Illustrative list of Identified Conservation Research Needs / Interests – Appalachian LCC Region

**Ad hoc compilation – shared by implementing organizations and institutions*

Thematic Areas of Research Interest/Needs

1. [Foundational Information and Information Management]
2. [Aquatic Communities]
3. [Cave and Karst Communities]
4. [Forest Communities]
5. [Climate- and Land Use-Change]
6. [Ecosystem Services and Benefits]

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1. [Foundational Information and Information Management]

(e.g., "Need to identify what common data set that can be used in developing conservation network designs, or need to be assembled and standardized, and made available or linked to data servers to provide organizations with the same foundational data.")

1a. Freshwater Mussel Conservation Planning GIS/database tool

Proposal: Build upon existing tool: expanding it to other states in an effort to standardize and support a common aquatics database for conservation planning

Background: TNC developed a database and spatial mapping tool to manage the large amounts of data on Species of Greatest Conservation Need (SGCN), their habitats, and problems affecting these species and habitats as the foundational materials to help inform the State Wildlife Action Plan (SWAP). The final advancement of the GIS/Access tool being made at this time is the utilization of National Hydrography Dataset+ (NHD+) information, allowing watersheds to be broken down into smaller scale catchments which are useful for analyzing both local scale and cumulative point and nonpoint source watershed impacts.

1b. Eastern Brook Trout Science and Research Focus List

Specific Areas of Research: (1) Identifying baselines and their current range, trajectories and gaps in knowledge (focus on baseline / existing data) [e.g., Evaluate baseline assessment approach; Groundtruth assessment (i.e. test models)]; (2) Appropriate standardization of sample design, methodology, and monitoring for data analysis [e.g., Scale of assessment vs. sample scale vs. project scale; Identification of suitable accountability measures, robust measures of success].

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2. [Aquatic Communities]

2a. Enhance existing recovery planning of federally listed aquatic species

Specific Area (Planning): Can more efficiently address recovery with a strong cross-program partnership commitment between Fisheries and ES (endangered species). Recovery could be enhanced and achieved for some mussel species with better strategic planning that directs and

focuses resources towards priority actions and delineates more specific objectives and population goals, by watershed, for each priority species.

2b. Clinch-Powell Clean Rivers Initiative Science Plan

Proposal: Indentify specific stressors responsible for the biological decline of globally rare freshwater mussels using the Clinch and Powell Rivers as the model to inform remedial actions and enhance Clean Water Act implementation.

Specific Areas of Research: (1) Measure environmental properties and processes with a potential to act as influential stressors at locations representing a range of in-stream conditions using the Clinch and Powell as a system for analysis; (2) Expose laboratory reared native mussels *in situ* to the environmental conditions at those locations and determine the biological responses; and (3) From among the environmental variables measured, identify those that are statistically correlated with critical population metrics (e.g. species diversity, age class distribution, etc. based on previous mussel sampling efforts) and/or biological responses of caged or resident mussels in a manner that indicates probable causative link.

2c. Modeling selenium bioaccumulation in stream food webs in the Appalachian coalfields

Proposal: Selenium (Se) naturally occurs within geological formations in Appalachia, and may be mobilized into downstream waters by surface mining operations. High doses of Se may cause developmental abnormalities and population declines in fish and wildlife. Identify Se levels mobilized into downstream waters by surface mining operations to determine water quality standards from an aqueous concentration to a fish tissue concentration.

Specific Areas of Research: (1) What are the population-level effects of Se bioaccumulation in fishes; (2) Over what spatial and temporal scales does Se bioaccumulation influence stream fish communities; (3) Does Se bioaccumulation in streams affect riparian foodwebs.

2d. Eastern Brook Trout Science and Research Focus List

Specific Areas of Research: (1) Fish-habitat relationships, including human impacts and their variation at different scales (focus on trout biology) [e.g., Brook trout response to changes in the annual flow cycle in streams and rivers; Determination of persistent population size; Determination of effective population size from a genetic perspective]; (2) Identifying and predicting impacts and their cumulative effects, and determining thresholds above which fish populations recover [e.g., Identification of factor and elements of successful and unsuccessful restoration techniques; Impacts of projected changes in land use / water use on restoration potential (e.g. Marcellus Shale development); Incorporation of climate change into restoration potential at small scales].

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3. [Cave and Karst Communities]

3a. Utilize technology to detect abnormal emergence behavior by bats outside hibernacula as an "early warming" of White Nose Syndrome

Proposal: Assesses the use and efficacy of utilizing electronic monitoring systems as a potential WNS "early warning" indicator. First system uses a beam-break that allows the automated counting of bats within hibernacula through the use of paired infrared (IR) beams which allow for detection of individual bats and their direction of travel. The system will function full time,

year-round, and can be used to study relationships between environmental variables and bat emergence behavior, including eventual prediction of peak spring emergence. The beam-break system cannot distinguish among bat species in sites with multiple species present; however this limitation can be overcome when used in conjunction with the Anabat acoustic detection systems at selected sites to provide an index to the percentage of each species present. .

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4. [Forest Communities]

4a. Community-based habitat restoration and rehabilitation and population response modeling

Proposal: Development of a suite of landscape-level habitat models linking habitat characteristics with population and response objectives for priority forest birds and bats in the Appalachian Mountains region

4b. Long-term prescribed burning for restoration objectives

Proposal: Study the impacts of multiple prescribed fires --long-term repeated prescribed fire -- to soils, water, and fauna as a strategy to achieve desired conditions (ecological process and ecosystem health): develop a better understanding of how fire chronology varies across the region and among sites within a landscape will help to define the fire regimes capable of achieving realistic restoration goals.

