Assessing Priority Amphibian & Reptile Conservation Areas (PARCAs) and Vulnerability to Climate Change in the North Atlantic Landscape Conservation Cooperative

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Funds Requested: **$298,628***

***This amount is contingent upon authorization to use indirect rates for MCFWRU rather than UMaine, and for CESU rather than UGA, respectively. With WMI, rather than USFWS, serving as the fiduciary but not (as far as we can tell) a participant in the Cooperative Units, we are awaiting authorization to honor the CU rates. The authors are exploring every avenue to keep the indirect costs lower; any assistance from the NA-LCC to facilitate the use of the CU and their rates would be greatly appreciated.**

Project Summary: Amphibians and reptiles are experiencing severe habitat loss throughout North America; however, this threat to biodiversity can be mitigated by identifying and managing areas that serve a disproportionate role in sustaining herpetofauna. Identification of such areas must take into consideration the dynamic nature of habitat suitability. As climate rapidly changes it is possible that areas currently deemed suitable may no longer be so in the future. *To address these needs, we are proposing to generate spatially-explicit data that will (1) identify Priority Amphibian and Reptile Conservation Areas (PARCAs) – those discrete areas most vital to maintaining reptile and amphibian diversity, (2) project regions of current and future climatic suitability for a number of priority reptiles and amphibians in the North Atlantic Landscape Conservation Cooperative, and (3) identify gaps in distributional data for these species that may prevent or inhibit the identification of species-level climatic suitability.*

Objective 1, identification of PARCAs will proceed by collecting natural history information, distributional data, and by weighing expert opinion for key species. Objectives 2- 3 will rely on collection of known locality data and the use of inductive species distribution modeling. Collectively, this process will take place over three years (January 2012 – December 2014), and will represent the assembling and processing of all necessary information for identifying PARCAs. Collectively, these approaches will offer a long-term assessment of resiliency of PARCAs identified with respect to those that may provide refugia as the climate changes.

Project Narrative

Introduction

Given limited conservation resources, the need to prioritize specific geographic areas for conservation action that maximizes cost-effectiveness is more important than ever. Incorporating future climate vulnerability projections into analyses for high priority conservation areas allows for improved, long-term ecological planning and adaptive management. Climate change, in conjunction with threats such as land use change, disease, and habitat degradation, is predicted to seriously alter global biodiversity patterns[1]. For many species, the "fingerprint" of climate change can already be detected through shifts in range and phenology. For example, Parmesan and Yohe[2] detected an average poleward shift of 6.1 km per decade for organisms as diverse as birds, butterflies, and alpine herbs. Given the strong correlation between climate and the distribution of some ectotherms[3], it is reasonable to believe that climate change may have especially strong effects on taxa[4] such as reptiles and amphibians.

Because of these needs and anticipated effects, we propose to implement Priority Amphibian and Reptile Conservation Area (PARCAs) criteria[5], developed and peer-reviewed via the national PARC expert network (a methodology informed by scientific criteria for exceptional species diversity and rarity, and local expert review), throughout the North Atlantic Landscape Conservation Cooperative (NA-LCC). We will generate spatially-explicit projections of current and future climatic suitability for a number of priority reptiles and amphibians in the NA-LCC, as determined by the Northeast Partners in Amphibian and Reptile Conservation (NEPARC), and will summarize these results with respect to lands under state and federal management. As part of this process, we will identify gaps in distributional data for these species that may prevent or inhibit the identification species-level climatic suitability. Finally, we will synthesize these results to provide an assessment of climate sensitivity, or future resiliency, of the current identified PARCAs.

An existing effort currently underway through PARC partners in the South Atlantic LCC also implements the PARCA criteria. This common theme of identifying PARCAs provides comparable cross-LCC data layers resulting from a national set of PARC-produced criteria for identifying areas of exceptional herpetofaunal diversity.

Which of the Priority LCC topics does this proposal address?

The NA-LCC Science Strategy identifies "Components and Goals" of the LCC that include "Ecological Planning and Conservation Design". Our vulnerability assessment facilitates long-term ecological planning and conservation design by focusing on species that already have been identified as priorities by NEPARC[5], and will be used in the identification of PARCAs. By selecting species in this fashion, the PARCA identification process will be able to assess the long-term climatic suitability of proposed areas with respect to species of highest management priority.

