Project Title: Landscape connectivity of a sagebrush obligate: functional continuity of habitat for the pygmy rabbit.

Project type: Science Project 1. A(1), A(2), A(3)

Lead Investigator, Organization, Title, Address, Telephone, Email
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Project Objective(s):
1) Quantify functional landscape connectivity of pygmy rabbit through integration of landscape genomic data with statistical modeling of habitat quality; 2) Create management-oriented simulation model to predict spatial and genetic response of populations to climate change, revealing particular areas of sensitivity to regional persistence of pygmy rabbits and the sagebrush ecosystems on which they rely.

Management Objective(s):
Land management agencies in Nevada are tasked with protecting critical habitat and restoring habitat functionality to landscapes impacted by vegetation changes due to historic land use, fire, and invasive species. Nowhere is this goal more pressing than in sagebrush ecosystems across northern and central Nevada where both the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) have instituted policies to promote the health and resilience of sagebrush ecosystems and dependent wildlife. These initiatives require targeted and prioritized implementation of management strategies that are science-based, account for climate change, and are focused on sensitive species. The proposed project will meet these needs by providing a modeling tool to land managers that will identify areas of particular sensitivity to climate change in the distribution of pygmy rabbit and the sagebrush ecosystem on which this species relies. Pygmy rabbit is expected to be a key indicator species of the health and resilience of sagebrush habitats and this project seeks to vastly expand our knowledge of this taxon and its relationship to this sensitive ecosystem. The management objectives to be met through this project include: 1) *a spatial model of pygmy rabbit occurrence* to help managers assess if and how land use and restoration activities may impact this taxon and how local and regional dynamics of this species can help guide implementation of such activities and be indicators of success; 2) *identification of local, regional, and landscape-level connectivity corridors* given current habitat and climate conditions. Importantly, our measure of connectivity will be based on functional ecological and evolutionary connectivity as recorded in the genomes of these populations. That is, we seek to identify habitat corridors that facilitate dispersal and multi-generational gene flow across the landscape, thus maintaining genetic diversity and evolutionary potential; 3*) identification of local, regional, and landscape-level changes in connectivity under various climate change scenarios.* Using our spatial models of pygmy rabbit occurrence and landscape connectivity, we will forecast these models to predict areas of greatest change, and in particular, identify corridors that will be most impacted by climate change. Finally, we will develop a process-modeling tool to further refine our prediction of population response to climate change and other environmental or land-use changes (e.g. energy development). This simulation model will allow land

managers to identify areas within the distribution that warrant continued monitoring in order to track and facilitate climate adaptation. Helping our state and federal partners establish an informed adaptive management-oriented monitoring program for pygmy rabbit is particularly important because this sagebrush obligate has already been petitioned for listing distribution-wide and the Columbia Basin DPS (Washington state) is currently listed as endangered.

Project Description:

The pygmy rabbit (*Brachylagus idahoensis*) is known to be a sagebrush obligate species with a broad but patchy distribution across the Great Basin (Green and Flinders 1980). As a sagebrush obligate, pygmy rabbit is considered an indicator species for the health and resilience of the sagebrush ecosystem (Nevada Wildlife Action Plan, WAP, 2012). Because of its local abundance and relatively rapid life history, pygmy rabbit may be a particularly sensitive indicator for tracking short-term changes to sagebrush habitat quality and connectivity. Therefore, its habitat requirements warrant increased research attention. Because the majority of the intact range of this taxon is found in Nevada, our team has launched a broad reaching project in close collaboration with the Nevada Department of Wildlife (NDOW) and the Bureau of Land Management (BLM). While the distribution of pygmy rabbit in Nevada is relatively well understood because of long-term interest by resource agency and academic personnel (Larrucea and Brussard, 2008a; Figure 1), we still have little understanding of fundamental aspects of the ecology and demography of this species across habitat types. The overall goal of our project is to establish the underlying habitat correlates of individual survival, reproductive success, and dispersal to develop a more complete view of the habitat and landscape characteristics that sustain local and regionally connected populations. We seek funding from the Great Basin LCC for three discrete components of our larger project: (1) to develop functional models of landscape connectivity from the integration of habitat models, landscape connectivity analysis and multi-scale genomic data; (2) to integrate these analyses into a new species distribution model for pygmy rabbit; and (3) to develop a dynamic process-modeling tool to help agency personnel assess potential future shifts in genetic diversity and connectivity associated with climate change, habitat loss and fragmentation, or in response to restoration efforts.

