**Appalachian LCC**

**Climate change vulnerability methods: narrative descriptions**

**September 30, 2012**

**Bagne, K.E., M.M. Friggens, and D. Finch. 2011**. A system for assessing vulnerability of species (SAVS) to climate change. Gen. Tech. Rep. RMRS-GTR-257. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 28 p. Available online at http://www.fs.fed.us/rm/pubs/rmrs\_gtr257.pdf

The system for assessing vulnerability of species (SAVS) is a simple and flexible tool designed for managers to assess the relative risk of individual species to population declines in response to projected changes in climate and related phenomena. The SAVS uses an easily completed questionnaire based on predictive criteria that translate response of terrestrial vertebrate species into scores indicating vulnerability or resilience to climate change. In addition to the scoring tool itself, authors provide worksheets for score calculations, methods for calculating uncertainty, detailed instructions for scoring a species, guidelines for tool application, a glossary of terms, and discussion of application of scores to vulnerability assessments.

**Coe, S.J., D.M. Finch, and M.M. Friggens.** 2012. An assessment of climate change and the vulnerability of wildlife in the Sky Islands of the Southwest. Gen. Tech. Rep. RMRS-GTR-273. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 208 p. Available online at http://www.fs.fed.us/rm/pubs/rmrs\_gtr273.pdf

Reviewed scientific literature on historical trends in climate and vegetation. Climate Wizard was used for climate data. Projections of vegetation change in the western US were used to predict where suitable climate for plant communities may exist. Projections of vegetation change were developed by Rehfeldt et al. (2006) using regression tree analysis of plant presence-absence data, Random Forests algorithm, and climate data at 1 km resolution. Current and projected maps of vegetation were generated.

**Comer, P. J., B. Young, K. Schulz, G. Kittel, B. Unnasch, D. Braun, G. Hammerson, L. Smart, H. Hamilton, S. Auer, R. Smyth, and J. Hak.** 2012. Climate Change Vulnerability and Adaptation Strategies for Natural Communities: Piloting methods in the Mojave and Sonoran deserts. Report to the U.S. Fish and Wildlife Service. NatureServe, Arlington, VA. Available online at https://connect.natureserve.org/sites/default/files/documents/NatureServe\_HCCVI\_Report.pdf

The Climate Change Vulnerability Index for Ecosystems and Habitats (HCCVI) documents series of indicators of vulnerability to climate change.  Indicators are organized within categories of indirect effects, direct effects, and adaptive capacity.  A series of 3-5 indicators for each of these, each requiring a separate type of analysis, produces sub-scores that are then used to generate an overall score or rating of relative vulnerability for the community type.  Indirect effects assessed include past and current landscape condition, current invasive species effects, and dynamic process alterations. Adaptive capacity factors include intra-habitat diversity, keystone species vulnerability (assessed separately using the CCVI), bioclimatic variability, etc. The individual scores from indirect effects and adaptive capacity are used to calculate a resilience score. Direct climate effects (climate stress index, envelope shift index, and dynamic process forecast) are similarly scored, and these are used to generate a sensitivity score. The sensitivity and resilience scores are then combined to generate a final vulnerability score.

**Enquist, C. and D. Gori.** 2008. A climate change vulnerability assessment for biodiversity in New Mexico, Part I. Implications of recent climate change on conservation priorities in New Mexico. The Nature Conservancy and Wildlife Conservation Society. 49 pages plus appendices.

Downscaled climate data generated by the PRISM model was used in combination with an expert-based conceptual framework to address further the temperature and precipitation variations in mountainous terrain. Climate maps were generated for New Mexico by averaging across annualized PRISM grids for each year of a 30-year time frame for temperature and precipitation. Extreme climatic effects were also accounted for by generating anomalous departures of mean temperature and precipitation for two time periods. Climate exposure scores were generated for conservation targets (species, communities, and ecosystems) using location data from the New Mexico Natural Heritage Program and summarized location data across key conservation areas by 1) drought-sensitivity of species and four terrestrial groups: birds, mammals, amphibians, and plants.

**Galbraith, H. and J. Price**. 2009. U.S. Environmental Protection Agency (EPA). (2009) A framework for categorizing the relative vulnerability of threatened and endangered species to climate change. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/011. Available from the National Technical Information Service, Springfield, VA, and online at <http://www.epa.gov/ncea>.

