and a review of the LCC Mission and Vision statements. The next step of the Workshop involved ranking the top science needs – initially by each thematic group or group of experts, often referred to as "Communities of Practice (COP)." These smaller working groups were identified closely with the thematic areas described above and were further grouped based on expertise in the northern or southern areas. This distinction reflects the relative differences in landscape-level threats across such a large extent of the Appalachian region. Technical Experts, drawn from research and management agencies across the region and professionally trained as group facilitators, served as both Facilitators and Technical Note-takers in leading the redrafting and review of the Science Needs. The experts were then reassembled into several cross-disciplinary groups. They were charged with re-ranking the lists out of each thematic group with a large, landscape-level perspective to identify projects that address immediate conservation needs or served to assemble or create data and information that is currently lacking but foundational to advance future research. The resulting 2-tier ranked projects were then passed on as recommendations to the Steering Committee for FY11/12 funding consideration.

Staying Relevant: The Annual Process

As piloted in the November 2011 Workshop, the Science Needs Portfolio is reviewed annually. It is done so by reassembling through teleconferencing and webinars the broad science and management communities using an extensive Experts Database originally developed through Workshop registration, where participants self-identified their expertise. This Experts Database includes the 150+ participants that were involved in the original November 2011 workshop and has since grown to include others from the more than 400 members of the Appalachian LCC website (<http://applcc.org>). These experts represent applied research scientists and on-the-ground managers who are asked to update the Portfolio using a two-tier approach similar to the structure used for the November 2011 Workshop: the first based on each Thematic area of the Portfolio (e.g. Aquatics), and the second based on a more integrated landscape-level planning focus which generally represents landscape-level modelers, climate change scientists, or landscape-ecologists. The result of this broad and integrated consultation is continual refinement of the comprehensive Portfolio. The Steering Committee initiates this entire Annual Process by continuously building foundational materials needed by the conservation delivery partners, providing guidance on the scope of project funding each year, and being strategic in its funding to address both needs and opportunities.

2013 Portfolio of Science Needs

In February 2013, almost 50 experts from a wide range of technical background in both natural and social sciences, as well as geographic expertise across the entire region, volunteered to participate in the annual review of the Portfolio. This year marked the first revision of the Portfolio that will inform the Cooperative on the most pressing needs to guide funding allocation that supports conservation planning, delivery, and applied research as well as monitoring efforts. This year's revision was accomplished through the Appalachian LCC Web Portal that assembled the various technical groups or "Communities of Practice" (COP) to review and revise the conservation needs across the region.

Thematic Areas

It is recognized that there are many different ways to describe and organize science needs. For the purpose of assembling a vast amount of information, a group of nine broad thematic areas were selected for the purpose of the Portfolio organizing structure. The November 2011 Science Needs Workshop was structured around these areas: [1] Aquatic, Terrestrial; [2] Cave/Karst/ Mines; [3] Wetlands, [4] Forests, and [5] Openlands/Grasslands; [6] Human Dominated or Economic Lands – later renamed as "Working Lands" (e.g., urban, agricultural, and energy); [7] Human Dimensions (referring to issues of environmental benefits or ecosystem services that benefit human communities and

associated social expectations); and [8] Climate Change. Research topics related to IT and Information Management were also considered as a cross-cutting theme. The emphasis in this area was less about IT structure and more on function and user needs/interface (i.e., how information/resource/data are served up or build off of rather than software/server/technical IT issues.)

The Science Needs Portfolio is organized by “Themes,” “Programs,” and “Projects.” Category

titles are used simply for ease of presentation as they serve to group like-programs and like-projects. Under the thematic areas, “level” is used to present like-programs. The category title of “science need (SN) element” is used to group like-projects that support the many elements that may need to be investigated to address the scientific question or focus within a program. The relationship of the Portfolio is presented here as a nested outline.

THEMATIC AREA

[HEADING: used to organize or group like-Programs]

PROGRAM

[GROUPING – used to group like-Projects]

PROJECT

The Science Needs Portfolio as identified by the November 2011 Workshop participants appear in this document but have been further restructured in its revision. Appalachian LCC staff has inserted Community of Practice (COP) Comments in square brackets “[]”. Given the large geographic extent of the Appalachian LCC and the varying level of threats or stressors by region, project descriptions are identified by the experts from the northern region [N] or southern region [S] as so noted.

Portfolio Outline Standardized Structure

The over-arching structure of the Portfolio by focus and Program appears in the first section below. Detailed descriptions that identify specific Projects to build these Programs follow in subsequent sections individually by Thematic Area.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

(Grouping) – Foundational/Stock-taking Assessment/Classification System

(Grouping) – Climate Change Science and Abiotic or Mechanical Aspects

(Grouping) – Climate Change Impacts on Ecological Function and Response to Changes

(Grouping) – Energy and Related Infrastructure and Roads

(Grouping) – Urbanization, Population Growth and (Domestic or Industrial) Water Demands

(Grouping) – Agricultural Expansion and (Ag-related) Water Demands

(Grouping) – Effects of Air Pollution

(Grouping) – Cumulative Impacts

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

(Grouping) – Value/Ecosystem Services and Conflict

(Grouping) – Recreational, Commercial, Subsistence Use

C. Heading: System Level

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – Foundational/Stock-taking Assessment/Classification System

(Grouping) – Barriers (Flows and Species Movement)

(Grouping) – Mitigating Ag and Forestry Impacts

(Grouping) – Protection & Restoration Approaches

4. PROGRAM: Ecological Functions of Natural/Intact Systems

(Grouping) – Foundational/Stock-taking Assessment/Classification System

(Grouping) – Effects of Fire on Ecosystems

(Grouping) – Relationship/Ecological flows and Nutrient dynamics

(Grouping) – Ecosystem Integrity/Resiliency

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – Basic Ecology/Ecological Relationships

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

(Grouping) – Basic Biological Information

(Grouping) – At-Risk Species/Populations & Endemics

(Grouping) – Contaminants/Pollutants Effects on Species/Populations

(Grouping) – Invasive Organisms Effect on Species and Populations

(Grouping) – Effects of Disease (on a Species or Taxonomic Group)

F. HEADING: “HOW (THE LCC) SHOULD DO BUSINESS”

THEMATIC AREA:

AQUATIC

MISSION: *To maintain native habitats and endemic aquatic species in their current locations or support these as they migrate with land use and climate changes in the future.*

[Science objective] Quantitatively describe current and future hydrologic and structural habitat conditions, and aquatic population trends (in order).

[Management objective] To set conservation goals for both.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

PROGRAM DESCRIPTION: *This Program looks at biological integrity, ecological flows and ecological function in response to large-scale, transformation/alteration of the system + change of state (generally beyond the Focal Management Level) and large-scale or regional planning tools.*

- a. Climate Change: Using existing CC models, work with NOAA and the USGS Climate Science Centers to develop down-scaled climate change models and observational data for the LCC that can: (1) help managers predict likely impacts to the region's water resources, aquatic species, and human systems that rely upon those resources; (2) facilitate the development of more robust regional mitigation, monitoring and management plans; and (3) help managers provide meaningful input to future revisions of state and Federal water regulations.
- b. Expanding Energy and Related Infrastructure and Roads
- c. Urbanization and Population Growth
- d. Effects of Air Pollution

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** [N] Conduct a comparative analysis of existing landscape planning tools.
- **Project Description:** [S] Conduct stream habitat and riparian corridor classification at fine scale [e.g. catchment level] to allow modeling that can be expanded to the landscape scale. Have adequate data at the catchment scale [and] link models to GIS to make the data more visual and available to partners. *[COP Comment: TNC, TN, has a good example of this (compiling, not field-collecting) catchment data and linking to GIS. Includes projections of urban growth, energy*

development, agricultural land-use, riparian habitat quality mapped onto areas of species diversity.]

- **Project Description:** [S] Using a science-based methodology, identify priority species for the App LCC, around which partners can collaborate to address and remove or minimize threats. [COP Comment: Consider the use of environmental mapping to match species and changes in climate with mapping tools as a component of threats analysis—USFWS RAMP. This tool could be used to look at environmental changes and changes to species-matched environments.]

(Grouping) – *Climate Change Science and Abiotic or Mechanical Aspects*

- **Project Description:** [S] Develop a regional comprehensive description of seasonal and diurnal thermal and flow characteristics of surface waters including effects of climate change. [COP Comments: 1) Would need to be tied to a classification scheme (e.g., cold headwaters, warm medium rivers, etc.) to be more descriptive rather than overly generalized. 2) Have seen something like this for flows and precipitation, from VA southward to GA Atlantic drainage streams, in Dec 2012 JAWRA article, “Streamflow changes in the South Atlantic, United States during the mid – and late 20th century”.]
- **Project Description:** [S] Develop models/analytical tech to bridge the gap between down-scaled Global Climate Models and watershed based projections of climate change effects on aquatic species and habitats.
- **Project Description:** [S/N] Project the impact of land-use and climate change on the delivery of key aquatic ecosystem services, including the loss of cold/cool water habitats in response to thermal regime shift.

(Grouping) – *Climate Change Impacts on Ecological Function and Response to Changes.*

- **Project Description:** Develop a web-based tool for riparian restoration based on variables indicative of climate change resiliency.
[AppLCC FY11/12 Funded Project: (Nislow/USFS) “Web-Based Tool for Riparian Restoration Prioritization to Promote Climate Change Resilience (RPCCR) in Eastern US Streams”]
- **Project Description:** [N] Identify riparian and floodplain vegetation with climate change effects on aquatic community and the food chain. Of particulate interest is the ability of riparian and floodplain vegetation to moderate changes to food webs in species composition and changes to aquatic communities. [COP Comment: Consider also the impact by invasive or nuisance species or species (Asian carp, zebra mussels, New Zealand mud snail); these species impact food webs, energy flows, etc.]

- **Project Description:** [N] Document the effects of extreme events on key habitat (specifically changes in structure & composition). [COP Comments: 1) Need to clarify if focus is general weather? Hydrologic events? 2) This would require information on how peak rainfall and runoff events are changing with climate and land use change.]
- **Project Description:** [S] Identify temp and flow tolerance limits of species. [COP Comments: 1) How would this be narrowed? Narrow to a taxonomic group or group of keystone/priority/surrogate species. 2) See <https://nccwsc.usgs.gov/display-project/4f8c648de4b0546c0c397b43/50070884e4b0abf7ce733fee>; this CSC project on spatial and temporal variability of fishes in response to climate change may be a good guide for work related to benthics or other target species.]
- **Project Description:** Determine species/taxa contaminants/toxicity thresholds.
- **Project Description:** [N] Model and identify, for T&E species, where natural refugia are likely to occur in light of changing climate or altered environments and where there is potential for reserves and captive holding of Evolutionary Significant Units (ESU).
- **Project Description:** [S] Develop a method to utilize mussels and their habitat as an indicator to identify multi species refugia, restoration sites for priority species, monitoring, and watershed restoration.
- **Project Description:** [S] Develop methods to rank taxonomically-related groups of species resistance and resiliency to climate change using generic traits.
- **Project Description:** [S] Develop a rigorous predictive understanding of the net water quality outcomes from aquatic species restoration/augmentation.

(Grouping) – *Energy and Related Infrastructure and Roads*

- **Project Description:** Develop flow-ecology relationships to enable states to redirect or change their flow standards to ensure adequate protection of aquatic ecosystems. Review existing information. Compile and make information available.
 [AppLCC FY11/12 Funded Project: (Fisher & Walter / Cornell University) “Development of a hydrologic foundation and flow-ecology relationships for monitoring riverine resources in the Marcellus Shale region”]
- **Project Description:** Determine the effects of resource extraction – related to energy development.
 - o (related/component) Sitings; physical landscape; effects of fragmentation, and network refugia and connectivity sedimentation.

- o **(related)** [N] Create an interactive GIS-based decision support tool useful in the planning and impact analysis stage for siting energy-related projects and for reducing environmental impacts of the footprint of these projects.
- o **(related)** Vulnerability and impacts of aquatic species from the quantity of water extraction for the various methods of gas shale development in Appalachia.
- **Project Description:** [S] Determine if dissolved ion/ions and or heavy metals discharged downstream of surface and underground mining sites are toxic to aquatic organisms, mollusks or fishes. Specifically, identify the effects of chemicals constituents associated with coal processing and storage, fly ash, and discharges from settling ponds on survival, condition and reproduction of fish and aquatic invertebrates; especially lacking this information for all stages of freshwater mussels. [COP Comment: Lab work is underway or completed but many questions unanswered. Lacking is in situ mesocosm studies. USFWS funded USGS to do this with surrogate lab organisms; manuscript written. But does it translate to indigenous Appalachian fauna?]

(Grouping) – *Urbanization, Population Growth and (Domestic or Industrial) Water Demands*

- **Project Description:** [N] Predict the influence of major land use changes (e.g. urbanization, etc.) on flow regimes within the context of climate change. Include all major water withdrawals, e.g. energy extraction.
 - o **(related) Project Description:** [N] Evaluate the effects of future predicted water withdrawals and return flows on aquatic resources and populations.

(Grouping) – *Agricultural Expansion and (Ag-related) Water Demands*

(Grouping) – *Effects of Air Pollution*

- **Project Description:** [N] Effects of atmospheric deposition on aquatic ecosystems.
- **Project Description:** [N] Improve understanding of the synergistic effects of complex mixtures (air contaminants).