Species that are dependent on a narrow range of habitat types, like the pygmy rabbit, are expected to be particularly vulnerable to climate change (WAP, 2012). In fact, the pygmy rabbit is the only species identified in NDOW's WAP that is categorized as "extremely vulnerable", the highest ranking in their system of classification. This listing is in part due to the predicted dramatic decline in sagebrush ecosystem suitability over the coming decades (WAP, 2012). Because of this expected change, it is particularly critical that we quantify functional landscape connectivity across a range of sagebrush habitat quality and patterns of fragmentation, to identify key areas that may serve as refugia or critical movement corridors for many sagebrush obligates, including pygmy rabbit. Our initial coarse-scale comparison of model-predicted suitable habitat for greater sage grouse (courtesy D. Gibson) and the known occurrence of pygmy rabbit (Figure 2) highlights the potential for conservation aimed at one sagebrush obligate to benefit other species dependent on the same ecosystem.

We have assembled a Nevada-based team of researchers with expertise in small mammal ecology and genetics (M. Matocq), landscape ecology (P. Weisberg and T. Dilts), demography and population dynamics (J. Sedinger) and pygmy rabbit ecology (E. Larrucea). **The proposed scope of work herein includes a critical subset of goals that are part of a larger project that seeks to quantify current population dynamics of pygmy rabbits in various habitat types, to identify the habitat characteristics that facilitate connectivity across the landscape and to integrate these parameters into predictive models that allow exploration of population response to climate change.** Thus far, we have garnered agency partnership from both the Nevada Department of Wildlife and Bureau of Land Management for other portions of the larger project that are focused on fine-scale habitat correlates of population dynamics (see letter of support). Together, pending commitments from NDOW and BLM along with funds requested from the LCC will substantially improve our capability to manage pygmy rabbit and their habitats into the future.

Project Goals and Products:

1. Generate a species distribution model for pygmy rabbit based on species-habitat relationships and genomic landscape connectivity parameters.
2. Identify habitat characteristics and configurations that allow connectivity within and among regional populations, including delimitation of key corridors and pinch-points for dispersal.
3. Develop a process-modeling tool that agency personnel can use to explore the impact of particular disturbances or other environmental shifts including climate change on the local and regional genetic connectivity of pygmy rabbit.

General Approach:

Our project goals will be met by focusing efforts at multiple hierarchical spatial scales: distribution-wide, among regions within the Great Basin, and among populations within regions. At each of these scales, we will infer landscape connectivity from patterns of genetic connectivity across habitat types sampled within each focal region (Figure 1). Using patterns of genetic variation within and among populations across the core of the pygmy rabbit's Great Basin distribution, we will identify landscape and habitat variables that are positively correlated with genetic diversity and genetic continuity. Using habitat and landscape variables that are correlated with the maintenance of diversity and successful movement through the landscape, we will create regional models of habitat suitability for pygmy rabbit. We will integrate these estimates of habitat suitability into a process-modeling framework to develop a tool that researchers and agency personnel can use (and refine as new data are generated) to model predicted distributional and abundance responses under various climate change scenarios or other sources of environmental change.

Specific methodology:

Goal 1. *Species distribution model*.