Specific Areas of Research: (1) What are the impacts of burning in different seasons and at different frequencies to each component of the ecosystem and how should these fire regimes be changed to fit the highly variable sites across the landscape; (2) Will long-term burning move ecosystems toward a desired outcome or will the same goal be achieved by climate change; (3) Will restoration by different long-term prescribed burning regimes improve ecosystem resilience to other disturbances such as diseases, insects, invasive flora and fauna, wind and ice; (4) What are the direct impacts of prescribed fire on threatened and endangered species that currently regulate the burning window.

4c. High elevation conservation and restoration of ed spruce-northern hardwood and wetland ecosystem

Specific Areas of Research: (1) Identify spruce forest reference conditions for restoration purposes; (2) using latest science and tools identify high priority areas for spruce community restoration and conservation (analysis should include selecting sites by their expected resiliency to changing temperature and precipitation patterns); (2) Identify threatened areas of highest priority for red spruce community restoration; (3) understand soil carbon relationships with conifer forests; (4) Development of a restoration model in GIS to help evaluate and implement strategic locations for restoration projects (the model would use base layers to evaluate least cost path and greatest biological benefit (based on user criteria) to provide areas best suited for restoration).

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5. [Climate- and Land Use-Change]

5a. Assessing Freshwater Mussel Vulnerability to Changes in Streamflow and Temperature Associated with Climate Change

Specific Areas of Research: (1) Assess the impact of changing streamflow and stream temperature on existing mussel populations in the Clinch River utilizing Global Climate Model (GCM) predicted precipitation and air temperature data with forecasted land use change data sets; (2) Assess the impact of changing streamflow and stream temperature on potential mussel re-introduction and refugia throughout the Upper Tennessee River Basin (UTRB); (3) Assess the combined impacts of projected water supply withdrawals, climate change, and future land use conditions on existing mussel populations and potential re-introduction sites for rivers in the UTRB; (4) Develop a Decision Support System to aid managers in evaluation of risks associated with streamflow and stream temperature scenarios, habitat persistence predictions, land use change effects on freshwater mussels and future water supply needs. The results from these scientific research activities should directly inform Endangered Species Act Section 7 consultations and state water-supply planning initiatives throughout the UTRB.

5b. Effects of fragmentation on stream fish vulnerability to climate change in Appalachia

Specific Areas of Research: Predicting biological responses to climate change requires an understanding of spatially-explicit dispersal and migration dynamics, but most current models lack this necessary spatial resolution: (1) What proportion of Appalachian stream fish species would require range shifts based on projections from downscaled water temperature change models; (2) To what extent would major barriers affect such potential range shifts; (3) Which stream networks would exhibit the greatest and least resiliency in this regard.

5c. Vulnerability of fish species and communities to Marcellus shale development in Appalachia

Specific Areas of Research: Marcellus shale development is proceeding rapidly in the mid-Atlantic highlands region, and the potential consequences for freshwater biodiversity are largely unknown. Given the importance of water withdraw and discharge for shale extraction and the importance of flow regimes for freshwater biodiversity, a spatial analysis of biological vulnerability to shale development could provide an important planning tool: (1) Where do shale development permits and freshwater biodiversity hotspots overlap in Appalachia; (2) Which rare, threatened, and endangered species show the most and least overlap with shale development permits; (3) Which taxonomic groups and species traits may be most appropriate for biological monitoring of shale development in Appalachia.

5d. High elevation conservation and restoration of red spruce-northern hardwood and wetland ecosystem

Specific Areas of Research: Conduct viability modeling and sensitivity analyses for those species most likely to be affected by climate change so that we can see what landscape-level parameters (or microhabitat features) are best for land managers to key in on now to try and proactively manage habitats for those species.

6. [Ecosystem Services and Benefits]

6a. Eastern Brook Trout Science and Research Focus List

Specific Areas of Research: Evaluation of management activities and socioeconomic values [e.g., Relationship between brook trout and socioeconomic benefits; Cost-effectiveness of restoration techniques; Relationship between brook trout and production of ecosystem services; Economic impact assessment of brook trout throughout their historic range; Brook trout intrinsic value and value of brook trout fisheries].

6b. Linking People, Nature and Landscapes through Sound Science

Specific Areas of Research: (1) How do you track ecosystem services across the landscape; (2) How do you more closely link landscape conservation (and land use) planning to water quality Issues; (3) How do you better quantify the benefits (ecological goods and services) of Green Infrastructure, especially the role of landscape conservation in climate adaptation strategies; (4) How do you incorporate cost/benefit analysis into landscape network design

6c. High elevation conservation and restoration of red spruce-northern hardwood and wetland ecosystem

Specific Areas of Research: Conduct water value case study to show the ecological, economic, and human health importance of water coming from the high elevations of Central Appalachian forests to large population centers on the east coast.

6d. Integrating ecosystem services and adaptive management: Focus on brook trout and freshwater mussels

Proposal: Develop an analytical decision framework to engage resource managers and other stakeholders with the science community to better understand the impacts of native brook trout and mussel management decisions in the context of complex and dynamic changes associated with climate- and land-use change.

Specific Areas of Research: The work proposed here builds on existing research already identified as necessary to sustain and restore native brook trout and freshwater mussels in the ALCC region: (1) assess sensitivity of stream temperatures to increasing air temperatures and develop predictive models of stream temperature and thermal refugia under climate change scenarios (developing stream temperature models that predict reach –level thermal habitats from air temperature, solar radiation, canopy cover, topographic shading, and groundwater influence) using downscaled air temperature data; (2) evaluate vulnerability to climate change by developing predictive models for species occurrence based on the potential effects of water temperature changes; (3) apply structured decision-making (SDM) tools for resource managers to prioritize conservation actions for key species based on predictions regarding climate-changed induced changes and distribution to alternative management actions using SDM.