Proposal # 16-11
2016 NERA Planning Grants Program

Investigating the adaptive potential of a forest indicator species to climate change predictions in Northeastern forest ecosystems.

Team Member	Discipline	Institution/Agency	State
Chris Sutherland	Population Ecology	UMass-Amherst* Cornell University*	MA NY
Evan Grant	Population Ecology; Wildlife Management	USGS – Patuxent Wildlife Research Center; University of Maryland*	MD
Sean Sterrett	Wildlife Ecology and Management	USGS – Conte	MA
Danika Tyminski	Elementary education	Swift River Elementary School	MA
Amanda Hyde	Environmental Education	Greenfield Community College	MA
Catherine Devlin	Environmental Education	Greenfield Community College	MA
Lena Fletcher	Environmental Education	UMass-Amherst*	MA
Paola Dolcemascolo	Environmental Education	NJ School of Conservation	NJ
David Miller	Population Ecology	Pennsylvania State University*	PA
David Munoz	Population Ecology	Pennsylvania State University*	PA
Elise Zipkin	Population and Community Ecology	Michigan State University	MI
Alexa Warwick	Environmental Education; Population Genetics	Beacon Ctr for the Study of Evolution in Action; Michigan State University	MI
Nancy Karraker	Herpetology Conservation	University of Rhode Island*	RI
Stephen Morreale	Herpetology Conservation; Outreach & Extension	Cornell University*	NY

***** Northeastern experiment station institute (five in total)

Team Leader Contact Information
Chris Sutherland, Rm 118 Holdsworth Hall, 160 Holdsworth Way, Amherst, MA

Project mission

Our objective is to **increase our understanding, valuation, and management responses for the Red-backed salamander (RBS), in response to projected changes in climate at the scale of the species' range.** To achieve this, we propose developing an intellectually and geographically distributed network, the Salamander Population and Adaptation Research Coordination network (SPARCnet), that aims to facilitate and integrate scientific inquiry, education and public engagement to address pressing ecological questions related to species' distribution and range dynamics. Specifically, the network aims to:

1. Integrate multi-disciplinary scientific inquiry across multiple spatial scales to understand the controls and constraints on species' range dynamics.
2. Integrate research, education and public engagement to provide authentic learning experiences and develop associated curriculum and assessment tools for environmental education aimed at multiple ages while simultaneously generating data sources useful for objective (1).
3. Facilitate information flow among and between researchers, educators, citizens and managers to foster full participation in ecosystem understanding and stewardship.

Project outline

Predicting and mitigating the impacts of large-scale global change is an enduring challenge in applied ecology (Mace 2013) and is a research goal shared across a broad range of disciplines (Botkin et al. 2007). While discipline-specific progress has been made independently, it is clear that understanding species and community responses to climate change requires approaches that integrate research across many disciplines and geographic scales (Fraser et al. 2013). Therefore, rather than research being coordinated among small collaborator groups, the development of coordinated, diverse research networks is required (e.g., Weltzin et al. 2003, Wright et al. 2004, Adler et al. 2011). This proposal seeks to develop such a network, with the goal of developing a robust model system for understanding climate responses of the RBS (*Plethodon cinereus*), a forest ecosystem indicator species, across the Northeastern USA and SE Canada.

Red-backed salamanders are an important component of forest ecosystems and their broad distribution, high density, and sensitivity to environmental change and habitat disturbance have made them a model system for understanding species interactions and community ecology (Hairston 1987), behavior (Jaeger et al. 2016), physiology (Spotila 1972, Feder 1983), and evolution and speciation (Kozak and Wiens 2006, Wake 2009). RBS are considered a sensitive indicator species for local forest habitat condition (Welsh and Droege 2001; Homyack et al. 2011) and are promoted as ideal target species for long-term monitoring of forest ecosystems (Welsh et al. 2006), that can be useful for forest management assessment.

SPARCnet will consist of a set of replicated study sites distributed within forest patches across forested landscapes in the Northeast. While sites will be managed locally, all data collection will conform to a standardized design: at each site, there are six replicate plots spaced at least 20 m apart. Each plot is comprised of a 5 m x 10 m artificial cover object array that contains 50 wooden cover boards, each spaced 1 m apart. In order to gain detailed information about salamander population dynamics, these core study plots gather capture-mark-recapture (CMR) data, using visual implant elastomer to mark individuals, providing detailed demographic information (e.g. Sutherland et al 2016, Muñoz et al. 2016). Within each replicate, half of the

plots are assigned as control and half are experimental plots in which snow removal experiments will be conducted to simulate predicted reductions in snowfall. This basic sampling structure offers participants the flexibility to answer questions of local relevance, while also providing standardized information across a large part of the salamander distribution (i.e., NE USA).