(Grouping) – *Cumulative Impacts*

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

PROGRAM DESCRIPTION: *Determine direct and intrinsic socioeconomic benefits of aquatic species and resources.*

(Grouping) – *Value/Ecosystem Services and Conflict*

- **Project Description:** [N] Anticipate potential water rights conflicts between various user groups and develop alternative solutions to resolve conflicting needs (e.g. water supply versus ecological flow), using a structured decision making approach that considers the values of the various stakeholders in making land use decisions.
- **Project Description:** For threats often politically difficult to address (agriculture, forestry, urban growth, mining, etc.), conduct sociological studies to serve as the foundation to develop and communicate culturally viable solutions across the landscape.
- **Project Description:** Evaluate relative risks associated with invasive/non-native species in the context of social behaviors that value these species (aquaculture, pay lakes and streams, religious releases of species), and thereby increase threats to native fauna and flora.
- **Project Description:** [N] [S] Collect data and model ecosystem services (e.g. clean water) and social values (e.g. open space) to quantify and establish thresholds for ecosystem functions.
 - o **(related) Project Description:** [S] Measure and map the capacity to provide, and flow of, key aquatic ecosystem services (i.e., we need basic inventories of ES so we can formulate management questions and approaches).

(Grouping) – *Recreational, Commercial, Subsistence Use*

- **Project Description:** [N] Determine the economic and social value of various fisheries. *[COP Comment: USFWS Fisheries Program has completed an economic evaluation for fisheries, but this did not include mussels.]*
- **Project Description:** [N] What is the magnitude of current use and trends of recreational use?
- **Project Description:** [N] What is the magnitude of current use and trends of commercial use?
- **Project Description:** [N] What is the magnitude of current use and trends of subsistence use?

C. HEADING: SYSTEM LEVEL

SYSTEM LEVEL DESCRIPTION: *Compile data to help partners and stakeholders better understand the types of aquatic habitats that occur within the LCC, the distribution and condition of those habitats, issues threatening the quality of those habitats, the relative importance of those habitats for species conservation within each of the states, and techniques that can be used to restore those habitats after they have been degraded.(e.g., connectivity, water quality, habitat quality including riparian habitat, instream, and structural habitat, habitat quantity, hydrology including water quantity and timing, distribution.)*

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

PROGRAM DESCRIPTION: *Describe how altered systems function and how they can best be managed.*

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Assessment of common hydrologic models/hydrologic data (models like stream stats for non-gauged streams) (common to both Program 3 & 4). *[COP Comment: This is quite important. Prediction in ungagged basins (PUB) has been a big trend in hydrology lately, mainly because there is concern that we will miss important changes if we only rely on very limited and increasingly sparse (temporally) gage data.]*

(Grouping) – *Barriers (Flows and Species Movement) and Fragmentation (Populations and Habitats)*

- **Project Description:** Develop models to show where barrier removal would be most effective in species recovery and improving resiliency in the face of climate change.
 - o **(related) [S]** Develop a method to evaluate the effect of barriers (chemical, physical, and biological) and the interaction between those barriers. *[COP Comment: Several COP members said this was a lower priority than the primary Project Description above; and, for these evaluations to move forward, more specific language would have to be developed for this science need.]*
 - o **(related) [N]** Evaluate the effects of fragmentation (connectivity) on aquatic species – evaluate the genetic and demographic effects on population viability and resiliency, and the effect on animal movement and dispersal.
 - o **(related) [N]** Develop barrier removal prioritization scheme with multiple criteria. Include assessment of when is it desirable and undesirable to remove barriers.
- **Project Description [S]** Understand the influence of hydrology and sediment transport around dams.

(Grouping) – *Mitigating Ag and Forestry Impacts*

(Grouping) – *Protection & Restoration Approaches*

- **Project Description:** [S/N] Evaluate the relative effectiveness of various stream restoration techniques including riparian protection measures across different scales and land use practices - to restore both function and structure, and to protect water quality and habitat. Need to identify reference reaches to properly design and evaluate restoration projects. [COP Comment: Focus should be on instream barriers.]
 - o **(related/component):** [S] ID factors and elements of unsuccessful and successful restoration techniques.
 - o **(related/component):** Develop a protocol using these factors to identify areas for restoration. (Compare against control sites).
- **Project Description:** [N] Determine the effects of stormwater management/impervious surfaces on aquatics habitats and how these might vary for different types of aquatic organisms (benthic macroinvertebrates (mussels) vs. benthic fishes, vs. mid-water fishes, vs. fishes with different types of spawning requirements).
- **Project Description:** [N] Evaluate the upstream and downstream effects of natural channel design on ecosystems.
- **Project Description:** [N] Monitor effectiveness of BMPs/water quality standards/criteria – is it effective for target species?
- **Project Description:** [N] [Investigate approaches/]improvements to fish sterilization techniques (triploidy technology).
- **Project Description:** [N] Improve, refine, and test efficiency of captive propagation techniques.
- **Project Description:** [N] Develop criteria for relocation/augmentation (genetics, disease, etc.)

4. PROGRAM: Ecological Functions of Natural/Intact Systems

PROGRAM DESCRIPTION: *Develop understanding of natural systems interrelatedness and interdependency, focusing on ecological flows, fluvial geomorphology, and species/habitat responses. Accounting for natural differences in flow variability among rivers, and understanding the importance of this for the protection of freshwater biodiversity and maintenance of goods and services that rivers provide. Understanding how flow variability sustains river ecosystems.*

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Produce an assessment of common hydrologic models/hydrologic data (models like stream stats for ungauged streams) (common to both Program 3 & 4).
- **Project Description:** Establish a stream classification system
[AppLCC FY11/12 Funded Project: (Anderson et al., The Nature Conservancy & ORNL) “A Stream Classification System for the Appalachian Landscape Conservation Cooperative”]
- **Project Description:** Develop a rapid assessment program and ground-truthing for assessing riparian and floodplain vegetation. [COP Comment: I don’t know how rapid it is, but perhaps TNC’s active river concept, with delineation methodology discussed in Chapter 4 in Smith, M.P., Schiff, R., Olivero, A. and MacBroom, J.G., 2008. THE ACTIVE RIVER AREA: A Conservation Framework for Protecting Rivers and Streams. The Nature Conservancy, Boston, MA is a way to do this?]

(Grouping) – *Effects of Fire on Ecosystems*

- **Project Description:** [N] Effects of fire on aquatic ecosystems e.g., nutrient cycling/loading, temperature regimes, plant communities, etc. (especially in areas with prescribed burning).

(Grouping) – *Relationship/Ecological Flows and Nutrient Dynamics*

- **Project Description:** [N] Identify the role of Freshwater Mussels (aquatic organisms) in nutrient cycling, removal of suspended sediments, bioturbation, bottom stabilization and enrichment, and creating stable aquatic habitats.
- **Project Description:** [N] Identify the relationship between specific suites of benthic biodiversity and paired conditions of nutrient dynamics.

(Grouping) – *Ecosystem Integrity/Resiliency*

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

PROGRAM DESCRIPTION: [NEEDED: none given]

(Grouping) – *Basic Ecology/Ecological Relationships*

- **Project Description:** [N] Document the effect of non-native species on native biota.
- **Project Description:** [N] Identify interspecies relationships (pollinators, host fish, etc.).

- **Project Description:** [S] Assess levels and patterns of most fundamental form of biodiversity from the intra-specific to the community level.
- **Project Description:** [N] Document the impacts of density of aquatic vegetation (i.e., native or non-native) on fish community composition.
- **Project Description:** [N] Conduct an evaluation of macro-habitat features influence on biodiversity distribution.
- **Project Description:** Develop mussel/fish habitat models that relate occupancy and abundance to habitat characteristics.
- **Project Description:** [N] Describe the temporal and spatial scale relationships to aquatic communities (headwater disturbances, land use/cover associated with aquatic communities – can be temporal component).
 - o **(related) Project Description:** [N] Assess the effects of headwater stream disturbance from energy extraction practices or climate change on downstream fish/mussel communities, aquatic salamanders and macro invertebrates.

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

PROGRAM DESCRIPTION: [NEEDED: none given by COP] [... refers to basic, broadening our understanding of the biology of organisms]

(Grouping) – *Basic Biological Information*

- **Project Description:** [N] Conduct an inventory/status assessment of priority/keystone species (Identify at risk species within the AppLCC).
 - o **(related) Project Description** [N] Rigorous understanding of population dynamics/viability for species of conservation concern.
 - o **(related) Project Description:** [S] Develop range-wide genetic assessment of key-stone/priority aquatic species.
 - o **(related) Project Description:** [N] Identify key limiting factors and stressors for priority/keystone aquatic taxa.
- **Project Description:** [N] Describe the dispersal abilities of aquatic animals. [COP Comment: Unless need focus on keystone or priority species, generalized academic work on this has been published.]

- **Project Description:** [N] Describe environmental flow requirements for species and populations for the region. Determine relationship between flow, habitat and aquatic life (ecological flows).

[AppLCC FY11/12 Funded Project: (Fisher & Walter / Cornell University) “Development of a hydrologic foundation and flow-ecology relationships for monitoring riverine resources in the Marcellus Shale region”]

- **Project Description:** [N] Monitor effectiveness of BMPs / water quality standards / criteria – is it effective for target species?
- **Project Description:** [N] Investigate approaches / improvements to fish sterilization techniques (triploid technology).
- **Project Description:** [N] Map remaining suitable and free flowing riverine habitat for freshwater mussels and rare endemic fishes.
- **Project Description:** [N] Examine relationships between sedimentation rates and biological response, e.g. survival rates, breeding success of aquatic organisms.
- **Project Description:** [N] Develop additional IBIs tailored to basins / regions / additional species in order to establish baseline conditions and track changes over time, which might be linked to causes. *[COP Comments: Realize some have tried or are currently trying, but there remains a science need for a mussel IBI. Mussel IBIs will have to be tailored within basins nested within physiographic provinces in the AppLCC region. Common metrics would include richness, density, recruitment as indicated by number of age-classes (cohorts), and species sensitivities/tolerances. Heidi Dunn, Ecological Specialists, Inc. is developing a mussel community index for assessing overall health of a mussel community, and indeed it needs to adapt to the watershed and size of water body. I also believe Teresa Newton and USGS Lab have done some work, but this needs further study in Appalachia.]*
- **Project Description:** [N] Improve, refine, and test efficiency of captive propagation techniques. *[COP Comment: Already has been done for fishes (see recent publication in AFS), and also has been done for mussels.] [LCC Staff Comment: COP needs to review again and determine if there remain outstanding needs.]*
- **Project Description:** [N] Develop criteria for relocation / augmentation (genetics, disease, etc.)

(Grouping) – *At-Risk Species/Populations & Endemics*

- **Project Description:** [N] Conduct research to populate a genetics database for at-risk species.

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

- **Project Description:** [N] Document the synergistic effects of complex mixtures (water contaminants) on aquatic organisms and their reproductive and survival rates.

- o **(related) Project Description: [N]** Conduct a comparative assessment of relative sensitivity of biota to contaminants suspected of impairing survival or reproductive capacity.
- o **(related) Project Description: [S]** Collect data on toxic effects on reproduction and growth of priority aquatic species *[COP Comment: This is a priority because most water standards are based on tests with species that are extremely tolerant.]*
- **Project Description: [S]** Projecting effects of wastewater effluent on aquatic species and populations in light of continued human population growth projections. *[COP Comment: Two projects above should be done in conjunction with understanding future habitat conditions and planning for connectivity between current and future habitats when possible.]*

(Grouping) – *Invasive Organisms Effect on Species and Populations*

- **Project Description: [N]** Effect of invasive species on ecological function (lakes, riparian zone and instream) (e.g. Japanese knotweed). *[COP Comment: Some of this work should be linked to biological integrity and system function not just non-native species impacting native species.]*
- **Project Description:** Identify distribution of invasive species across watersheds and identify how and to what extent they threaten native aquatic species.
 - o **(related/component)** Complete a threats analysis of invasive species on aquatic species (refine threats to examine: hybridization, competition, disease, habitat alteration, and predation, potential impact of climate change and human perturbation?).
 - o **(related/component)** Gather data on how states regulate exchange between states or intra-state movement of species in relation to non-indigenous species or move between watersheds.
 - o **(related) Project Description: [S]** ID risks associated with pathways for introduction and spread of invasive species as well as the techniques to manage the risks. *[COP Comment: A literature review, or what? The Pest Plant Councils already have these.]*
 - o **(related) Project Description: [S]** Quantify the amount of critical habitat occupied by invasive species and identify which invasive species they are.
- **Project Description: [S]** Assess aquatic species diversity utilizing eDNA and contemporary monitoring tools (see URL for reference to “environmental DNA” <http://environmental-change.nd.edu/programs/asian-carp/>) basically to take water samples and filter out shed DNA to give an early warning of an invasive species moving into a previously undetected area. *[COP Comment: Before this can be really used, much more work needs to be done in determining detection rates by eDNA and factors affecting detection rates. Work on this front is ongoing, but more*

funding would help. If the bugs are worked out with eDNA technology, it could be a very powerful tool. Perhaps a better project description would state further development and refinement of eDNA techniques.]