To establish the distribution of pygmy rabbit habitat in Nevada, we will use a maximum entropy approach in the modeling software MaxEnt (Phillips et al. 2006). Prior to MaxEnt modeling, we will use known information on pygmy rabbit habitat suitability to identify areas that are clearly non-suitable (e.g. playas, desert shrub communities, subalpine forest) that will be masked from our analysis. Distributional data for pygmy rabbit occurrences at the statewide scale will be derived from existing data sets and museum records. Past research has identified habitat variables of importance for pygmy rabbit in Nevada (Larrucea and Brussard 2008b, Wilson et al. 2010), which include sagebrush cover and height, cover of understory herbaceous vegetation, soil texture, and cheatgrass cover. Our goal will be to create finer-scale spatial data layers for these variables that can then be projected to the broader, distribution-wide scale within Nevada. For certain of these variables (sagebrush cover, bare soil cover, tree canopy cover) we will use spectral image analysis of LANDSAT data, for which we have already developed methodology for estimation of percent cover of trees, shrubs and bare ground within 30-m Landsat pixels (Yang et al 2012). Our species distribution modeling will also incorporate spatial variables indicating historical disturbances that are likely to influence habitat quality for pygmy rabbit, including wildfires and historical land treatments. Existing approaches and datasets for regional-scale mapping of sagebrush cover will also be explored (e.g. Homer et al. 2012, Xian et al. 2013). Where possible, we will leverage current funding and ongoing research in our labs to augment data available to the pygmy rabbit project. For example, P. Weisberg is currently funded by NDOW, BLM and GBLCC to create high resolution cheatgrass layers associated with die-off events, and has been awarded McIntire-Stennis funding towards development of statewide maps of PJ woodland tree canopy cover and analysis of multidecadal changes in woodland distribution and density. Likewise, we anticipate that during the project period there will be substantial refinement to our understanding of the distribution of sagebrush habitat in the study region, through drone-assisted habitat assessments that may allow us to obtain LiDAR data for mapping sagebrush height classes (M. Walker, UNR, pers. comm.). As with ongoing drone-based sagebrush mapping in Idaho being conducted by USGS (J. Rachlow, pers. comm.), similar opportunities are rapidly developing in Nevada and as these resources become available we will integrate them into our analyses.

We will develop a series of candidate habitat models in MaxEnt with various combinations of ecologically-relevant variables for pygmy rabbit. We will evaluate model fit using Akaike's Information Criterion (Burnham and Anderson 2002). We will evaluate parsimonious models for accuracy, goodness-of-fit and plausibility with several methods including AUC, the Boyce index (Boyce et al. 2002), testing gain (Elith et al. 2011), and marginal and solitary response curves (Phillips and Dudik 2008).

Goal 2. *Habitat correlates of genomic landscape connectivity*.

At a finer spatial scale than for the rangewide species distribution model, we will develop spatial models of landscape connectivity for pygmy rabbit, useful for identifying areas that are critically important for dispersal and gene flow apart from their overall habitat quality. This requires first developing a fine-scale model of habitat quality from field-measured habitat variables and field surveys of pygmy rabbit occupancy. Genetic analysis will provide detailed information on genetic structure at the level of clustered local populations, which will be used to calibrate and optimize models of landscape connectivity. Such landscape connectivity models can be considered to describe functional connectivity because they are calibrated using best estimates of gene flow, as opposed to other approaches that use only habitat quality data to infer suitability for animal movement.

Using data from the initial species distribution model generated in Goal 1 and in consultation with agency personnel, we will sample potentially inter-connected pygmy rabbit populations that span a range of habitat types and presumed barriers to movement. We will survey pygmy rabbit populations through a combination of trapping (Tomahawk live traps set at burrows), fecal pellet collection, and genetic analysis. Our sampling design will include 10 focal populations (N = 12 individuals per locality) within 3 regional replicates in the core of pygmy rabbit habitat in the Great Basin (Figure 1, stars). Within each population we will quantify genetic variation across a representative portion of the genome by generating a large panel of single nucleotide polymorphisms (SNPs) from across the genome (10-20,000 SNPs). Briefly, we will use individually indexed samples and reduced representation genomic libraries along with high throughput Illumina sequencing to establish a robust, genome-wide dataset. Sample processing and bioinformatics pipelines will follow those in use in the Matocq lab.