In addition to the research activities of network participants, a key objective of SPARCnet is to strengthen the link between research and education by providing authentic scientific experiences for students of different ages and levels of education, and the general public. This will be accomplished using place-based educator-mediated citizen science efforts which collect locally relevant data on salamanders, develop key lessons that will aid students in interpreting and analyzing data thereby training them in the core scientific process of defending claims from evidence, with the ultimate goal of promoting climate change literacy and training a new generation of ecologically-informed citizens.

Project Justification

In Massachusetts, we have developed a working model for integrating classroom/community engagement, management and research objectives (see current MA team members). We have recruited researchers and educators from 5 other states across the RBS range, including from four NE State Agricultural Experiment Station institutions (see team member list), to serve on the SPARCnet steering committee. The primary focus now, is to share the progress made in MA so that the model can be expanded throughout the Northeast. The focus of this planning project is to bring together this diverse group of educators, managers, and researchers to build the capacity for growing the network and in doing so, better meet local and regional education, management and research objectives. We seek funding for two knowledge exchange (KE) events to foster the development of the network and specifically to (1) identify regional and local forest ecosystems research priorities and the role of salamanders as a model system and (2) identify and integrate local education and learning opportunities with scientific inquiry that contributes to the broader network objectives.

Team member activities and roles

The SPARCnet Research and Citizen Science Handbook (v.1.2; Appendix 2) acts as a comprehensive guiding document describing the network objectives, vision for future network development and provides a network management structure for participant roles and responsibilities of data collection and education curricula initiatives. All identified team members, designated as either educators or researchers (see team member disciplines), will serve on the network steering committee.

Educators will facilitate learning by providing students and community members with genuine and engaging research opportunities while collecting useable and valuable data on salamander populations. In the planning phase proposed here, educators will identify links between research objectives and recently developed Next Generation Science Standards (NGSS Lead States 2013) and generate interest from local schools, colleges, and nature centers. This includes working with educators to develop activities directly relevant to specific curriculum goals, including the use of 'Data Nuggets', an innovative approach to course activities that brings real data into the classroom (Schultheis and Kjelvik 2015). These activities will be developed to align with the overall network learning objectives:

1. developing an appreciation for hidden biological diversity.

2. promoting basic scientific literacy.
3. promoting quantitative skills to all audiences.

Researchers are directly involved with implementing long-term standardized research protocols across the network. Researchers will establish local sampling plots that conform to network sampling protocol. Research participants will identify local, discipline-specific research objectives (keeping in mind the regional research objectives), and develop knowledge transfer mechanisms to facilitate KE and collaboration. In this planning stage, researchers will develop a conceptual modeling framework for integrating local data for regional inference and identify available data and potential 'proof-of-concept' analyses, both of which will strengthen future funding applications.

All steering group members (educators and researchers) will be required to seek funding to maintain local research activities while also contributing towards writing larger grants to coordinate the network and fund range-wide research projects that take advantage of the diverse skillset offered by network facilitated collaborations.

Timetable

We propose two 3-day 'knowledge exchange' meetings that will bring together current and prospective network participants. The first meeting, hosted at UMass-Amherst, will take place within 2 months of the beginning of the grant period. The second will take place 6 months after the beginning of the grant period at another participating institution. We have identified two substantial funding sources that the proposed project would be appropriate for: the first to fund network coordination and data management (National Science Foundation – Research Coordination Network), and the second to fund network wide research activities focused on the adaptive potential of salamanders to climate change (National Science Foundation – Division of Environmental Biology). Preparation of at least one of these proposals will be the ultimate goal of this planning grant.

Budget for planning activities (total request $10,000)

Based on the current average airfare (approx. $400) and the average hotel costs (approx. $100 per night), we request $8,000 ($4,000 per KE event) to provide travel and accommodation assistance to participants attending the two 3-day knowledge exchange and grant development meetings. The requested amount will be used to subsidize out-of-state participant via eight $500 travel grants per meeting (additional costs will be covered by participants). The first meeting will be hosted by UMass-Amherst where room hire will be provided free of charge. The location of the second meeting will be confirmed at the first event but will be hosted without charge at a participating institution.