(Grouping) – *Effects of Disease (on a Species or Taxonomic Group)*

- **Project Description:** [N] Describe the effects of disease and parasites. *[Editor: Vague, COP needs to elaborate/explain]*

F. HEADING: “HOW (THE LCC) SHOULD DO BUSINESS”

- [N] Encourage BMPs for riparian zone management.
- Encourage standard monitoring protocol where not available but appropriate.
- [S] Support and add value to ongoing efforts to establish methods for assessing cumulative watersheds impacts.
- [N] Support USFWS with updating recovery plans for those species already identified.
- [N] Develop conservation genetic management plans for aquatic species being captively managed or being transplanted/ supplemented with stocking of wild and/or cultured animals.
 - o **Project Description:** [N] Improve, refine, and test efficiency of captive propagation techniques.
 - o **Project Description:** [N] Develop criteria for relocation/ augmentation (genetics, disease, etc.).
- [N] Develop technology and protocols for restoring ecologically functional mussel communities in order to enhance ecosystem goods and services provided by functional aquatic ecosystems. *[COP Comment: This is also recommended in the UTRB strategic plan, and National Strategy for Conservation of Freshwater Mollusks... some technology and protocols exist; however, a comprehensive understanding of population dynamics, trophic interactions, inter and intra species feeding interactions, and ecological function is needed to inform appropriately designed mollusk community restoration management protocols/plans.]*
- Develop a way to access privately collected monitoring data from the permitted community.
 - AppLCC’s Web Portal** offers to host most data sets and these can be shared narrowly or widely, as controlled by the content source.
- Develop a phone book or list of data, expert advice, etc. and make it available to all partners.
 - AppLCC’s Web Portal** includes an Experts Database that has been compiled from attendees at the November 2011 Projects Workshop and from members.
- [N] Develop efficient environmental inventory tools.
- Need to develop NHD data at 1:24K.

THEMATIC AREA:

CAVE/KARST - MINELANDS

MISSION: *Conserve and manage cave/karst and restored mine land (CKM) communities across jurisdictions.*

[Science objective] Inventory significant regional subterranean/cave/karst systems and communities, evaluate the condition and importance of those communities, and identify regional threats impacting these (in order).

[Management objective] To develop and implement cohesive regional strategies to protect and manage those resources across jurisdictions.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

PROGRAM DESCRIPTION: *Develop and compile data regarding the status and distribution of subterranean resources, threats impacting associated species, and work with partners to develop management strategies needed to address habitat threats and assist in the determination and recovery of threatened and endangered species. Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).*

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Develop a classification system for karst systems in the Appalachian region (to help prioritize conservation strategies).
 - o **(related) Project Description:** Map of springs throughout karst region— characterization and identification. Age dating and watershed delineation of major springs. Establish long-term spring monitoring network. *[COP Comment: Spring and other hydrology analyses will connect cave/karst systems and their conservation to larger watersheds/landscapes.]*
 - o **(related) Project Description:** Compilation and integration of cave data, some of which is sensitive or ‘not owned’ by LCC partners.
 - o **(related) Project Description:** [S] Update and compile species information from each state into a centralized database across the region. Develop methodology for

ranking degree of imperilment and apply to species. Fund inventory efforts to verify continued existence of pre-1990 records. [COP Comment: Should this be a Project or the charge of a Steering Committee Work Group?]

(Grouping) – *Climate Change Science and Abiotic or Mechanical Aspects*

- **Project Description:** Model projected abiotic effects of Climate Change on cave/karst habitats. Continue/establish long-term temperature and oxygen isotope monitoring sites.

(Grouping) – *Climate Change Impacts on Ecological Function and Response to Changes*

(Grouping) – *Energy and Related Infrastructure and Roads*

- **Project Description:** What are the impacts of land use changes, management regimes (especially prescribed burning and timber harvest), and climate change on water/cave resources in karst areas?

(Grouping) – *Urbanization, Population Growth and (Domestic or Industrial) Water Demands*

(Grouping) – *Agricultural Expansion and (Ag-related) Water Demands*

(Grouping) – *Effects of Air Pollution*

(Grouping) – *Cumulative Impacts*

- **Project Description:** [N] Effects of stressors (human use, urbanization, energy development) on stability and functionality of CKM systems and associated species. Establish long term studies comparing systems receiving storm water runoff with systems with agricultural and forested watershed.
- **Project Description:** [S] Develop predictive models for cave/karst high-biodiversity systems. COP needs to elaborate and provide specific details. [COP Comment: Commenters participating in review of this document agreed this was too vague but did not remember what Southern experts at the Nov. 2011 Science Needs Workshop had intended for this SN.]

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

(Grouping) – *Value/Ecosystem Services and Conflict*

(Grouping) – *Recreational, Commercial, Subsistence Use*

- **Project Description:** Conduct water value case study to show the ecological, economic, and human health importance of water coming through karst systems in the Apps. *[COP Comment: Approximately 25% of the US population depends on groundwater from karst systems and that number may be higher in the Appalachians. This could be a very powerful study which could lead to increased awareness, areas in need of priority management, increased funding potential, and much more. Managing karst is essentially managing water.]*

C. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

(Grouping) – *Dams/Instream Barriers*

(Grouping) – *Mitigating Ag and Forestry Impacts*

(Grouping) – *Protection & Restoration Approaches*

- **Project Description:** [N] Inventory and geo-referencing of restorable caves post-WNS and identify what Communities are expected to benefit.
- **Project Description:** Develop (or identify existing) BMPs that are appropriate/adequate to ensure protection of cave/karst ecosystems, based on existing science. *[COP Comment: Currently, there is no standard for karst buffers, etc. Forests across the US have buffers ranging from 50 feet to 500 meters with very little research to back up these distances. This is a vital need for land managers and could be shared with private entities including cities, etc.] [LCC Staff Comment: COP should review bird literature which finds that the wider the buffer, the better; most minimum buffer widths are policy decisions except those pertaining to water quality/filtering capacity (NRCS standards) which also look at vegetation type, slope, soil type, etc.]*

4. PROGRAM: Ecological Functions of Natural/Intact Systems

PROGRAM DESCRIPTION: Establishes how these systems are supposed to work, understanding the systems and their interrelatedness/interdependency.

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

(Grouping) – *Effects of Fire on Ecosystems*

(Grouping) – *Relationship/Ecological Flows and Nutrient Dynamics*

- **Project Description:** [N] Understanding of hydrology, recharge, and quality of ground water as it relates to cave/karst/mine systems. Establish long-term drip and cave stream water quality observatories.
- **Project Description:** Understanding of nutrient dynamics (in disturbed systems). *[COP Comment: This PD is much too vague to pursue without further definition.]*

(Grouping) – *Ecosystem Integrity/Resiliency*

- **Project Description:** [N] Linkages of above ground processes and management regimes to cave/karst/mine systems. *[COP Comment: This PD is much too vague to pursue without further definition; could be further clarified and combined with 2 bullets above.]*

D. HEADING: COMMUNITY LEVEL

5. Program: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – *Basic Ecology/Ecological Relationships*

- **Project Description:** Determine species and community distributions, their habitat relationships, and linkages across systems.
- **Project Description:** [S] Biological inventory of animal communities. *[COP Comment: Much of this is occurring at the state or academic level and a regional inventory (as above) can collate that existing information.]*

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

[COP Comment: While I do think this is critical, many partners are on top of this right now and so the priority of the LCC should be to take that knowledge and make it widely available through the regional analysis and strategic thinking that comes with that.]

(Grouping) – *Basic Biological Information*

- **Project Description:** Conduct spring emergence studies for Indiana bats, northern long-eared bats, eastern small-footed bats, and tri-colored bats across the range to locate maternity colonies and identify possible spring migration routes. While we have a fairly good understanding of where Indiana bats hibernate, we still only know where less than 20% of the winter population occurs during the summer and we know even less for northern long-eared, small-footed

and tri-colored bats. These species have been affected by white-nose syndrome (WNS) and locating summer colonies can lead to a better understanding of where to focus mitigation efforts. These studies will be very useful for informing wind project siting decisions.

- **Project Description:** Conduct meta-analysis of previously collected acoustic data to look at bat population occurrences and trends over time. Multiple agencies in a large number of states have been collecting acoustic data via transects for several years; however, there is currently no repository for the data and no funding to conduct any analyses. This project would coordinate the collection, analysis, and summary of currently available acoustic transect data. This effort will also be very useful for informing wind project siting decisions and better understanding where to focus mitigation efforts.

(Grouping) – *At-Risk Species/Populations & Endemics*

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

(Grouping) – *Invasive Organisms Effect on Species and Populations*

(Grouping) – *Effects of Disease (on a Species or Taxonomic Group)*

- **Project Description: [S]** Identify / understand of disease threats and their impacts on species of greatest conservation need.
 - o **(related) Project Description: [N]** Etiology, response, and management of WNS. *[COP Comment: Important, but probably already being addressed by many others.]*
 - o **(related) Project Description:** Inventory / monitoring and geo-referencing of caves with highest potential of supporting bat populations post-WNS. *[COP Comment: Most important WNS-related project for LCC pursuit.]*
- **Project Description: [S]** Develop process to prioritize taxonomic descriptions of described species (to understand their conservation status, population level).
- **Project Description: [S]** Develop sampling criteria to determine statistical likelihood of a species/genera presence/absence, and predictive models for cave species to assist with targeted monitoring efforts.

F. HEADING: “HOW (THE LCC) SHOULD DO BUSINESS”

- Need cave/karst training workshops for resource managers, citizens, developers, and consultants (e.g., provided by Karst Waters Institute). Need to get cave/karst coursework included in all regional state and private college and university curricula. *[COP Comment: The US Forest Service has a one week training session for resource managers that has already been developed and I believe there is some kind of training at NCTC. Is it possible to develop and support a small cadre of instructors to tweak this training and to host workshops across the AppLCC?]*
- Need BMPs that include a monitoring/evaluation component for cave/karst landscape based on existing science, particularly for stormwater management and nutrient application.
- There seems to be a lot of emphasis on bats and WNS in this list of priorities. While bats are an important aspect of cave and karst management, they are only one small component of that ecosystem. For example, there are approximately 26 bat species that use caves in America (for some part of the year) and over 1400 described species of invertebrate cave-obligate species. We should not prioritize projects that focus on bats or WNS over gathering basic data on the cave/karst ecosystem. Plus, there are other pots of money focused on this issue.
- Ensure USGS National Karst mapping products are available to AppLCC communities via web portal.
- A big push to protect summer roosts is the single most important thing we can do to encourage recovery from WNS impacts.

THEMATIC AREA:

WETLANDS

MISSION: *[LCC Staff Comment: No mission statement has been suggested or developed by this COP.]*

[Science objective] To inventory significant regional wetland habitats, evaluate the condition and importance of these habitats, and identify regional threats impacting those resources.

[Management objective] So that LCC partners and stakeholders can develop and implement cohesive regional management strategies to protect and manage wetlands across jurisdictions.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

(Grouping) – Foundational/Stock-taking Assessment/Classification System

(Grouping) – Climate Change Science and Abiotic or Mechanical Aspects

(Grouping) – Climate Change Impacts on Ecological Function and Response to Changes

- **Project Description:** [S] Model effects of climate change on wetland habitats and species. Identify wetlands vulnerability to climate change and understand the impacts of climate change on the spatial distribution and quality of ephemeral wetlands and further understanding how those changes (earlier drying, loss of small wetlands, etc.) might impact biota, especially amphibians relying on ephemeral wetlands. *[COP Comment: Consider using the presence of rare plants or animals as criteria for determining vulnerability.]*
- **Project Description:** Establish wetland IBI(s) for the entire LCC as critical to being able to do landscape functional assessment leading to ecosystem service valuation. This would form a baseline from which to we could model/measure effects of climate change, hopefully leading to thresholds and adaptation strategies.

(Grouping) – Energy and Related Infrastructure and Roads

(Grouping) – Urbanization, Population Growth and (Domestic or Industrial) Water Demands

(Grouping) – *Agricultural Expansion and (Ag-related) Water Demands*

(Grouping) – *Effects of Air Pollution*

(Grouping) – *Cumulative Impacts*

- **Project Description: [S]** Rank the impacts of various managed land uses to all wetland communities/ecosystems, including naturally functioning floodplains.
 - o **(related) Project Description: [S]** Identify and quantify effects of urbanization and impervious surfaces on the viability of vernal pools.
 - o **(related) Project Description:** Understand impacts of surrounding land use to the quality and viability of ephemeral wetlands, including vernal pools, seeps, etc.

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

[No specific Projects articulated by COP.]

(Grouping) – *Value/Ecosystem Services and Conflict*

(Grouping) – *Recreational, Commercial, Subsistence Use*

C. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description: [S]** Determine current extent of wetland connectivity to perennial streams compared to historical connectivity. *[COP Comment: Could be stepped-down to a set of priority watersheds within AppLCC (i.e., those currently supporting good populations of priority/rare/ listed aquatic species).]*
- **Project Description: [S]** Develop wetland Index of Biological Integrity for Appalachian LCC region. *[COP Comments: How about customizing a rapid wetlands assessment protocol (as has been done for TN, Ohio (ORAM – Ohio Rapid Assessment Method) to help identify ecologically important wetlands in the ALCC area? IBIs may not be something that can be done LCC-wide; would have to concentrate on smaller geographical areas due to the large differences in biological communities within our LCC.]*

(Grouping) – *Barriers (flows and species movement)*

(Grouping) – *Mitigating Ag and Forestry Impacts*

(Grouping) – *Protection & Restoration Approaches*

- **Project Description:** [S] Identify wetland persistence as it relates to habitat fragmentation.
 - **(related) Project Description:** Identify areas for bog restoration by first better understanding individual wetland/bog/fen hydrology.
- **Project Description:** [S] Develop restoration of hyporheic exchange (subsurface flow) techniques to connect wetlands to perennial streams.
- **Project Description:** [S] Evaluate success of created or restored wetlands in Appalachia; may be facilitated through review of existing data sources.