To estimate habitat variables associated with pygmy rabbit occupation, we will conduct vegetation and soil surveys. At each site, we will establish 6, 50-m transect lines along which vegetation and soil surveys will be conducted. Vegetation surveys will include line-point intercept, gap intercept, and herb and shrub density estimates following the approach of Herrick et al. (2005). Using these data we will quantify the presence and cover of individual plant species and ground cover composition including vegetation, litter, rocks and biotic crusts. We will quantify soil composition and depth at 10-m intervals along the baselines used for vegetation surveys. Soil depth will be measured using an aluminum soil probe (Harner and Harper 1976). Soil samples will be collected from surface soils to 10-cm depth, and surface soil texture, pH and conductivity will be determined in the laboratory. For textural analysis, soils will first be sieved for coarse fragments (> 2mm) and then analyzed for percent sand, percent silt and percent clay using the hydrometer method. We note that while habitat-associations are relatively well understood for pygmy rabbits, because we seek to specifically link patterns of population connectivity to specific habitat characteristics (*i.e.* quality), the need to generate integrated datasets is central to our goals.

We will generate both standard population estimates of differentiation (linearized F_{ST}, Rousset 1997) as well as individual-based distances and examine the correlation of these estimates to underlying habitat and landscape variables. We will use both cost-weighted distance (Adriaensen et al. 2003) and cumulative resistance (McRae 2006) as measures of habitat-based distance. Cost-weighted distance uses Dijkstra's algorithm to determine an optimal least-cost route between populations and sums the resistance values for each cell along the single optimal route. In contrast, cumulative resistance is based on circuit theory and does not assume a single optimal route, but rather integrates numerous potential routes into one overall measure of cumulative resistance.

We will use UNICOR software to calculate cost-weighted distance among populations (Landguth et al. 2010) and Circuitscape to calculate cumulative resistance (McRae and Shah 2009) between populations. In addition to habitat-based resistance of the landscape, we will also examine the influence

of potential discrete barriers. We will further quantify and map functional connectivity across the landscape using the GARM package (soon to be available, E. Landguth) and ResistanceGA (Peterman et al. 2014), approaches that weigh combinations of different habitat variables to establish the most well-supported map of landscape resistance. Beyond a comprehensive view of functional connectivity across the landscape, these analyses will identify "pinch-points" where pygmy rabbit habitat connectivity is restricted to a single or few potential routes, highlighting areas that may be particularly vulnerable to fragmentation.

Goal 3. *Process modeling tool.*

We will develop a process-modeling tool that agency personnel can use to predict population response to specific landscape changes. We will use the program CDPOP (Landguth et al. 2010), which tracks occupancy and maintenance of genetic variation through time, to simulate pygmy rabbit population dynamics across generations. Using this tool, we can directly compare land-use alternatives or projected environmental change to make basic predictions concerning the persistence of pygmy rabbit populations under these hypothetical scenarios of habitat availability and connectivity. We will use this approach to compare pygmy rabbit population response to alternative models of climate change to help inform spatial prioritization of conservation efforts for this sagebrush-obligate species. This tool will be further enhanced by habitat-specific demographic data (partly supported by commitments from NDOW and BLM to this project) and will then be applied to several other scenarios including response to different models of cheatgrass invasion, fire disturbance, renewable energy development, restoration efforts and other land-use changes of interest.