We request a further $1,500 ($750 per KE event) to cover meeting refreshments ($50 per day for three days) and contributions towards participant meals (~$33 per person per event). Finally, we request $500 for demonstration materials which will be used as a recruitment tool during meetings and outreach events during the grant period to demonstrate the standardized establishment and data collection procedures (these materials will not be used for research).

Appendix 1 – Sutherland CV

CURRICULUM VITAE

Chris Sutherland, Assistant Professor
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EDUCATION

Univ. Brighton, United Kingdom	B.S., Biological Sciences	2005-2008
Univ. Aberdeen, United Kingdom	M.Res., Ecology & Sustainability	2009-2010
Univ. Aberdeen, United Kingdom	PhD, Ecology & Statistics	2010-2013

PROFESSIONAL APPOINTMENTS

Assistant Professor. Dept. of Environmental Conservation. Univ. Massachusetts. 2015 – Present
Postdoctoral Research Associate. Cornell University. Dept. of Natural Resources. 2013-2015

FIVE MOST RELEVANT PUBLICATIONS

Muñoz, D. J., Miller, D. A., Sutherland, C., & Grant, E. H. C. (2016). Using spatial capture-recapture to elucidate population processes and space-use in herpetological studies. Journal of Herpetology. (*In Press*)

Sutherland, C., Muñoz, D. J., Miller, D. A., & Grant, E. H. C. (2016). Spatial Capture-Recapture: A Promising Method for Analyzing Data Collected Using Artificial Cover Objects. Herpetologica, 72(1), 6-12.

Sutherland, C., Brambilla, M., Pedrini, P., Tenan, S. 2016. A multi-region community model for inference about geographic variation in species richness. Methods in Ecology & Evolution, 7 (7), 783-791.

Royle, JA, Fuller, A., Sutherland, C. 2016. Spatial capture–recapture models allowing Markovian transience or dispersal. Population Ecology, 58 (1): 53-62.

Sutherland, C., Elston, D.A. & Lambin, X. 2014. A Demographic, Spatially Explicit Occupancy Model for Describing and Predicting Metapopulation Dynamics and Persistence. Ecology, 95 (11): 3149-3160.

FIVE ADDITIONAL PUBLICATIONS

Fuller, A. K., Sutherland, C. S., Royle, J. A., & Hare, M. P. (2016). Estimating population density and connectivity of American mink using spatial capture–recapture. Ecological Applications, 26(4), 1125-1135.

Royle, JA, Sutherland, C., Fuller, A., Sun, C. 2015. Likelihood Analysis of Spatial Capture-Recapture Models for Stratified or Class Structured Populations. Ecosphere, 6 (2) art22.

Sutherland, C., Fuller, A., Royle, JA. 2015. Modelling non-Euclidean movement and landscape connectivity in highly structured ecological networks. Methods in Ecology and Evolution, 6 (2), 169-177.

Sutherland, C., Elston, DA. & Lambin, X. 2013. Accounting for false positive detection error induced by transient individuals. Wildlife Research, 40 (6) 490-498.

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SYNERGISTIC ACTIVITIES

- **Invited Contributor -** National Socio-Environmental Synthesis Center (SESYNC) Workshop – *Socio-Spatial Ecology of the Bed Bug and its Control.*

- **Invited Contributor -** The National Oceanic and Atmospheric Administration (NOAA) workshop – *North Atlantic Right Whale Visual and Passive Acoustic Data Integration Modeling Workshop.*

- **Software contributor and developer** – main developer of the freely available R package '*oSCR*', statistical for analyzing spatial encounter history data and estimating abundance. In addition, I contribute to the development and maintenance '*unmarked*', winner of the 2014 outstanding contributions to spatial ecology from The Wildlife Society Spatial Ecology and Telemetry Group.

- **Member** – New York State Moose working group – A moose conservation and management steering group that coordinates and integrates the scientific research and management need of the State.

- **Peer review** – Reviewer of >30 peer reviewed journal articles, for >10 journals and an internal reviewer for U.S. Geological Survey.

Appendix 2 – SPARCnet Handbook

A copy of the SPARCnet handbook can be found here: http://bit.ly/2bHesHk

Appendix 2 - References

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