4. PROGRAM: Ecological Functions of Natural/Intact Systems

PROGRAM DESCRIPTION: *Determine how these systems are supposed to work; understand the systems and how they are inter-related and dependent.*

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Identify and quantify the extent of naturally functioning floodplain habitat to support priority habitat and species.

(Grouping) – *Effects of Fire on Ecosystems*

(Grouping) – *Relationship/Ecological Flows and Nutrient Dynamics*

- **Project Description:** Quantify ecosystem services of wetlands and their contribution to nutrient cycling to both aquatic and terrestrial systems. [COP Comment: *This sounds like work that has already been completed in many wetland systems – it is not clear what new information is needed and this would need to be determined.*]
- **Project Description:** [S] Use of groundwater and effects on wetland hydrology. [COP Comment: *Needs more work. Is this intended to be a GIS exercise that identifies where areas are/will be projected to have groundwater use impacts to wetland hydrology (and therefore stream flow, etc.)? Do you mean “consumptive” use of GW?*]

(Grouping) – *Ecosystem Integrity/Resiliency*

- **Project Description:** [S] Determine how and if conversion of wetland types effects ecosystem services associated with aquatic species.

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – *Basic Ecology/Ecological Relationships*

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

(Grouping) – *Basic Biological Information*

- **Project Description:** [S] Document ephemeral wetlands as sites of concentration and transfer of heavy metals through amphibian reproduction and immigration. *[COP Comment: Looking at the impacts/transfer of heavy metals through amphibian reproduction could be interesting and important, but we conducted a mercury study on vernal pools in Canaan and found that the levels were very low in amphibian eggs (possibly because of the short time spent in the wetlands).]*
- **Project Description:** A health assessment for amphibian communities (including contaminant loads).

(Grouping) – *At-Risk Species/Populations & Endemics*

- **Project Description:** [S] Assess presence of rare and invasive wetland species using contemporary genetic techniques.
- **Project Description:** [S] Assess meta-population structure among vernal pool species.

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

(Grouping) – *Invasive Organisms Effect on Species and Populations*

- **Project Description:** [S] Determine characteristics that make wetlands vulnerable to invasion and invasive species establishment. *[COP Comments: Much work has been done on ecosystem vulnerability to invasive species- this research may not be necessary. However, it would be useful to have a prioritization of wetlands that need management to protect them from invasives.]*

(Grouping) – *Effects of Disease (on a Species or Taxonomic Group)*

F. HEADING: “HOW (THE LCC) SHOULD DO BUSINESS”

- [S] For the stressors currently politically impossible to correct (agriculture, forestry, urban growth, mining, etc.), develop and communicate culturally viable solutions to address these stressors across the landscape.

THEMATIC AREA:

TERRESTRIAL: FOREST LANDS

MISSION: *Identify and prioritize regional forest habitats and natural communities to foster resiliency in the face of current and future threats while supporting a larger multi-jurisdictional framework for planning and management.*

[Science objective] Inventory significant regional forest habitats while evaluating present and future conditions (including threats), importance, and connectivity of these habitats (in order).

[Management objective] To carry-out conservation planning, based on landscape-scale scientific assessments, so that LCC partners and stakeholders can develop and implement cohesive regional management strategies to protect and manage forest resources across jurisdictions.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

PROGRAM DESCRIPTION: *Describe how forested systems respond to large-scale transformation of biotic and/or abiotic conditions. Examine major disturbances (including climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population). Describe the major system stressors and response to those stressors. Work with partners and stakeholders to develop and compile information about how stressors individually and cumulatively impact forest sustainability and rare and unique species and communities.*

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Map extent of existing forest, fragmenting features, and developed areas for the entire region, then discriminate between and map the extent of managed/human altered forests and natural/intact forests.

(Grouping) – Climate Change Impacts on Ecological Function and Response to Changes

- **Project Description:** Describe how forest biochemical cycles (e.g. nutrient, etc.) are altered due to changing climate and if those changes affect ecosystem services.
- **Project Description:** Investigate impacts of climate change on chemistry of the soil and/or biota needs to include potential interactions with chemical changes caused by deposition of acids, nitrogen, mercury, etc.

- **Project Description:** Assess Priority Amphibian & Reptile Conservation Areas (PARCAs) and vulnerability to climate change in the Appalachians. *[COP Comment: This project is already going on in the southeast (SEPARC and the South Atlantic LCC). Maybe what they've done could be used as a framework.]*
- **Project Description:** Evaluate the synergistic impacts of deer over-browsing and climate change. *[COP Comments: 1) Considered here due to cumulative effects of atmospheric pollution on regeneration, species composition, calcium, invasives (replacing natives suppressed by excess deer browse); 2) and, conversely, are some climate change impacts mitigated by deer over-browsing? There is some indication that certain boreal conifers (especially spruce) may actually benefit from deer preferentially browsing more palatable hardwoods.]*

(Grouping) – *Energy and Related Infrastructure and Roads*

(Grouping) – *Urbanization, Population Growth and (Domestic or Industrial) Water Demands*

(Grouping) – *Agricultural Expansion and (Ag-related) Water Demands*

(Grouping) – *Effects of Air Pollution*

- **Project Description:** Determine air quality impacts due to acidic deposition (sulfur & nitrogen), mercury, and ozone.

(Grouping) – *Non-human Biotic Stressors and Disturbance Agents*

- **Project Description:** Identify areas where excessive deer (or other) herbivory is threatening forest resiliency. Establish sustainable carrying capacities and identify indicators for determining sustainable levels of herbivory.
- **Project Description:** Determine impacts of forest tree pests on forest community health at landscape scales.
- **Project Description:** Determine impacts of non-native invasive species on forest community health at landscape scales.

(Grouping) – *Cumulative Impacts*

- **Project Description:** Describe the interaction among identified threats (e.g., fragmentation and invasive species/disease introduction, spread) on communities and species. Determine effects of individual or groups of stressors (e.g., urbanization, energy development) on forest integrity/functionality and endemic species. *[COP Comments: "Integrity" and functionality" are vague terms that need further definition before this project could move forward. Any assessment of the stressors in the Apps needs to consider their cumulative impacts and interactions, as no one stressor*

operates in a vacuum. It is critical that urbanization be addressed as one of these stressors.]

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

PROGRAM DESCRIPTION: *This program outlines the social values of ecosystem services.*

(Grouping) – *Value/Ecosystem Services and Conflict*

- **Project Description:** Conduct water value case study to show the ecological, economic, and human health importance of water coming from the high elevations of Appalachian forests to large human population centers on the East Coast.

(Grouping) – *Recreational, Commercial, Subsistence Use*

C. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

PROGRAM DESCRIPTION: *Describe community level population responses to non-natural disturbance.*

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Map extent of existing forest, fragmenting features, and developed areas for the entire region, then discriminate between and map the extent of managed/human altered forests and natural/intact forests.
- **Project Description:** Compile data resources that exist in various forms, and provide it in a usable/accessible format for LCC partners (e.g., comprehensive mine lands layer, Regional Conservation Database of protected/easement lands, invasive species maps).
- **Project Description:** Complete Environmental Compliance and Protection (ECAP) for entire region—what is the natural range of variability in forested systems, and where are we now in relation to reference conditions – with focus on building resiliency? [*COP Comment: This is important work, but there is great potential for re-inventing wheels. Synthesize and build on the substantial existing work that has been done by TNC, Landfire, state Natural Heritage programs, and many academic researchers. Historical data are scant and most of it has already been reported before. Focus on 1) searching out and inventorying any existing old growth stands that have not been previously inventoried, 2) conducting additional dendrochronology studies of fire regime in stands that still contain presettlement and early settlement age trees, 3) analyzing pre-logging era witness tree data, 4)*

refining existing reference condition descriptions, with a focus on clearly identifying the parts of those descriptions that are based on empirical data vs. informed speculation.]

- **Project Description:** Crosswalk existing Ecological Land Units (ELUs) to other initiatives (e.g., LandFire, Ecological Zone Modeling).
- **Project Description:** Utilize existing intact ecosystems/communities to identify important functional, structural, compositional (species composition), and distributional ties/relationships with other ecosystems/communities necessary for the sustained health of one or both of those systems.

[AppLCC FY11-12 Funded Project (Baldwin, Clemson University) “Data Needs Assessment”]

(Grouping) – *Barriers (Flows and Species Movement)*

(Grouping) – *Mitigating Ag and Forestry Impacts*

- **Project Description:** Describe carbon sequestration dynamics and potential for use of this mitigation approach for Appalachian forest systems.
- **Project Description:** Complete and compare forest block modeling/prioritization (e.g. TNC connectivity/flow models, Atlantic Flyway Initiative with Audubon and Joint Ventures). Identify minimum area requirements [need to explain, for what?]. [COP Comments: For the central and northern Apps, this has largely been done by TNC. Focus on finishing up that effort and extending to southern Apps and central hardwoods. There are a lot of these types of efforts ongoing in the Apps, and a synthesis of such efforts would 1) minimize redundancy given the work already invested in this work, 2) provide a comprehensive assessment of what partners feel are critical forest blocks, 3) illustrate both overlap and gaps/conflicts in areas of prioritization and 4) foster and improve cooperation and communication among the many LCC partners involved in this work.]

(Grouping) – *Protection & Restoration Approaches*

- **Project Description:** Develop and compile data regarding the utility of silvicultural tools, invasive species management approaches, prescribed burning, and other activities as restoration and management tools for a full complement of forest communities.
 - o **(related) Project Description:** Research how these practices (above) might facilitate habitat conservation and coordination of forest conservation actions across regional boundaries under changing conditions.
 - o **(related)Project Description:** Identify spruce forest reference conditions to support

restoration design and planning purposes. *[COP Comments: This should probably be included within the project (four bullets up) that addresses nrv/reference conditions of all ecosystems. The Central Appalachian Spruce Restoration Initiative (CASRI) partnership has already done a good bit of work toward this end; recommend building on that work and incorporating it into the larger nrv/reference condition project.]*

(Grouping) – *Effects of Fire on Ecosystems*

- **Project Description:** Develop Best Management Practices (BMPs) for use of prescribed fire for ecosystem restoration. *[COP Comment: All Appalachian Fire Learning Networks are working on this, as part of their process. Also active Prescribed Fire Councils at the state level. Currently active FLNs in GA/NC/TN/VA/KY/WV/PA.]*
- **Project Description:** Detail use and efficacy of prescribed fire in the presence of and control of invasive fauna, flora, and pathogens.

4. PROGRAM: Ecological Functions of Natural/Intact Systems

PROGRAM DESCRIPTION: *Understanding the system relatedness and dependency.*

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Update and refine the regional classification for natural forests, bringing together quantitative data (plots) on forest structure and composition and experts from the entire region to perform statistical analysis and hold workshops to validate, revise, and fill gaps in the U. S. National Vegetation Classification (USNVC).
- **Project Description:** Map extent of existing forest, fragmenting features, and developed areas for the entire region, then discriminate between and map the extent of managed/human altered forests and natural/intact forests.
- **Project Description:** Develop, describe, and apply broad-scale, regionally consistent units for mapping forested ecosystems across the LCC.
- **Project Description:** Complete ELU mapping for entire Appalachian region. *[COP Comment: Need this in order to do credible ECAP analyses.]*
- **Project Description:** Collate existing LiDAR efforts and curate data to identify and prioritize new data capture. *[COP Comment: Need to specify an application for the data.]*

(Grouping) – *Relationship/Ecological Flows and Nutrient Dynamics*

- **Project Description:** Determine disturbance impacts on nutrient cycling (e.g., fire, pests, erosion).
- **Project Description:** Set canopy targets for the region’s forest to reduce stormwater flows. *[COP Comment: Consider are conflicts with management restrictions for certain species that need resolution (e.g. Indiana bat restrictions may impede (temporary) canopy reduction from young forest management.)]*

(Grouping) – *Ecosystem Integrity/Resiliency*

- **Project Description:** Identify important functional, structural, compositional (species composition), and distributional relationships within and among ecosystems/communities necessary for the sustained health of one or both of those systems. *[COP Comment: We need to understand dynamic thresholds that cause system failure or serious degradation including water quantity and quality, canopy cover etc. This will ultimately get us at some of the big cumulative impact questions we are currently struggling with right now. I think we have some good handles on the no regrets levels (like maintaining >80% canopy for forest interior birds, but the struggle comes at being more precise at the limiting effects level and is likely to vary by community or species guilds etc. Good easily I think be rolled into E.6 below in some regard.)]*

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

PROGRAM DESCRIPTION: *Describe community-level population responses to disturbance. Develop and compile information about the distribution and status of existing high priority forest communities and work with partners to develop management strategies that will either conserve existing forest types under changing climatic conditions or will facilitate successional transition to other forest types, if appropriate to public and management needs.*

(Grouping) – *Basic Ecology/Ecological Relationships*

- **Project Description:** Based on a revised USNVC of natural forests of the region (see classification project added under program 4) assign and/or revise conservation status ranks (rarity/imperilment) for individual associations and map and determine relative viability/ecological integrity for occurrences of the most vulnerable associations, to establish priority conservation sites.
- **Project Description:** Need for up-to-date landcover data and refined modeling techniques for determining the appropriate amount of each stage within each community type; must be

able to down-scale to local area to incorporate species-specific needs/ data. [COP Comments: 1) Some current forest service products get us close to this and should more broadly applied; 2) This seems like too much to bite off for an LCC-wide project. The “appropriate amount of each stage within each community type” will be broadly defined by the hrv/reference conditions project. When down-scaling to local areas, the landowner’s/manager’s goals and objectives become the main driving factor behind the distribution of stages across the landscape; 3) National Fire Plan Landfire efforts started this and several Fire Learning Networks are refining these models for their particular areas.]