More specifically, this proposal is responding to three of the top twelve priorities (two within the top three priorities) established by the NA-LCC. In Handout 13 ("Common Science Needs by Rank"), the second-leading priority is to conduct general climate change vulnerability assessments for northeastern wildlife habitats and species. Under this priority, the LCC has specifically identified spatially-explicit modeling as a method for addressing the scientific need. The third-ranked priority is to conduct specific vulnerability assessments of northeastern

amphibians and reptiles. The 12th ranked priority is to identify focal areas for conservation in the Northeast. This proposal will address all of these priorities by identifying gaps in distributional data and currently important conservation areas for amphibians and reptiles, as well as future climate vulnerability assessments for priority species and their associated habitats in the North Atlantic Landscape.

In what area or state(s) will your project be conducted?

We will conduct this assessment for priority herpetofaunal species across the NA-LCC; however, to maximize the utility of this project, we will not clip projections of future climatic suitability at the borders of the LCC. In many cases, the current and future zones of climatic suitability for species of interest will include political and biogeographic units that are within, but extend beyond, the NA-LCC boundary. By including the full complement of spatial information in our final products, we will facilitate cooperation between the NA-LCC and adjacent LCCs and states. Facilitation of conservation goals among such regional units is a stated part of the NA-LCC's Vision and Mission as articulated in the LCC's Science Strategy document.

NOTE:

An existing effort currently underway through PARC partners in the South Atlantic LCC also implements the PARCA criteria. This common theme of identifying PARCAs using nationally-derived PARC guidance criteria provides comparable cross-LCC data layers.

This proposal can serve as a model that could be adapted for any LCC across the country, with costs varying based on number of species desired for modeling and institutional differences in indirect cost policies.

What is the start date of the project and the projected end date?

Start date: January 01, 2012

End date: December 31, 2014

What is the goal of your project and what major objectives or tasks will you undertake to achieve that goal?

The goals of the proposed project are to (1) implement PARCA criteria to identify current high priority conservation areas; (2) conduct a spatially-explicit climate vulnerability assessment for high priority species in the NA-LCC, including identification of data-deficient species; (3) use the climate vulnerability assessment results in a final analysis to determine future climate sensitivity of PARCAs identified. These will be accomplished through the following **six** objectives:

Objective 1*: Work directly with state fish and wildlife agency personnel throughout the NA-LCC states to gather data toward PARCA criteria review and proposed conservation area identification.*

Objective 2*: Provide spatially-explicit maps of current and future climatic suitability for priority amphibians and reptiles in the NA-LCC region, and then use these data a) to rank species vulnerability to climate change based projected losses in the species' ranges, and b) to identify areas within the NA-LCC where either there are high losses of vulnerable species or there is high potential for climatic refugia for priority species, and c) identify species for which this Objective cannot be completed due to gaps in current known distributional data and thus identifies priorities for species data acquisition.*

Objective 3*: Summarize these results with respect to species occurring on lands under current state and federal management.*
Objective 4: *Conduct an analysis of candidate PARCAs to help identify those highest priority conservation areas supporting reptiles and amphibians in the Northeast that are not currently protected.*
Objective 5*: Incorporate climate vulnerability projections into final PARCA analysis, including a ranking of high priority current and future conservation areas.*
Objective 6: *Communicate results to key state, federal, and NGO partners via publications and a Northeast regional workshop.*

What are the methods by which you propose to carry out the work?
Objective 1. USGS-Maine Cooperative Fish and Wildlife Research Unit (MCFWRU) scientists will contact personnel in charge of herpetofauna management at the state fish and wildlife agencies throughout the NA-LCC states to gather natural heritage, atlas, and other point location distribution data toward PARCA criteria implementation, with attention to data sensitivities for the purposes of reporting. Other point data will be gathered through the publically accessible museum database portal HerpNet. To the extent that such data is available and forthcoming from state partners, the MCFWRU scientists will use the published PARCA model criteria (see Appendix) for designating eligible proposed conservation areas drawing on the scientific concepts of species rarity, richness, endemicity, and landscape integrity.
Objective 2. University of Georgia (UGA) scientists will construct species distribution models for species identified by NEPARC as High Regional Responsibility. These models will be generated using the data gathered in Objective 1, in collaboration with MCFWRU scientists, and with a goal of obtaining as many locality records (latitude/longitude coordinates) as are required for each modeled species to create a comprehensive and representative depiction of the species current climatic/ecological tolerances. In addition to the NEPARC list, we will also model amphibians and reptiles (excluding sea turtles) that were not included in the regional-scale NEPARC high priority designation, but listed by NatureServe as having a Global Rank from 1 – 3, as well as those species with a state or federal designation of Threatened or Endangered and having a range that overlaps with the NA-LCC. Species for which data are deficient will represent priority species for future data acquisition.