Project Products:

1*) Species distribution model for pygmy rabbit*. To be used for prioritization of conservation or restoration actions. 2) *Landscape-scale spatial models of habitat suitability and functional landscape connectivity*. These will yield maps of critical habitat, core habitat, important (non-redundant) corridors and crucial "pinch-point" habitats for connectivity, such as are needed to facilitate dispersal and gene flow, long-term population viability, and potential range shifts in response to climate change. 3) *Overlay of key habitat areas and corridors for two sagebrush-obligate species, Greater Sage-grouse and pygmy rabbit*. GSG information from other studies will be combined from results of the proposed study to identify areas of critical importance to the two umbrella species. 4) *Spatial information on genetic structure of pygmy rabbits, at the scale of local populations*. Long-term population viability and climate change adaptation depend upon maintaining genetic diversity. 5) *Interim and final reports, conferences, workshops*, *webinar*. Communication with federal and state partners will be facilitated through ongoing exchange of project findings and workshops to integrate use of projects products into management and conservation decisions; final project outcomes will be shared through a webinar hosted by the Great Basin Consortium. 6) *Presentations and publications*. PIs and graduate student personnel will present project data at scientific conferences and through publications in the peer-reviewed literature.

Communication & Engagement: The scope and goals of this project have already been formally communicated to the Nevada Department of Wildlife and the Bureau of Land Management (see letter of support) and refined to more completely fill their immediate knowledge gaps for this sensitive taxon and primary indicator of sagebrush ecosystem health. Close collaboration with NDOW, BLM, and USFWS will continue throughout the planning, implementation, communication and future assessment associated with this research. The process-modeling tool we will develop as a part of this project will enable continued integration of future survey data so that agency personnel will be able to continuously refine their understanding of ongoing dynamics and areas of conservation priority for this taxon and the ecosystem on which it relies.

Budget:
We request funds over a 24-month period in the total amount of $99,897 with the following timeline and key deliverables:

January 1, 2015: Project start date.

February 1, 2015: Primary personnel will be hired and first meeting will be set with NDOW, BLM, USFWS, Forest Service and other interested partners to make final plans for field season 1.

July 1, 2015: Region 1 sampling complete, interim report submitted, set date for follow-up discussion with state and federal partners.

November 1, 2015: Region 2 sampling complete.

March 1, 2016: Region 3 sampling complete, annual report submitted, set date for follow-up discussion with state and federal partners.

September 1, 2016: All genetic analyses complete, fall presentation and discussion with partners on primary genetic results.

December 31, 2016: All landscape connectivity and simulation models complete, final report submitted. Manuscript preparation will continue and spring presentation/workshop to agency partners on landscape connectivity results and webinar to broader community through the Great Basin Consortium.

Funds requested in the current proposal will be complementary to a larger project. Please see the letter of support from NDOW indicating their participation in the project along with the Bureau of Land Management through their joint oversight of the Ruby Pipeline Mitigation program.

Budget Justification:

SALARIES AND WAGES

Senior Personnel. Matocq ($1660 + 4% fringe benefits) and Weisberg ($1744 + 4% fringe benefits) each request a total of 3 days of compensation in each project year for overseeing the project, advising the graduate student, overseeing analyses, writing interim and annual reports, conducting meetings with state and federal personnel and seeing project products through delivery and publication.

Tom Dilts will contribute 2 months of time to the project in each year ($9412 + 31%) to conduct all habitat modeling, landscape genetic modeling, and development of simulation models.

Graduate Student. Funds are requested for the half-time support of one graduate student to conduct field collections, oversee the field technician, and conduct genetic analyses. $10,200 per project year plus 15% fringe benefits.

Undergraduate Assistant. Funds are requested to hire a 3-month field technician in each project year to assist the graduate student in sample collection. $4500 in each project year plus 2% fringe benefits.

TUITION
As per UNR guidelines, graduate student tuition must be requested to support the education of the graduate student. This is estimated at 6 units per year for the half time support requested here ($1122.24).

MATERIALS AND SUPPLIES

An expendable field supply budget of $400 per project year is requested. All traps and the vast majority of field equipment are already available in the Matocq lab, we only request funds for expendable supplies and small repairs of traps.