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

PROGRAM DESCRIPTION: Work with partners and stakeholders to develop and compile information about priority species and priority conservation areas within the LCC, their habitat requirements, and changes in the distribution of those species and habitats to facilitate the regional management of those resources. Develop and compile information about the LCC’s terrestrial species, work with partners to better estimate their current degree of imperilment, and coordinate the development of regional management strategies that will help conserve these species in the face of changing land-use and climatic conditions. Describe needs for additional study to support sustainable populations and outlines emerging threats.

(Grouping) – Basic Biological Information

- **Project Description:** Develop statistically sound inference methods to be able to develop models based on existing data sources (e.g., methods that would allow us to relate detection probability to a process of establishing scientifically valid population trend analyses). COP needs to verify scope and intent of this science need. [COP Comment: Existing data sources are often not appropriate for this type of analysis, so in each case need to address their suitability to the specific questions being asked.]

(Grouping) – At-Risk Species/Populations & Endemics

- **Project Description:** Adapt standardized approach for developing at-risk wildlife and plant species/community list. [COP Comment: Suggest the LCC instead adopt NatureServe G/N/S ranks as the criteria for determining what constitutes “at risk”.]
- **Project Description:** Develop and overlay taxa-specific priority areas (e.g., terrestrial salamanders, priority birds). [COP Comment: Goal would be to develop synergy between taxa based on ecosystems. Examples: aid rare insect taxa by managing scrub barrens for GWWA. Protect rare wetland plants & insects by protecting swamp (wide buffers) for CAWA.]

- **Project Description:** Document the incidence/cumulative impacts of forest pests/pathogens/invasives on forest/wildlife species and investigate mitigative measures.
- **Project Description:** Identify and fill gaps in basic distribution and abundance data for at-risk species. [*COP Comment: This information is expensive and time-consuming to collect, but it is absolutely necessary if we are to get the fine-filter component of the LCC's conservation strategy right.*]
- **Project Description:** Identify and fill gaps in basic life history and ecology data for at-risk species.
- **Project Description:** Transition from nest-box surveys to acoustical surveys for the endangered Carolina and Virginia northern flying squirrel.
 - o **(related) Project Description:** Determine linkages between northern flying squirrel habitat preferences for conifer-dominated, i.e., red spruce, mature hemlock and fir systems. [*COP Comment: DOT Corridor H mitigation is funding USGS study investigating these two projects above.*]

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

(Grouping) – *Invasive Organisms Effect on Species and Populations*

(Grouping) – *Effects of Disease (on a Species or Taxonomic Group)*

- **Project Description:** Describe Chytrid fungus: incidence and impact on Appalachian amphibians.

F. HEADING: “HOW THE LCC SHOULD DO BUSINESS”

- Coordinate management plans/treatments across jurisdictional and ownership boundaries (including private lands) to achieve broader conservation goals (e.g., regional connectivity).
- LCC should support two initiatives underway that are working on spruce restoration, CASRI (central apps) and SASRI (southern apps).
- Develop finer-scale conservation objectives that are based on existing regional data/ layers.
- Identify availability/scale/format/source of existing resources, provide access to those resources, and identify gaps for addressing existing science needs.

THEMATIC AREA:

TERRESTRIAL: OPENLANDS

(grasslands, meadows, balds, shale barrens)

MISSION: *To maintain native habitats and native species in their current locations or support these as they migrate in response to land use and climate changes in the future.*

[Science objective] Inventory significant regional grassland/open land communities and evaluate the condition, importance, and regional threats impacting these communities (in order).

[Management objective] Develop and implement comprehensive regional strategies to conserve and manage natural and non-natural (e.g., restored mine lands) grassland/open land communities across landscape jurisdictions.

[COP Comment: There is a need to define the Theme better. What is open land? How open?]

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population)

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Map extent of existing open lands, forest, wetlands, fragmenting features, and developed areas for the entire region, then discriminate between and map the extent of managed/human altered open lands and natural/intact open lands.

(Grouping) – Climate Change Science and Abiotic or Mechanical Aspects

(Grouping) – Climate Change Impacts on Ecological Function and Response to Changes

(Grouping) – Energy and Related Infrastructure and Roads

(Grouping) – Urbanization, Population Growth and (Domestic or Industrial) Water Demands

(Grouping) – Agricultural Expansion and (Ag-related) Water Demands

- **Project Description:** [N] Understand impact of agricultural practices and mine land restoration on grassland/open-land wildlife and communities (and develop BMPs for those systems).

(Grouping) – *Effects of Air Pollution*

- **Project Description:** Assess the effects of atmospheric contaminants and agricultural chemicals on open land habitats.

(Grouping) – *Cumulative Impacts*

- **Project Description:** Document historic distributions, threats to the quality and quantity of existing open land habitats, and the relative importance (i.e. quality as habitat, ecosystem services functions) of natural, restored, and created open habitats for species conservation across the region. [COP Comment: It was suggested that AppLCC develop a matrix of relative rank to be used to focus on most important open land types for conservation; could combine with open wetlands habitats.]
- **Project Description:** [N] Determine effects of stressors (urbanization, energy development, climate change) on open-lands integrity/functionality and associated species.
- **Project Description:** Effects of resource extraction on open land habitats.

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

(Grouping) – *Value/Ecosystem Services and Conflict*

(Grouping) – *Recreational, Commercial, Subsistence Use*

(Grouping) – *Public Attitudes*

- **Project Description:** Document and evaluate the attitudes of various stakeholders (e.g., farmers, general public) toward open lands, especially those associated with human land use (for example abandoned agriculture, reclaimed mining operations); determine how these attitudes might affect conservation goals and identify approaches/opportunities for public education.

C. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Map extent of existing open lands, forest, wetlands, fragmenting features, and developed areas for the entire region, then discriminate between and map the extent of managed/human altered open lands and natural/intact open lands. *[COP Comment #1: A foundational georeferenced database for natural and managed open land habitats across the LCC is a high priority for this Theme, and should include areas of potential recovery as well as areas where recovery has been precluded by urban or other development; COP Comment #2: Emphasis should be on determining resilience/sustainability of this ecotype and not simply on reestablishing habitat in historic areas/distributions.]*

(Grouping) – Dams/Instream Barriers

(Grouping) – Mitigating Ag and Forestry Impacts

(Grouping) – Protection & Restoration Approaches

- **Project Description:** Develop and compile data to help partners and stakeholders better understand techniques that can be used to restore [open land] habitats after they have been degraded.
- **Project Description:** [N] Conduct community-based habitat restoration/rehabilitation and population response modeling.

(Grouping) – Effects of Fire on Ecosystems

- **Project Description:** Assess the effects of prescribed fire on open land habitats. *[COP Comment: Could be combined with bullet above that calls for development and compilation of data on management techniques.]*

4. PROGRAM: Ecological Functions of Natural/Intact Systems

PROGRAM DESCRIPTION: *Establish how these systems are supposed to work, understanding the systems and their interrelatedness/interdependency. [COP Comment: Critical Program – as we have worked on some projects with Golden-winged Warbler and bald eagles for example. The interplay of the content, elevation, landscape extent, size and other factors can really confound efforts for restoration, control of invasives.]*

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Update and refine the regional classification for natural open lands, bringing together quantitative data (plots) on community structure and composition and experts from the entire region to perform statistical analysis and hold workshops to validate, revise, and fill gaps in the U. S. National Vegetation Classification (USNVC). *[COP Comment: Could be combined with similar assessments for forests and wetlands.]*

- **Project Description:** Map extent of existing open lands, forest, wetlands, fragmenting features, and developed areas for the entire region, then discriminate between and map the extent of managed/human altered open lands and natural/intact open lands.
- **Project Description:** Develop and compile data to help partners and stakeholders better understand the types of open land habitats that occur within the LCC, and the distribution and condition of those habitats. *[COP Comment #1: An important first step is standardizing terminology; COP Comment #2: My interpretation of this task is to better understand/inventory of the current extent and types of openlands in the LCC landscape, not a better classification scheme.]*
- **Project Description:** [N] Understand historical vegetation distributions and disturbance regimes in the landscape and the extent to which they can be advantageously replicated given existing conditions. *[COP Comment: This project and previous one could be joined; highest priority should be placed on scrub barrens, balds, and native grasslands.]*

(Grouping) – Relationship/Ecological Flows and Nutrient Dynamics

- **Project Description:** Assess the effects of nutrients on open land habitats.
- **Project Description:** [N] Understand the dynamics and extent of potential carbon sequestration for grassland/open land systems.

(Grouping) – Ecosystem Integrity/Resiliency

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – Basic Ecology/Ecological Relationships

- **Project Description:** [N] Determine carrying capacity of open land habitats for birds. *[COP Comments: This work should be done by the bird JVs.]*
- **Project Description:** Conduct studies that improve understanding of community distributions across the region, their habitat relationships, and migration corridors.
- **Project Description:** Understand habitat selection of communities within a shifting mosaic of open lands with spatial and temporal variations in availability.

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

PROGRAM DESCRIPTION: *Work with partners and stakeholders to develop and compile information about species within the LCC, their habitat requirements, and changes in the distribution of those species and habitats to facilitate the regional management of those resources.*

(Grouping) – *Basic Biological Information*

(Grouping) – *At-Risk Species/Populations & Endemics*

- **Project Description:** Develop and compile information about the LCC’s terrestrial endemic species; work with partners to better estimate their current degree of imperilment, and coordinate the development of regional management strategies that will help conserve these species in the face of changing land-use and climatic conditions.
- **Project Description:** [N] Assess vulnerability of priority conservation areas to stressors (e.g., climate change).

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

(Grouping) – *Invasive Organisms Effect on Species and Populations*

- **Project Description:** Determine community impacts from invasive species (Note: Coordinate with Aquatic Nuisance Panels.) and most efficient ways to combat this threat.
- **Project Description:** Determine nutritional and energetic impacts of invasive plant species for migratory birds in open land stopover habitats.

(Grouping) – *Effects of Disease (on a Species or Taxonomic Group)*

F. HEADING: “HOW THE LCC SHOULD DO BUSINESS”

- Develop BMPs for grassland/open-land community restoration and creation - need to develop BMPs for scrub barrens, meadows, and native grasslands and plan for persistence after initial management / disturbance. Need to synthesize work done to date first, and gain consensus on habitat labels/nomenclature.
- For almost all of the “develop and compile” types of projects, I question whether they should be listed as projects. To me, they all seem more like a data gathering exercise than a formal project - more appropriate for Working Group or similar ad-hoc committee of LCC partners?

THEMATIC AREA:

WORKING LANDS

MISSION: *To improve planning and integration of “working lands” (which include urbanized, agricultural, forestry, industrial, and energy development) and conservation interests.*

[Science objective] Develop a better understanding of how potential land use changes will affect conservation goals and how these effects can be avoided or mitigated to reduce economic impacts and pressures on the natural resources of the Appalachian region (in order).

[Management objective] Collaboratively meet economic development and conservation management goals through improved decision-making and resource management.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

PROGRAM DESCRIPTION: *Develop/compile information about new or expanding land development (e.g. urbanization, energy) within the LCC and the opportunities and cumulative impacts these have on fish and wildlife. Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).*

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Collaborate with NRCS to obtain data on private agricultural lands enrolled in federal farm bill programs, indicating an existing level of conservation.

(Grouping) – *Climate Change Science and Abiotic or Mechanical Aspects*

(Grouping) – *Climate Change Impacts on Ecological Function and Response to Changes*

- **Project Description:** Profile human populations that manage resource in geographical areas projected to experience adverse impacts.

(Grouping) – *Energy and Related Infrastructure and Roads*

- **Project Description:** Model the impacts of strategically mitigating impacts of water discharges and land disturbance associated with Abandoned Mine Lands (AML).
- **Project Description:** Forecast Energy Development in new or expanding markets (shale, wind, biomass).

[AppLCC FY11/12 Funded Project (Kiesecker, The Nature Conservancy) “Forecast

Resource Extraction” -- to forecast energy development for shale, wind, and coal for 20-year timeframe and produce geospatial displays.]

- **Project Description:** Develop a scientific method of weighing the benefits of energy development and the costs of conservation value of lands (mitigation banking, carbon sequestration, monetizing ecosystem services.)
- **Project Description:** Estimate demand for energy use with increased temperatures resulting from predicted climate change: assess increases in electricity use and as it relates to heat island effect. Consider how demand for different types of energy may change as supply (and therefore prices) changes?
- **Project Description:** Develop guidance for water withdrawals for natural gas, abandoned mine lands (AML) and other energy uses.

[AppLCC FY11/12 Funded Project (Fisher & Walter / Cornell University) “Development of a hydrologic foundation and flow-ecology relationships for monitoring riverine resources in the Marcellus Shale region”]

- o **(related) Project Description:** Research question: What’s going to happen with land ownership (in light of gas production)? Ownership is key. Concern that lands will revert to local governments.
- **Project Description:** Determine the effects of land use alterations in the energy industry on species, populations, and natural communities.
 - o **(related) Project Description:** Effects of shale gas development on aquatic communities, and thresholds of ecological impacts as it relates to this energy sector activity.
 - o **(related) Project Description:** Effects of shale gas development] on avian communities, and thresholds of ecological impacts as it relates to this energy sector activity.
- **Project Description:** Map areas of energy development or energy extraction sites (present and predicted) for use by researchers and/or to look for focus areas for research? [COP Comment: (for this Grouping) A minelands DST is under development now (Feb 2013) by partners within AMJV; need to ensure coordination between JV and LCC.]