Vulnerability of species is conducted using a framework composed of four modules. Module 1 categorizes baseline vulnerability to extinction or major population reduction by scoring those elements of the species’ life history, demographics, and conservation status that influence the likelihood of its survival or extinction (excluding climatic changes); Module 2 scores the likely vulnerability of a species to future climate change, including the species’ potential physiological, behavioral, demographic, and ecological response to climate change; Module 3 combines the results of Modules 1 and 2 into a matrix to produce an overall score of the species’ vulnerability to climate change, which maps to an adjectival category, such as “critically vulnerable”, “highly vulnerable”, “less vulnerable”, and “least vulnerable”; Module 4 is a qualitative determination of uncertainty of overall vulnerability (high, medium, and low) based on evaluations of uncertainty done in each of the first 3 modules. Inputs for modules are based on empirical evidence where available, supplemented with expert opinion.

**Galbraith, H.** In prep. Development and structure of the NEAFWA habitat vulnerability assessment model.

This advance copy of a draft report details the formation and input of an expert panel, and the development of a spreadsheet model comprised of four modules. Module 1 comprises 11 variables and scores the likely vulnerabilities of non-tidal habitats to future climate change (and the potential interaction between climate and non-climate stressors). Module 1 can be used alone if the objective is limited to only categorizing climate change vulnerabilities, rather than overall future vulnerabilities. Module 2 has 5 variables and scores the comparative vulnerabilities of habitats to existing, non-climate change stressors. Module 3 combines the results of Modules 1 and 2 to produce an overall evaluation and a score of the habitat’s future vulnerability to climate change and to non-climate stressors. Module 3 also groups these scores into five categories: critically vulnerable, highly vulnerable, vulnerable, less vulnerable, and least vulnerable. These translate into habitat response categories varying from habitats that are likely to be eradicated from or greatly reduced in the study area (critically and highly vulnerable, respectively) to habitats that may be relatively unaffected (vulnerable), to habitats that may extend or greatly extend their range within the area (less and least vulnerable, respectively).

**Gonzales, P., R.P. Neilson, J.M. Lenihan, and R.J. Drapek.** 2010. Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. Global ecology and biogeography 19: 755-768. Available online at http://onlinelibrary.wiley.com/doi/10.1111/j.1466-8238.2010.00558.x/abstract

Examining global vegetation biomes, the authors examined nine combinations of three sets of potential indicators of the vulnerability of ecosystems to biome change: (1) observed changes of 20thcentury climate, (2) projected 21st-century vegetation changes using the MC1 dynamic global vegetation model under three Intergovernmental Panel on Climate Change (IPCC) emissions scenarios, and (3) overlap of results from (1) and (2). Estimating probability density functions for climate observations and confidence levels for vegetation projections, areas were classified into vulnerability classes based on IPCC treatment of uncertainty.

**Iverson, L.R. and A.M. Prasad.** 2001. Potential Changes in Tree Species Richness and Forest Community Types Following Climate Change. Ecosystems 4: 186-199. Available online at http://www.fs.fed.us/ne/newtown\_square/publications/other\_publishers/OCR/ne\_2001\_iverson001.pdf

The authors used DISTRIB, a regression tree analysis, to predict suitable habitat for individual tree species. The relationship between 33 environmental variables and 80 tree species was analyzed using against five climate scenarios. Distribution maps of forest types, using different classification schemes, were produced by plotting FIA data for each tree species, and potential distribution changes of each type were also mapped. Although not explicitly a vulnerability analysis, the maps could be used to determine vulnerability of forest types.

**North Carolina Natural Heritage Program**. 2010. North Carolina Ecosystem Response to Climate Change:  DENR Assessment of Effects and Adaptation Measures. Office of Conservation, Planning, and Community Affairs, NC Department of Environment and Natural Resources, Raleigh, NC 27699.

The authors use the Climate Wizard mid century (2050s) ensemble average model with the medium A1B emission scenario to estimate regional changes in temperature and frequency of droughts, floods, wind damage, and wildfires for each of 42 ecosystem groups. Information is integrated with ongoing threats, particularly habitat loss and invasion of exotic species. The goal of the analysis is to provide the predicted climate change effects and possible ecosystem responses to these effects.

**North Carolina Natural Heritage Program**. 2010. North Carolina Ecosystem Response to Climate Change:  DENR Assessment of Effects and Adaptation Measures. Spruce-Fir Forests. Office of Conservation, Planning, and Community Affairs, NC Department of Environment and Natural Resources, Raleigh, NC 27699.