We will generate a SNP genomic dataset for 450 samples at a total cost of $10,500 in year 2. This includes the cost of DNA extraction, genomic library preparation, size selection, Illumina sequencing and bioinformatics analysis. All equipment, computers, and software to conduct this work are available in the Matocq lab.

To conduct the fieldwork we request 3 months of truck rental in each project year ($3000 per year) and a gas allowance of $750 per year.

INDIRECT COSTS

UNR's federally negotiated (DHHS) indirect cost rate for on campus research is 43.5% of the modified total direct costs base. A copy of the NICRA is attached. This proposal has been calculated using the GB-CESU agreement indirect cost rate of 17.5% of the modified total direct costs as outlined in the RFP.

Figure 1. Current state of knowledge of the distribution of pygmy rabbit in Nevada. Stars indicate general location of 3 regional sampling areas within which intensive genetic and habitat sampling will occur. The exact location of collection sites will be planned in collaboration with state and federal partners, and locations will be added as additional project partners become involved.

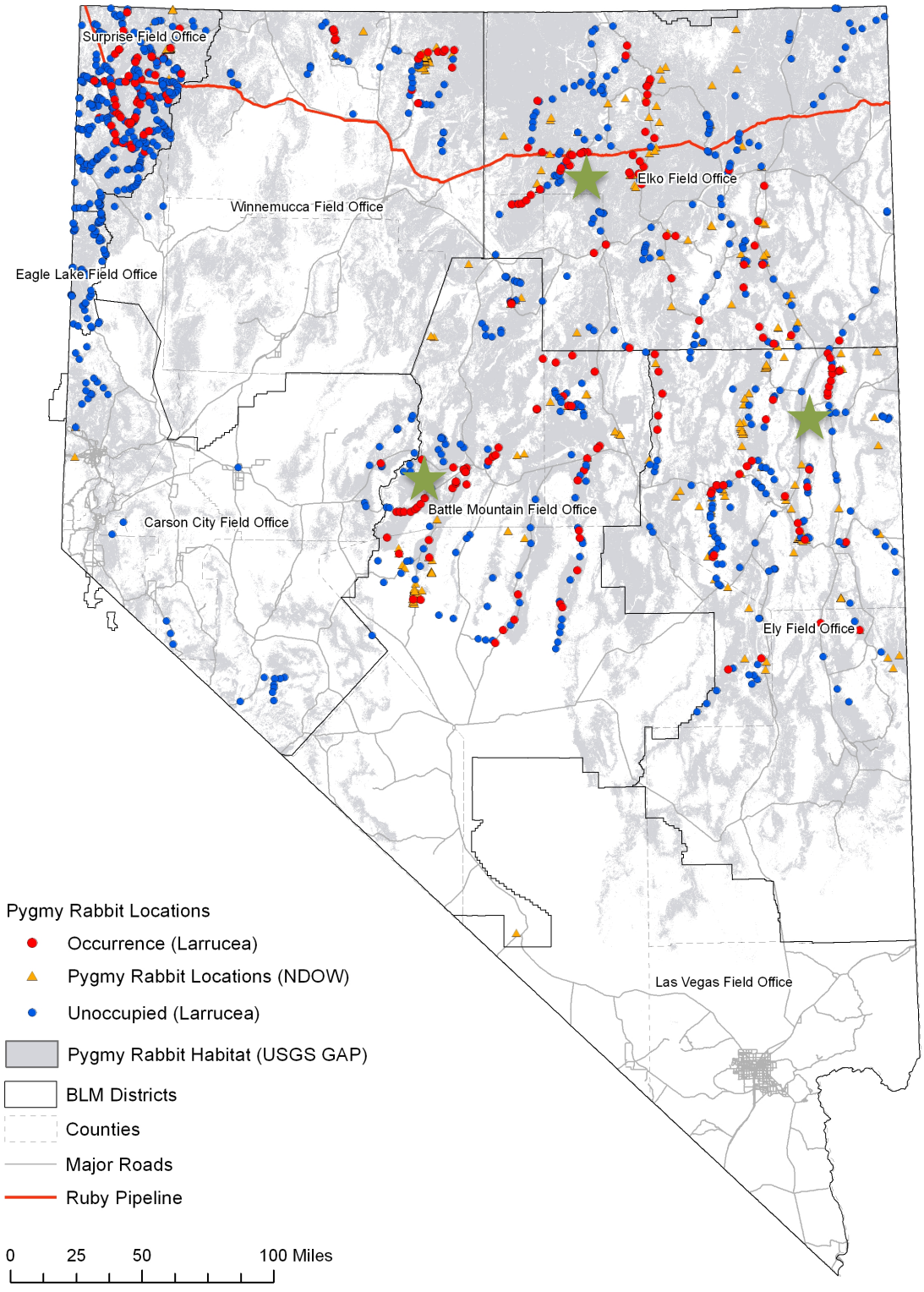
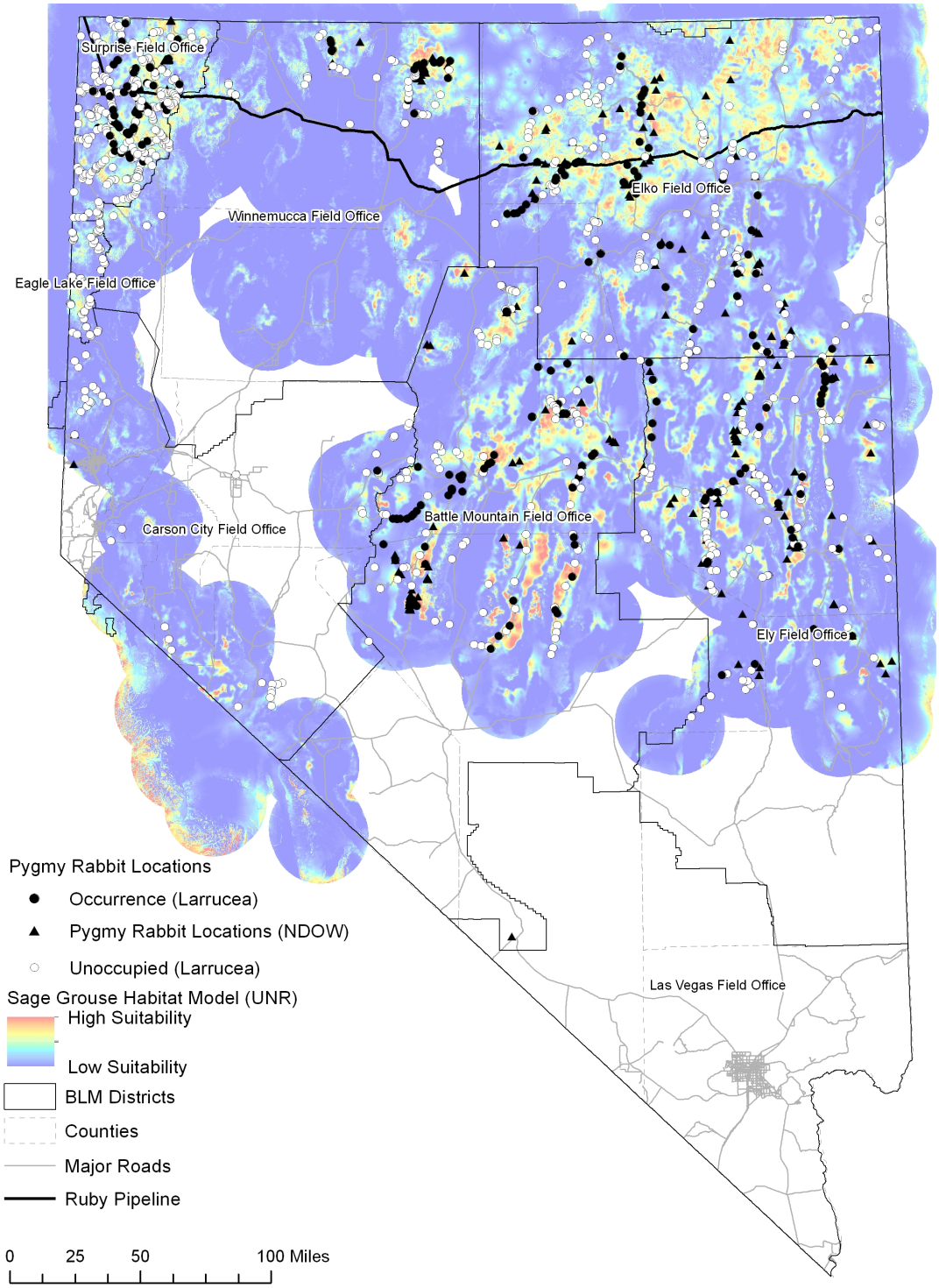