(Grouping) – *Urbanization, Population Growth and (Domestic or Industrial) Water Demands*

- **Project Description:** Develop/ compile information about the ongoing/ future conversion of agricultural land to urban and suburban uses within the LCC and the impacts these changes are having on the character and distribution of human communities and fish and wildlife habitats so that partner agencies may be better able to understand system dynamics and

recommend alternatives to minimize future land-use conflicts involving human communities, wildlife, and ecosystem service functions. *[COP Comments: 1) To most effectively meet this goal, work with NRCS to obtain data on current conservation practices impacting local species. Use the census of Agriculture databases to profile changes in landscape specifically related to number of farms and size of farms at the county level. Also consult with the Farmland Trust to determine conservation activities. 2) Seems like a lot of the modeling and study of urbanization has been done or is on-going focus of partners like USDA FS and EPA. LCC should retain focus on those models and their effects on the biotic community, but we may need some more basic science to be able to link the biotic response to the predicted changes from urbanization models.]*

- o **(related) Project Description:** Create spatially-explicit econometric urbanization model coupled with habitat models playing out different scenarios – future projections – for this type of development; forecast future spatial footprint of development in 20 years in light of changes to demand, technology and regulation; develop scenario simulations to evaluate effects of different policies and market conditions. Need social science research into policy option and natural resource impacts given a particular policy direction. There are good models to help with our understanding. Model land use change resulting from urban growth.
- o **(related/component):** Develop decision-support tools for growth assessments/projections; run scenarios at a landscape level.
- o **(related/component):** Develop planning decision support tools to assist state and local governments and other agencies with jurisdictional decision-making power to make informed land use change decisions. *[COP Comment: Much of this work is being done on a state-by-state basis...landscape scale coordination could greatly enhance these efforts.]*
- **Project Description:** Human population shifts – need to understand complexities of population growth/urbanization patterns. *[COP Comments: Identify land grant and private Universities that have special population study institutes to obtain land use changes, example Texas A&M University.]*
 - o **(related) Project Description:** Update the 1996 (SAMAB) Southern Appalachian Man and the Biosphere report (Chapter 3 – Changing Demographics and Economic Conditions in Southern. Appalachia.
- **Project Description:** Assess the effects of land use change on the quality of life of human populations.

(Grouping) – Agricultural Expansion and (Ag-related) Water Demands

- **Project Description:** Establish a working agreement with the USDA-NRCS to identify current conservation practices on private lands focusing on irrigation management and other related agricultural water practices.
- **Project Description:** Establish a task force to address the quantity and quality of water on agricultural lands in light of urban encroachment on rural landscapes. Obtain data from local state and Federal agencies along with non-profits to identify the number and types of small specialized agricultural operations that impact water resources.

(Grouping) – *Effects of Air Pollution*

- **Project Description:** Establish a working group across Federal, State, and Local agencies, along with private non-profit organizations for long-term monitoring of air quality parameters across Appalachian LCC due to acid deposition, mercury, sulfur, and ozone.

(Grouping) – *Cumulative Impact*

- **Project Description:** Develop a landscape-scale approach for evaluating cumulative impacts of land use change, including human population characteristics, using satellite imagery, aerial photography, and geographic information systems.
 - o **(related) Project Description:** Develop a shared database, system or method for tracking land use conversions over time.
 - o **(related) Project Description:** Forecast land-cover changes based on economic drivers and other factors. Note: Include climate change models, but incorporate other LULC changes (urbanization, etc.). Institute a tracking system to develop uniform methodology and improved coordination, and facilitate adjustments for forecasts over time.
- **Project Description:** Identify indicator species (also known as representative or surrogate species), as a means of tracking effects of land use change (development impacts, edge effects, etc.) on habitats and species assemblages.

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

For activities related to information and education it will be important to develop a socioeconomic profile of the human population managing the resources. If the human population is on agricultural lands, social characteristics such as tenure on the land, age, formal level of education, income derived from agriculture, experience with conservation practices/ systems, etc., will be key in assessing the attitudes and behaviors relative to the

protection and enhancement of working lands, forest management (with a specific emphasis on ecological services).

(Grouping) – Value/Ecosystem Services and Conflict

- **Project Description:** Conduct opinion survey to understand people/group motivations and values as they relate to making decisions that involve trade-offs between environmental sustainability and human needs or desires. Purpose: Support ability to craft communication products that are sensitive to public motivations and values, but are also effective conservation tools.
- **Project Description:** Conduct research into economics of small landowner forestry practices (example of oak forests). *[COP Comment: Can we find triggers or tipping points that enable small landowners to more sustainably manage forested lands? Identify in detail the human characteristics of landowners/ producers managing the resources on small acreage of land with forested and agricultural tracks (row crops and livestock). Assess barriers to participation in conservation activities and develop strategies to overcome identified barriers.]*
- **Project Description:** Need to identify the drivers of environmental change. Need to define this around multiple sectors (forest products, [energy] industry, urbanization, etc.).
- **Project Description:** To more effectively promote adaptation, it will be important to develop a socioeconomic profile of the population within the Region. Most specifically, it is important to develop a socioeconomic profile at local levels that have been identified as having vulnerable species, populations, or are where climate estimates indicate that species will be adversely impacted by climate change.

(Grouping) – Recreational, Commercial, Subsistence Use

- **Project Description:** Impacts of land use alterations on [availability and types of outdoor] recreation.
- **Project Description:** Submit a request for proposals for a comprehensive socioeconomic study, which will include the evaluation of the inter-relatedness of other ecosystem services and recreation: Focus on brook trout and freshwater mussels.
 - o **(related) Project Description:** Evaluate [the implications of] resource management [decisions/policies] on socioeconomic values: especially the relationship between brook trout and socioeconomic benefits.
- **Project Description:** Establish a task force across government agencies, private and non-profit organizations to identify published and unpublished reports that address the cultural and overall social value of outdoor recreational activities in the Appalachian Mountains.

A summary report of the findings should include data gaps at specific geographic areas and recommend methods to obtain incomplete data.

B. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Fund a contract with an upper level or graduate GIS specialist to Map land use practices to identify vulnerable ecosystem services.
- **Project Description:** Create a task force to develop an electronic template that would facilitate the measurement and tracking of the degradation of Soundscapes.
- **Project Description:** Create a task force to develop an electronic template that would facilitate the measurement and tracking of the degradation of Viewsheds.

(Grouping) – *Barriers (flows and species movement)*

(Grouping) – *Mitigating Ag and Forestry Impacts*

- **Project Description:** Develop new/enhanced sustainable Ag and Forestland management practices.

(Grouping) – *Protection & Restoration Approaches*

- **Project Description:** Explore how species and habitat restoration can mitigate land use stressors.

4. PROGRAM: Ecological Functions of Natural/Intact Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

(Grouping) – *Effects of Fire on Ecosystems*

- **Project Description:** Work with federal, state and local partners to assess conservation practices related to fire and prescribed burning.
- **Project Description:** Assess human populations that are most vulnerable to increasing temperature and fire- characteristics of the population such as age, transportation routes to and from fire hazard areas.

- **Project Description:** Work with NRCS as partner to determine areas that use prescribed burning as a conservation practice.

(Grouping) – *Relationship/ Ecological flows and Nutrient dynamics*

- **Project Description:** Stream classification system and subsequent geospatial data used to quantify the amount and types of streams and rivers allowing conservation partners to better allocate conservation actions and resources, and recommend flow and hydrology policies and management actions for streams that lack site specific data. To effectively accomplish this project, consider partnering with EPA, NRCS and private non-profit organizations such as the Chesapeake Bay foundation to share data on project elements.

[AppLCC FY11/12 Funded Project (Anderson et al., The Nature Conservancy & ORNL) “A Stream Classification System for the Appalachian Landscape Conservation Cooperative”]

(Grouping) – *Ecosystem Integrity/Resiliency*

- **Project Description:** Coarse-filter assessments of ecological integrity and resilience to complement priority species approach. *[COP Comment: Examples include CAPS in Massachusetts and Geophysical and Resilient System Approach to Climate Change Adaptation proposed by TNC in the Northeast.*
- **Project Description:** Comprehensive/validated road/transportation maps/data layers (for use in corridor, connectivity, invasive species analyses etc.).
- **Project Description:** Develop comprehensive models that consider terrestrial and aquatic conservation needs by incorporating an aquatic component (e.g. stream and river networks) into terrestrial landscape models.

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – *Basic Ecology/Ecological Relationships*

- **Project Description:** Assessment of assumptions related to use of focal or representative species approach to guide development of decision support tools, i.e. do these approaches adequately represent larger sets of species and how do they compare to coarse-filter approaches.

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

(Grouping) – *Basic Biological Information*

- **Project Description:** Develop a phenological index of ecological health using high elevation communities.
- **Project Description:** Basic biological response information as it relates to key species/populations. [*LCC Staff Comment: COP needs to elaborate, provide specific details on areas of interest/importance.*]
- **Project Description:** Support a multi-scale vulnerability assessment (that incorporate species-specific physiological data) to identify habitats and species that would be most vulnerable to climate change in the LCC. This also needs to involve information on the human populations that are impacted by these climate changes. Coarse and fine scale. [*COP Comment: physiology includes environmental physiology, species-specific data- what are the thermal tolerances, and seasonal cues for organisms, and when plugged into population models, the predicted impact on the population level processes.*]

[AppLCC FY11/12 Funded Project (Young et al., NatureServe) “Understanding Land Use and Climate Change in the Appalachian Landscape “]

- **Project Description:** Identify effect of changing climate on species migration and distribution [across the AppLCC].
- **Project Description:** Landscape genetics-mine data from multi-species, multi-organizations to add as layers on landscape level spatial analysis. This will allow the identification of “genetic corridors” for obvious or cryptic movement of organisms, and “genetic hot-spots,” or areas that multiple species have high levels of genetic diversity to facilitate biological planning.
- **Project Description:** Species-habitat models that allow for the assessment of the capability of habitats to support populations at objective levels at present and in the future. Most existing species-habitat models do not allow for assessments of capacity, abundance or persistence/resilience.
- **Project Description:** Updated comprehensive population surveys-what are the current distributions, habitat preferences, and community/ecological necessities for organisms.

(Grouping) – *At-Risk Species/Populations & Endemics*

- **Project Description:** Climate change impacts on endemic and other native communities within the LCC including disease, range/habitat, breeding/spawning locations, migration routes {esp. aquatics}.
 - o **(related) Project Description:** Establish endemic species population trends [to investigate possible] relationships to climate change influences. Establish a profile of the human populations that manage the aquatic and endemic communities.

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

- **Project Description:** Work with federal, state and local agencies such as EPA and NRCS, and state agencies with parallel missions to obtain data relative to nutrient runoff and the human populations that have been targeted to reduce point and non-point source pollutants.

(Grouping) – *Invasive Organisms Effect on Species and Populations*

- **Project Description:** Identify [inter-related] effect of changing climate on invasives including: zoonotic and wildlife diseases, exotic plant and animal distribution {esp. in forests}.
- **Project Description:** [Document] climate change influences on invasive species across the US.

(Grouping) – *Effects of Disease (on a species or taxonomic group)*

F. HEADING: “HOW (THE LCC) SHOULD DO BUSINESS”

- Make conflict resolution and consensus building training more widely available in the conservation community; consider hosting joint sessions with industry or other public interests.
- Consider establishing and funding a full time social science position at the GS 12-14 level. The position should focus on establishing and sustaining working relationships in the form of inter-agency and inter-organizational networks. Often the missions of the various members of the network are similar to the goals and objectives of the AppLCC. Position requirement should focus on the fields of rural sociology and sociology, with a specific experience in community action research. The position should allow for short-term contracts establishing cooperative agreements with universities.
- Work with land trusts and land grant universities.

THEMATIC AREA:

HUMAN DIMENSIONS

(Environmental Benefits, Ecosystem Services, Social Expectations)

MISSION: *Incorporate ecosystem services values into natural resource decision-making.*

[Science objective] Conduct research necessary to sustain, enhance, and restore ecosystem services provided by natural ecosystems.

[Management objective] Develop and implement an ecosystem services framework to inform management actions and decisions in the Appalachian LCC region.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

(Grouping) – *Climate Change Science and abiotic or mechanical aspects*

(Grouping) – *Climate Change Impacts on Ecological Function and Response to Changes*

- **Project Description:** Continually measure and assess how climate change is impacting both biotic and abiotic resources of the Appalachians, and ecological functions.
- **Project Description:** Examine how predator's sustainability/population status will be impacted by climate change and potential for human-wildlife conflict/interactions increase.

(Grouping) – *Energy and Related Infrastructure and Roads*

(Grouping) – *Urbanization, Population Growth and (Domestic or Industrial) Water Demands*

- **Project Description:** Model land use practices to identify vulnerable ecosystem services, with focus on water quantity/quality but including all priority resources as determined by conservation and other stakeholder groups.
- **Project Description:** Describe water quality and supply for the LCC's freshwater resources, the human uses of those resources, and current or future conflicts between human and fish and wildlife needs for water. Model use and inter-dependency of water supply, and limiting factors contributing to potential future shortages to meet human and ecological needs.

(Grouping) – *Agricultural Expansion and (Ag-related) Water Demands*

(Grouping) – *Effects of Air Pollution*

- **Project Description:** Establish long-term monitoring of air quality parameters across Appalachian LCC due to acid deposition, mercury, sulfur, and ozone.