The UGA scientists will use an inductive, presence-only modeling approach to model species' climatic distributions via program MaxEnt. While many techniques are available for modeling the distribution of species, MaxEnt has consistently proven to perform as well or better than other approaches[6]. In addition, many of the other techniques that perform well, such as logistic regression and RandomForests[7], were explicitly developed to use presence-absence data. Very few (if any) amphibian and reptile species have reliable data on presence and absence throughout the species' range. As a result, a presence-only approach such as MaxEnt is most appropriate. Finally, the use and misuse of MaxEnt has been reported on in nearly 200 peer-reviewed papers since 2006. Such a high implementation rate means the tool is well-vetted, and that many of the early pitfalls of its implementation have been acknowledged and can be avoided in the proposed application.

The current climatic relationships species exhibit will be projected onto downscaled climate change models that are based on two different CO_2 emissions scenarios (the B2a "medium" and A2a "high" scenarios) as generated by two different general circulation models or GCMs (Met Office's Hadley Centre and the Canadian Centre for Climate Modelling and

Analysis). The current climate averages and the projected climate change data have been downscaled at approximately 1 km^2, and this will also be the grid cell size of our models of climatic suitability. We will evaluate three different thresholds for identifying whether or not a particular climate is suitable, representing a range from conservative to liberal estimates (i.e., some are more inclusive of a broader range of species climate tolerances than others). The two CO_2 futures crossed with two GCMs and three thresholds will yield a total of 12 binary models evaluated for each of the species. The 12 models will allow us to explicitly represent model uncertainty, which is a vital parameter in stakeholder decision making.

Objective 3. The UGA scientists will overlay resulting projects onto the Protected Areas Database and similar spatial data layers showing areas under state and federal ownership in order to provide a rank summary of vulnerability allowing for geographic prioritization of land management.

Objective 4: The MCFWRU scientists will identify existing gaps in the protected land network for proposed PARCAs identified in Objective 1.

Objective 5: The MCFWRU scientists will use the spatially-explicit climate vulnerability projections and rankings to create a final PARCA report, including assessment of climate sensitivity of PARCAs identified, with a ranking of high priority current conservation areas as well as areas to target future conservation efforts. As part of this process, we will examine other published work regarding terrestrial landscape prioritization, sustainability, or resiliency (e.g., Anderson and Ferree[8]) to incorporate them to the degree and extent that they are relevant. In addition, we will provide recommendations for application of these spatially-explicit results to on-the-ground conservation and management actions.

Objective 6: The Project Director and all Co-PIs will convene a workshop among key state, federal, and NGO partners (perhaps at the 2014 NEAFWA conference or other regionally-relevant meeting of Northeast stakeholders) to communicate results and discuss potential applications in relation to conservation and management actions; we also will prepare one or more manuscripts suitable for scientific journal publication.

Timeline: Objectives 1, 2, and 3 will occur simultaneously in Years 1-2; Objectives 4, 5, and 6 will occur in Years 2-3.

What measureable products or outcomes will result from your project?

This project will ultimately produce **nine (9)** different products:

(1) A set of PARCAs based on current known species distributions and landscape conditions will be produced, including spatially-explicit maps of these PARCAs. (Primary lead is MCFWRU.)

(2) Spatially-explicit projections of climatically suitable areas in 2050 for high priority species. This time horizon represents a period that is sufficiently far enough into the future for species to experience shifts in climate envelopes, but not beyond the timeline over which long-term conservation planning is typically done. These projections will include six different depictions of climatic suitability for each species under two different CO_2 scenarios. This approach addresses the uncertainty that is inherent to models of climate change and the associated ecological response; areas where model agreement is high represent zones of greater confidence in outcome (Fig. 1). (Primary lead is UGA.)