Methods as noted above, and used to determine the vulnerability of two Appalachian ecosystems; results are also extrapolated to species endemic to the ecosystems.

**Potter, K.M. and B.S. Crane**. 2010. Forest tree genetic risk assessment system: a tool for conservation decision-making in changing times. User Guide Version 1.2.

Available online at http://www.forestthreats.org/research/projects/project-summaries/genetic-risk-assessment-system-description-120610.pdf

The Forest Tree Genetic Risk Assessment System gives each species a rating for risk factors

relating to (1) its intrinsic attributes, such as population structure, fecundity and seed dispersal mechanism, that may increase its vulnerability in the face of change, and (2) the external threats to its genetic integrity, including changing climate and insect and disease threats. Species may be additionally rated for a set of conservation modifiers, such as listed status and endemism. The factor index values are weighted and summed to give risk ratings for the species within a given region, which are ranked according to their overall susceptibility to genetic degradation.

**Swanston, C., M. Janowiak, L. Iverson, L. Parker, D. Mladenoff, L. Brandt, P. Butler, M. St. Pierre, A. Prasad, S. Matthews, M. Peters, D. Higgins, and A. Dorland.** 2011. Ecosystem vulnerability assessment and synthesis: a report form the climate change response framework project in northern Wisconsin. General Technical Report NRS\_82, USFS Northern Research Station. USDA Forest Service, Newtown Square, PA.

Needs description

Available online at http://www.cakex.org/virtual-library/ecosystem-vulnerability-assessment-and-synthesis-report-climate-change-response-fram

**U.S. EPA (Environmental Protection Agency).** (2012) Vulnerability Assessments in Support of the Climate Ready Estuaries Program: A Novel Approach Using Expert Judgment, Volume II: Results for the Massachusetts Bays Program. National Center for Environmental Assessment, Washington, DC; EPA/600/R-11/058Fb. Available online at http://www.epa.gov/ncea.

(from abstract): An expert elicitation-type exercise was created to systematically elicit judgments from experts in a workshop setting regarding climate change effects on two key ecosystem processes within salt marsh systems: sediment retention and community interactions. Specific workshop objectives were to assess (1) the relative influences of physical and ecological variables that regulate each process, (2) their relative sensitivities under current and future climate change scenarios, (3) the degree of confidence about these relationships, and (4) implications for management. For each process, an influence diagram was developed identifying key process variables and their interrelationships (influences). Using a coding scheme, each expert characterized the type and degree of each influence to indicate its nature and sensitivity under current and future climate change scenarios. The experts also discussed the relative impact of certain influences on the endpoints.

**Whitman, A. B. Vickery, P. deMaynadier, S. Stockwell, S. Walker, A. Cutko, and R. Houston.** 2010. Climate Change and Biodiversity in Maine: A climate change exposure summary for participants of the Maine Climate Change Species Vulnerability Assessment. Manomet Center for Conservation Sciences (in collaboration with Maine Beginning with Habitat Climate Change Adaptation Working Group) Report NCI-2010-2. 22 pp. Brunswick, Maine. Available online at: [www.manometmaine.org](http://www.manometmaine.org)

Guidance document provided to experts who assessed vulnerability of species in Maine. Climate change exposure information provided: environmental projections, coastal and estuarine conditions, and stressors. Also provides exposure information on wildlife habitats and plant communities.

**Young, B., E. Byers, K. Gravuer, K. Hall, G. Hammerson, A. Redder**. 2011. Guidelines for using the NatureServe Climate Change Vulnerability Index. (Climate Change Vulnerability Index Version 2.1. NatureServe. available at:) <http://www.natureserve.org/prodServices/climatechange/ccvi.jsp>

(From Overview): The Index uses a scoring system that integrates a species’ predicted exposure to climate change within an assessment area and three sets of factors associated with climate change sensitivity, each supported by published studies: 1) indirect exposure to climate change, 2) species specific factors (including dispersal ability, temperature and precipitation sensitivity,

physical habitat specificity, interspecific interactions, and genetic factors), and 3) documented response to climate change. Assessing species with this Index facilitates grouping taxa by their relative risk to climate change, and by sensitivity factors, which we expect will help users to identify adaptation options that could benefit multiple species.