(Grouping) – *Cumulative Impacts*

- **Project Description:** Model cumulative impacts of lost ecosystem services.

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

(Grouping) – *Value/Ecosystem Services and Conflict*

- **Project Description:** Determine regional public attitudes, values, and opinions related to wildlife and natural resource conservation across the Appalachian LCC.
- **Project Description:** Determine methods to communicate complex technical issues to multiple stakeholders including decision-makers, especially information about ecosystem services.
- **Project Description:** Conduct opinion surveys to determine the public's preferences and priorities in regards to management of natural resources and ecosystem services.
- **Project Description:** Economic analyses to demonstrate the opportunity cost of losing our natural resources and ecosystem services.
- **Project Description:** Conduct an economic analysis to examine land use stressors *[and the community]* benefits of stream and wetlands restoration.
- **Project Description:** Economic valuation of goods and services provided by native bivalves.

(Grouping) – *Recreational, Commercial, Subsistence Use*

- **Project Description:** Evaluate the inter-relatedness of other ecosystem services and recreation: Focus on brook trout and freshwater mussels.
 - o **(related) Project Description:** Evaluate [the implications of] resource management decisions/policies on socioeconomic values: especially the relationship between brook trout and socioeconomic benefits.

- **Project Description:** Conduct opinion survey to better understand the cultural and overall social value of outdoor recreational activities in the Appalachian Mountains.

[LCC Staff/COP Comment: One Portfolio Reviewer offered the following project sequencing for consideration, noting that some services may already be known and could move to valuation and decision-making projects now:

1. *Identify the “most important” ecosystem services in the Appalachian region. Since the concept is connected to human well-being, this list will likely vary with location. Since we probably know or can easily develop this list for state and federal agencies, need to focus on public and stakeholders. What do they think is important? Includes mapping where these services exist on the landscape;*
2. *Identify drivers/stressors/threats to these services including linkages between structure and function (production functions), scaling issues, and appropriate metrics for quantifying, monitoring, and reporting changes. This includes work on bridging terminology gaps among disciplines and with public;*
3. *Conduct economic valuation of both market and non-market goods and services;*
4. *Develop an ecosystem services framework that includes scenario modeling, uncertainty analysis, and economic valuation to evaluate tradeoffs under different scenarios;*
5. *Identify and overcome barriers inhibiting agencies/organizations/general public from using ecosystem services science in decision-making.]*

C. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Measure and track degradation of Soundscapes.
- **Project Description:** Measure and track degradation of Viewsheds.

(Grouping) – Barriers (flows and species movement)

(Grouping) – Mitigating Ag and Forestry Impacts

(Grouping) – Protection & Restoration Approaches

4. PROGRAM: Ecological Functions of Natural/Intact Systems

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- o **Project Description:** Model individual ecosystem services at landscape scales and their cumulative benefits; map major ecosystem services provided in the Appalachians.
- o **(related) Project Description:** Map the significant beneficiaries of ecosystem services.
- o **(related) Project Description:** Establish metrics for measuring, reporting and verifying environmental performance of ecosystem services.

(Grouping) – Effects of Fire on Ecosystems

(Grouping) – Relationship/Ecological Flows and Nutrient Dynamics

- **Project Description:** Model nutrient dynamics as land use alters systems.

(Grouping) – Ecosystem Integrity/Resiliency

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – Basic Ecology/Ecological Relationships

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

(Grouping) – Basic Biological Information

- **Project Description:** Conduct studies that lead to broadening our understanding of the biology of organisms.

(Grouping) – At-Risk Species/Populations & Endemics

(Grouping) – Contaminants/Pollutants Effects on Species/Populations

(Grouping) – Invasive Organisms Effect on Species and Populations

- **Project Description:** Establish better tracking and coordination on the progression of invasive species into Appalachia (e.g. coordination through Aquatic Nuisance Panels).

(Grouping) – Effects of Disease (on a Species or Taxonomic Group)

F. HEADING: "HOW (THE LCC) SHOULD DO BUSINESS"

- Identify collaborative management opportunities by working with partners and stakeholders to identify existing foundational resources that describe the quality and supply of the LCC's freshwater resources, the human uses of those resources, and current or future conflicts between human and fish and wildlife needs for water.

THEMATIC AREA:

CLIMATE CHANGE

(Impacts, Downscale/Coupled Modeling, Adaptation)

MISSION: *Create an effective adaptation strategy for climate change based on the best available science.*

[Science objective] Provide the best available predictions of how the regional climate might change, and estimate the impacts those changes might have on the region's natural and cultural resources (in order).

[Management objective] To work with partners and stakeholders to determine adaptation and mitigation strategies that can be implemented and coordinated at a regional scale.

A. HEADING: REGIONAL LEVEL

1. PROGRAM: Landscape-level Disturbances & System-level Response

Examines major disturbances (includes climate change) as well as the impacts associated with these, regardless of ecological organization (e.g., community, species, population).

PROGRAM DESCRIPTION: *Project likely impacts climate change will have on the AppLCC, how those changes could affect the region, and work with partners to develop strategies to help human communities, industry, aquatic species and other conservation management interests, plan for, and adapt to those changes.*

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Develop a data catalog “Database of databases” to document historic or current long-term datasets being collected in the region.
 - o **(related) Project Description:** Archive important regional data that may be lost (e.g. such as SAMAB, or University research data sets). *[COP Comment: This may include local human history and obscure gray literature / newspaper / published histories that give information about previous vegetation, human activities. Many sources have not reached academic, geographic or ecological literature / databases.]*
 - o **(related) Project Description:** Develop a catalog of important climate publications; subset of the national work.
 - o **(related) Project Description:** Index technology and availability of ecologically scalable habitat-type focused imagery data (veg/forest types, talus, boulder or ground types, wetlands/water body) for application in species/habitat range and

habitat modeling/shifts.

[AppLCC FY 11-12 Funded Project (Baldwin, Clemson University) “Data Needs Assessment, to Support Conservation Planning for the Appalachian LCC”]

- **Project Description:** Develop a common set of parameters and data standards to facilitate integration of multi-agency/organization restoration, protection, and management (geo) databases into a more comprehensive conservation tracking system to: monitor land use land cover changes, refine decision support tools, and serve as sampling universe to test underlying assumptions.
- **Project Description:** Coordinate with the National Climate Assessment to build an indicator system that detects key climate change trends in the Appalachian LCC related to changes in land use, air and water pollution, water supply and demand, species and habitat ranges, pathogen and invasive species vectors, snowpack, and adaptation/response efforts.
- **Project Description:** Identifying/prioritizing species (population-level) or habitats (system-level) most at risk of effects from climate change, and developing subsequent management activities.

[AppLCC FY11-12 Funded Project (Young & Sneddon, NatureServe) “A climate change vulnerability assessment that will both assess CCVA methods in use, and identify vulnerable species and habitats within Appalachia”]

(Grouping) – *Climate Change Science and Abiotic or Mechanical Aspects*

- **Project Description:** Measure and model hydrologic regime changes related to climate change, including changes in water quality (temperature, chemistry) and quantity (storm intensity, floods, loss of stream baseflow, groundwater recharge, soil moisture, drought) to understand the impact of precipitation and temperature change on surface-water and groundwater hydrology in the context of regional land use, water use, recreation, industrial, municipal, agriculture, providing a needed basis for creating and synthesizing additional information on impacts to human and ecological systems. [COP Comment: *I imagine that changes in hydrology and soil moisture would be modeled with the Variable Infiltration Capacity (VIC) model by Cherkauer, or a similar complex process model.*]
- **Project Description:** Measure and track inter-annual variations in snow pack to support analysis of effects on high elevation species. [COP Comment: *This is very important, but difficult to measure. Monitoring snow depth requires physical measurements to be made at permanent plots. Most snow data is about snowfall, which is calculated from precipitation and temperature variables. Funding snow pack monitoring in an experimental design would be a good project.*]

(Grouping) – *Climate Change Impacts on Ecological Function and Response to Changes*

- **Project Description:** Characterize soil processes and chemistry changes due to changes in temperature and precipitation/moisture (as related to climate change). Identify parameters for highly vulnerable soils and map these areas (soil type, slope, position, elevation, land use). *[COP Comment: The effects on soil may be profound and have great effect on capacity to support vegetation types and fossorial species.]*
- **Project Description:** Examine how nutrient dynamics are influenced by climate change.
- **Project Description:** Use remote sensing technology to identify impact of climate change on edge habitat and migration corridors. *[COP Comment: I think the work of the USDA FS with ForWarn can get us there sooner rather than later with existing projects.]*
- **Project Description:** Apply landscape simulation models (e.g., LANDIS) that predict spatial and temporal dynamics of land-use/land cover under alternative scenarios (e.g., climate change, urban growth, energy development). *[COP Comments: Land cover changes are also going to be dependent on soil changes; These are very useful in combination with impact models (e.g., Tree Atlas) as a complementary approach to exploring forest impacts especially. Other impact- or process- modeling efforts can also add to the robustness of the information we inform our decisions with (VIC, PnET, etc.); Need more ground-truthing. Often the important elements / species are not well-detected by aerial views / ecosystem or forest typing. These may be the most sensitive for changes.]*
[COP Comment: I feel the three projects immediately above could be rolled into one, but the focus should be on changes to soil chemistry/hydrology/nutrient cycling. None of the models (that I'm aware of) that predict tree/plant species change (shift) as a function of climate change take into account soil types and processes. Plant species distribution is as much a function of soils and hydrology as temperature (if not more so), so I feel it's critical to consider how climate change will affect soil properties.]

(Grouping) – *Energy and Related Infrastructure and Roads*

- **Project Description:** Assess the relationship between climate change, energy development, and water-dependent socioeconomic sectors to inform regional and state-level energy and water use policies.
- **Project Description:** Compile comprehensive/validated road/transportation maps/data layers (for use in corridor, connectivity, invasive species analyses etc.).
- **Project Description:** Identify best management practices that are currently being used by land managers to increase energy efficiency and sequester carbon.
- **Project Description:** Use EPA and NRCS to develop a baseline of best management/ conservation practices/ systems.

(Grouping) – *Urbanization, Population Growth and (Domestic or Industrial) Water Demands*

- **Project Description:** Identify current land management practices and vulnerable ecosystem services.
- **Project Description:** Develop an electronic model and template that will allow for the ongoing assessment and evaluation of water quality and quantity for the LCC's freshwater resources, the human uses of those resources, and current or future conflicts between human and fish and wildlife needs for water.
- **Project Description:** Design a working model to identify the use and inter-dependency of water supply, and limiting factors contributing to potential future shortages to meet human and ecological needs.
 - o **(related) Project Description:** Identify barriers and promote strategies focusing on maintaining drinking water in the Southeast.

(Grouping) – *Agricultural Expansion and (Ag-related) Water Demands*

- **Project Description:** Identify current conservation practices on private lands focusing on irrigation management and other related agricultural water practices.
- **Project Description:** Document the quantity and quality of water on agricultural lands in light of urban encroachment on rural landscapes. Obtain data from local state and Federal agencies along with non-profits to identify the number and types of small-specialized agricultural operations that impact water resources.

(Grouping) – *Effects of Air Pollution*

- **Project Description:** Establish long-term monitoring of air quality parameters across Appalachian LCC due to acid deposition, mercury, sulfur, and ozone.

(Grouping) – *Cumulative Impacts*

- **Project Description:** Develop guidelines and principles for creating adaptation strategies. Develop an organized approach to developing relevant strategies, from adaptation concepts to adaptation actions, to provide a clear process.
- **Project Description:** Evaluate the interaction among land use, climate change, invasive species, and/or other environmental stressors to develop strategies for adaptation. Strategies: human interactions, biological augmentation, genetic banking, and restoration efforts.
- **Project Description:** Conduct a detailed literature search to identify the cumulative impacts of lost ecosystem services.

B. HEADING: HUMAN DIMENSIONS

2. PROGRAM: Social Component

(Grouping) – *Value/Ecosystem Services and Conflict*

- **Project Description:** Support economic and cultural analyses related to decision-making about land use, land management, water resources, ecosystem services, and how these sectors respond to changes in the climate system.
- **Project Description:** Map or develop overlays of the human populations and demographics at the specific geographic local in order to develop most effectively information and education-outreach strategies. Most specifically, it is important to develop a socioeconomic profile at local levels that have been identified as having vulnerable species, populations, or are where climate estimates indicate significant adversely impacts – or significant resilience – related to climate change.
- **Project Description:** Support a multi-scale vulnerability assessment to identify human populations, inhabited geographic areas, and infrastructure or other human interests that would be most vulnerable to climate change in the LCC (i.e. a climate vulnerability assessment for humans).
- **Project Description:** Assemble climate change scenario planning methods to support policy development at local levels and to broaden civil society’s understanding of a changing climate.
- **Project Description:** Develop, administer and analyze a survey instrument to determine regional public attitudes, values, and opinions related to wildlife and natural resource conservation across the Appalachian LCC.
- **Project Description:** Develop a customized internal and external information dissemination plan including messages and strategies for all stakeholder groups- public citizens, public officials, program managers and others. Determine methods to communicate complex technical issues to multiple stakeholders including decision-makers, especially information about ecosystem services.
- **Project Description:** Conduct opinion surveys to determine the public’s preferences and priorities in regards to management of natural resources and ecosystem services.
- **Project Description:** Conduct an economic assessment to demonstrate the opportunity cost of losing our natural resources and ecosystem services. Also include an economic analysis to examine land use stressors and the community benefits of stream and wetlands restoration.