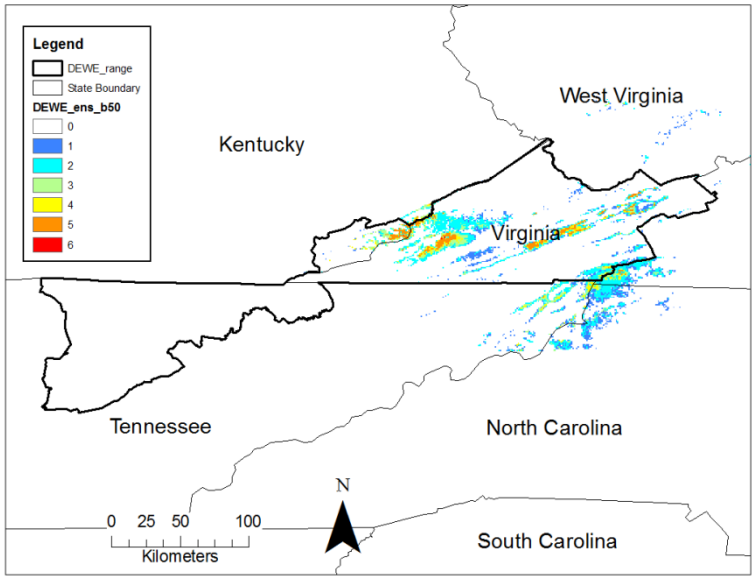

Fig. 1. *Desmognathus welteri* (Black Mountain Dusky Salamander) suitability in 2050, B2a (low emissions) scenario. Three thresholds of climatic suitability were generated under two general circulation models of climate change; so, the above map represents the output of six possible futures. The numbers (0 - 6), and corresponding colors (white - red), indicate the sum of modeled futures that overlap for a particular area. For example, a patch of red indicates all 6 of the models agree the area will remain climatically suitable, but a patch of dark blue is a zone where only one model suggests climatic suitability for the species in 2050. Areas where more than one model overlap are zones of increased confidence in model output.

(3) A table that ranks high priority species based on the amount of climatically suitable habitat they are projected to lose by 2050 under various climate change scenarios. This ranking will provide a tool for conservation decision making. (Primary lead is UGA.)

(4) Maps that represent the change in species richness (where species ranges are based on climatic suitability) between current estimates and estimates for 2050, including an assessment of areas (a) where loss of a number of important species is expected to be high versus low and (b) where this expectation has high versus low confidence based on a number of model scenarios. (Primary lead is UGA.)

(5) A descriptive table providing, by state, a comprehensive documentation of available locality data for each priority species, including localities from academic institutions and Natural Heritage databases. This list will help meet one of the priority science needs identified by the NA-LCC: to identify gaps in distribution data for amphibians (and reptiles), and it will demonstrate areas within the species' distribution that are data-deficient and requiring additional survey effort. (Joint effort among Project Partners.)

(6) An analysis to identify existing gaps in the protected land network for proposed PARCAs identified. (Primary lead is MCFWRU.)

(7) An assessment of long-term viability of PARCAs based on climate projections, including existing studies from the North Atlantic LCC area that address species and landscape resiliency. (Joint effort among Project Partners.)

(8) A final report, suitable for one or more scientific journal publications, summarizing products (1) – (7), and including maps produced in these products. This report will include recommendations for how to apply these spatially-explicit results toward on-the-ground conservation and management actions. (Joint effort among Project Partners.)

(9) A workshop at a regional gathering of Northeast stakeholders in state and federal agencies as well as relevant NGOs where the Project Partners will present results and discuss potential applications in relation to conservation and management actions. (Primary lead is AFWA.)

Literature Cited

[1]Pereira, H.M. et al. 2010. Science 330:1496-1501; [2]Parmesan, C and G. Yohe. 2003. Nature 421:37-42; [3]Buckley, L.B. and W. Jetz. 2007. Proc. Royal Soc. B 274:1167-1173; [4]Aragon, P. 2010. Animal Conservation 13:363-373. [5] NEPARC. 2010. Northeast Partners in Amphibian and Reptile Conservation (NEPARC). Publication 2010-1. [6] Elith, J. et al. 2006. Novel methods improve prediction of species' distributions from occurrence data. Ecography 29:129-151. [7] Elith et al. 2008. Journal of Animal Ecology 77:802-813; [8]Anderson, M.G. and C.E. Ferree. 2010. PLoS ONE 5(7): e11554.

Budget

See attached Budget worksheet.