- **Project Description:** Research and analyze economic valuation of goods and services provided by native bivalves.

(Grouping) – *Recreational, Commercial, Subsistence Use*

- **Project Description:** Determine climate impacts on Recreation.
- **Project Description:** Determine climate impacts on Subsistence.

C. HEADING: SYSTEM LEVEL

3. PROGRAM: Ecological Functions of Managed/Human-Altered Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

(Grouping) – *Barriers (flows and species movement)*

(Grouping) – *Mitigating Ag and Forestry Impacts*

- **Project Description:** Develop/compile best practices for forestry and agriculture that reduce vulnerability and build resistance and resilience to negative climate change impacts across the landscape. This should be done in cooperation with agencies that have extension worker networks such as NRCS, state forestry departments, and/or farm bureaus.
- **Project Description:** Develop a socioeconomic profile of human populations managing the impacted natural resource base.

(Grouping) – *Protection & Restoration Approaches*

- **Project Description:** Develop a common set of parameters and data standards to facilitate integration of multi-agency/organization restoration, protection, and management (geo) databases into a more comprehensive conservation tracking system to: monitor land use land cover changes, changes in human populations, refine decision support tools, and serve as sampling universe to test underlying assumptions.

4. PROGRAM: Ecological Functions of Natural/Intact Systems

(Grouping) – *Foundational/Stock-taking Assessment/Classification System*

- **Project Description:** Compile consistent land-use/landcover classification and mapping using common ecological systems or similar nationally consistent classification system, ideally with 5-year updates. [COP Comment: This is being discussed/addressed among the broader LCC community in cooperation w/ the NAWMP NSST.]

- **Project Description:** Compile updated, complete and coordinated land cover data (NLCD, NWI, etc.).
- **Project Description:** Increase use/availability of LIDAR technology and infra-red mapping in water/land thermal mapping (temporal/spatial applications for aquatic, wetland terrestrial habitat etc.).
- **Project Description:** Compile consistent secured (protected) lands spatial data system that allows assessment of lands and habitat types in the conservation estate. The system should include both public and private lands (conservation easements), and should be updated annually. (Purpose: Needed for analysis of how well habitats are represented in the conservation estate.)
- **Project Description:** Assemble existing vegetation plot/releve data from the region in a central database (e.g., VegBank) so that it is accessible for quantitative analyses of species and habitat distribution, range shifts, and environmental requirements/tolerance. Existing vegetation plots within the Appalachian LCC likely number well over 10,000. Encourage plot sampling of data-poor habitat types.

[COP Comments: All of the projects mentioned above in 4. are cross-cutting, needed for all Portfolio Themes and in fact are not either limited to climate change or very closely aligned with the stated program description of Ecological Function. Having said that though I feel the standardization, rapid deployment of updates, and standard classification schemes is the most critical thing we need on the ground but requires National-level coordination and planning. Lastly, planning for updates to keep the information relevant should be a critical element of any project or effort.]

(Grouping) – Effects of Fire on Ecosystems

- **Project Description:** Work with federal, state and local partners to assess conservation practices related to fire and prescribed burning.
- **Project Description:** Assess human populations that are most vulnerable to increasing temperature and fire- characteristics of the population such as age, transportation routes to and from fire hazard areas.
- **Project Description:** Work with NRCS as partner to determine areas that use prescribed burning as a conservation practice.

(Grouping) – Relationship/Ecological Flows and Nutrient Dynamics

- **Project Description:** Assess impacts on species range shifts and losses of ecosystem function related to changes in climate parameters including extreme weather events, water/ fire regimes, food availability and nutrient cycles.

- **Project Description:** Research carbon source and sink dynamics of natural sites and common management practices. Deepen understanding of the relationship between the fate of human-induced and natural carbon emissions, and subsequent uptake and storage by the terrestrial biosphere.
- **Project Description:** Stream classification system and subsequent geospatial data used to quantify the amount and types of streams and rivers allowing conservation partners to better allocate conservation actions and resources, and recommend flow and hydrology policies and management actions for streams that lack site specific data.

[AppLCC FY11/12 Funded Project (Anderson et al., The Nature Conservancy & ORNL) “A Stream Classification System for the Appalachian Landscape Conservation Cooperative”]

(Grouping) – *Ecosystem Integrity/Resiliency*

- **Project Description:** Coarse-filter assessments of ecological integrity, connectivity, and resilience to complement priority species approach and which would support land acquisitions, conservation investments, and planning. *{Examples include CAPS in Massachusetts and Geophysical and Resilient System Approach to Climate Change Adaptation proposed by TNC in the Northeast.}*
- **Project Description:** Identify potential climate refugia inside and outside natural sites, where there is higher likelihood of maintaining biodiversity values (e.g., species, habitats, evolutionary processes).
- **Project Description:** Develop comprehensive models that consider terrestrial and aquatic conservation needs by incorporating an aquatic component (e.g. stream and river networks) into terrestrial landscape models.

D. HEADING: COMMUNITY LEVEL

5. PROGRAM: Community Level (Description and Function or Basic Community Ecology)

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Update the National Vegetation Classification (NVC) with unique environmental descriptors to accompany floristic descriptions, in order to identify the range of ecological niches that should be conserved, even if species migrate and the natural communities become unrecognizable in terms of floristics. The NVC represents a key baseline index of the diversity of communities and environments in the Appalachian LCC. Upgrading the NVC to allow its use into the future is a key step in allowing science-based conservation to move forward. Habitats that have not yet been described in the NVC should be a priority for inclusion.

(Grouping) – Basic Ecology/Ecological Relationships

- **Project Description:** Assess the assumptions related to use of focal or representative species approach to guide development of decision support tools, i.e. do these approaches adequately represent larger sets of species and how do they compare to coarse-filter approaches.

E. HEADING: SPECIES/POPULATION LEVEL

6. PROGRAM: Basic Biological Understanding (Species-level)

(Grouping) – Foundational/Stock-taking Assessment/Classification System

- **Project Description:** Assemble and/or develop high resolution species range maps in a standard GIS format, with an emphasis on foundational species (e.g., red spruce), ecosystem engineers (e.g., beaver), climate indicator species (e.g., Lepidoptera or spiders that are known to move with climate), highly vulnerable species (e.g. high elevation amphibians), and other species or groups of interest. *{Nice example in Southeastern Naturalist 11(4):551-566 mapping Golden Silk Orbweaver occurrences moving northward since 1863}.*
- **Project Description:** Compile georeferenced species occurrence and population viability data in a central database (e.g., NatureServe Explorer), with updates on a yearly basis. Such data forms the basis for a broad base of quantitative and/or spatial assessments.

(Grouping) – Basic Biological Information

- **Project Description:** Identify critical thresholds in species' physiological tolerances and abilities to adjust or adapt to short term and long term habitat alterations caused by changing climate.
- **Project Description:** Develop an ecological health index for high elevation (and other at-risk) communities based on phenological variables (e.g. bud burst, migration timing, etc.).
- **Project Description:** Support a multi-scale vulnerability assessment (that incorporate species-specific physiological data) to identify habitats and species that would be most vulnerable to climate change in the LCC. (Coarse and fine scale). *[Notes: physiology includes environmental physiology, species specific data- what are the thermal tolerances, and seasonal cues for organisms, and when plugged into population models, the predicted impact on the population level processes.]*
 [AppLCC FY11/12 Funded Project (Young & Sneddon, NatureServe) "Understanding Land Use and Climate Change in the Appalachian Landscape "]
- **Project Description:** Identify effect of changing climate on species migration and distribution across the AppLCC; elevation and micro scale habitat related to aspect, elevation, etc. create opportunities for fine scale and macro scale changes and adaptation (like the specific location, timing, elevation, etc. of migrant species).
- **Project Description:** Landscape genetics-mine data from multi-species, multi-organizations to add as layers on landscape level spatial analysis. This will allow the identification of "genetic corridors" for obvious or cryptic movement of organisms, and "genetic hot-spots," or areas that multiple species have high levels of genetic diversity to facilitate biological planning; critical for our LLC given the preponderance of endemic or possible endemic trinomial and clines.
- **Project Description:** Species-habitat models that allow for the assessment of the capability of habitats to support populations at objective levels at present and in the future. Most existing species-habitat models do not allow for assessments of capacity, abundance or persistence/resilience. And for some fauna, no or limited models exist (herps). *[COP Comment: Suggest developing this as smaller a pilot/proof-of-concept type of project. Given all the species of endemics with restricted ranges in the Apps, this project could be helpful in addressing their conservation needs under climate change. I suggest that the modeling be done on select species that represent high-priority species in the LCC (e.g. one of the woodland salamanders, a migratory bird species, and maybe a small mammal species; should already be well studied and relatively abundant in the landscape (where it occurs – i.e. it's ok if it has a relatively small range), but also viewed as susceptible to/threatened by climate change.]*
- **Project Description:** Updated comprehensive population surveys-what are the current distributions, habitat preferences, and community/ecological necessities for organisms.

(Grouping) – *At-Risk Species/Populations & Endemics*

- **Project Description:** Assess climate change impacts on endemic and other native communities within the LCC including disease, range/habitat, breeding/spawning locations, and migration routes {esp. aquatics}. *[COP Comment: This is very broad. Rather than comprehensive surveys (for this climate change theme), I would rather see targeted research on thresholds in climate tolerance of species, as listed in one of the projects above.]*
 - o **(related) Project Description:** Establish endemic species, trinomial taxa, and unique genetic group population trends to investigate possible relationships to climate change influences.
 - o **(related From Aquatics) Project Description: [S]** Identify temp and flow tolerance limits of species and appropriate management technologies to improve the management of controlled systems to reduce impacts on downstream communities.
 - o **(related from Aquatics) Project Description: [N]** Assess aquatic species vulnerability to changes in stream flow and temperature, water quality. *[COP Comment: This CSC project on spatial and temporal variability of fishes in response to Climate Change may be a good guide for work related to benthics or other target species. <https://nccwsc.usgs.gov/display-project/4f8c648de4b0546c0c397b43/50070884e4b0abf7ce733fee>]*
 - o **(related from Aquatics) Project Description: [N]** Responses of populations to altered thermal /hydrologic regimes. *[COP Comment: Specify or ask the researcher to specifically target certain species or a group of species that are most likely at risk. Conversely, specify that this must be done for the most abundantly available biological data source—Benthic macro invertebrates across Appalachia.]*

(Grouping) – *Contaminants/Pollutants Effects on Species/Populations*

- **Project Description:** Work with federal, state and local agencies such as EPA and NRCS, and state agencies with parallel missions to obtain data relative to nutrient runoff and the human populations that have been targeted to reduce point and non-point source pollutants.

(Grouping) – *Invasive Organisms Effect on Species and Populations*

- **Project Description:** Identify impacts of changing climate on invasives including: zoonotic and wildlife diseases, exotic plant and animal distribution {esp. in forests and ranavirus and chytrid fungus}. Part of impact assessment would be predictive modeling to support early detection and rapid response action.

(Grouping) – *Effects of Disease (on a Species or Taxonomic Group)*

F. HEADING: “HOW (THE LCC) SHOULD DO BUSINESS”

- Participate in national enterprise systems through the networks of LCCs and Climate Science Centers (CSCs) that will compile information from multiple sources at larger relevant scales than the AppLCC. “Don’t build your own.”
- Work with partners to develop regional climate adaptation strategies that will, to the extent possible, help ensure the persistence of healthy human and fish and wildlife communities in the face of changing climatic conditions. Such strategies would reduce vulnerability to negative impacts, build ecosystem resistance and resilience, and improve landscape integrity and connectivity.
- Identify natural sources/examples of adaptation. (Species that are less sensitive to climate change serve as an example of strategies to manage throughout the LCC.)
- Serve as a clearinghouse to ensure that there is coordination and sharing of datasets and current climate change research products; host datasets and products that have no other established “home.” Link to existing clearinghouses, especially those that are national or international in scope, where possible. Link decision-makers to adaptation tools, data, and expertise that support adaptation decision-making. Foster proactive communication between the scientific community, decision-makers, and land managers. Support large-scale monitoring efforts to document and track impacts of climate change on Appalachia.

[2010-xx NASA/URI Funded Project] Mega-Transect - large-scale, multi-agency/research for climate change monitoring and impact studies (and 2012 NASA/NPS Funded Project) across the Appalachian and Rocky Mt Transect]

- Consider establishing and funding a full time social science position at the GS 12-14 level. The position should focus on establishing and sustaining working relationships in the form of inter-agency and inter-organizational networks. Often the missions of the various members of the network are similar to the goals and objectives of the AppLCC. Position requirement should focus on the fields of rural sociology and sociology, with a specific experience in community action research. The position should allow for short-term contracts establishing cooperative agreements with universities.
- Compile, develop, and make available consistent managed-lands spatial data and products.
- Identify institutional strategies to support adaptation to climate change, including revisions to legal codes and policy practices. Identify capacity-building needs of institutions and land managers and promote exchanges and training that result in an increase in their adaptive capacity.
- Explore ways that the activities of the LCC and its partners can become carbon neutral by reducing and/or offsetting the carbon emissions of their activities.

- The ability to think in terms of triage for the most vulnerable will unfortunately become more common and should then be underpinned with systems level planning for those changes, providing for corridors, larger landscape resilience etc.
- As with other thematic units the LLC can and should be the source for organizing the rapidly developing science and management trials and pushing that back out to planners and managers as fast as is possible and meaningful.