Figure 2. Overlap of known pygmy rabbit sites and predicted suitable habitat for greater sage grouse, the latter based on a model courtesy of Dan Gibson, UNR.



Literature Cited

Adriaensen, F., Chardon, J. P., De Blust, G., Swinnen, E., Villalba, S., Gulinck, H., & Matthysen, E. (2003). The application of 'least-cost'modelling as a functional landscape model. *Landscape and urban planning*, *64*(4), 233-247.

Boyce, M. S., Vernier, P. R., Nielsen, S. E., & Schmiegelow, F. K. (2002). Evaluating resource selection functions. *Ecological modelling*, *157*(2), 281-300.

Burnham, K. P., & Anderson, D. R. (2002). *Model selection and multimodel inference: a practical information-theoretic approach*. Springer.

Elith, J., Phillips, S. J., Hastie, T., Dudík, M., Chee, Y. E., & Yates, C. J. (2011). A statistical explanation of MaxEnt for ecologists. *Diversity and Distributions*, *17*(1), 43-57.

Green, J.S. & Flinders, J.T. (1980). *Brachylagus idahoensis*. *Mammalian Species* 125:1-25.

Harner, R. F., & Harper, K. T. (1976). The role of area, heterogeneity, and favorability in plant species diversity of pinyon-juniper ecosystems. *Ecology*, 1254-1263.

Herrick, J. E., Van Zee, J. W., Havstad, K. M., Burkett, L. M., & Whitford, W. G. (2005). *Monitoring manual for grassland, shrubland and savanna ecosystems. Volume I: Quick Start. Volume II: Design, supplementary methods and interpretation*. USDA-ARS Jornada Experimental Range.

Homer, C. G., Aldridge, C. L., Meyer, D. K., & Schell, S. J. (2012). Multi-scale remote sensing sagebrush characterization with regression trees over Wyoming, USA: laying a foundation for monitoring. *International Journal of Applied Earth Observation and Geoinformation*, *14*(1), 233-244.

Landguth, E. L. & Cushman, S. A. (2010) CDPOP: A spatially-explicit cost distance population genetics program. *Molecular Ecology Resources* **10**, 156-161.

Larrucea, E.S. & Brussard. P.F. (2008a). Habitat selection and current distribution of the pygmy rabbit in Nevada and California, USA. *Journal of Mammalogy*, 89(3):691-699.

Larrucea, E. S., & Brussard, P. F. (2008b). Shift in location of pygmy rabbit (*Brachylagus idahoensis*) habitat in response to changing environments. *Journal of arid environments*, *72*(9), 1636-1643.

McRae, B. H. (2006). Isolation by resistance. *Evolution*, *60*(8), 1551-1561.

McRae, B. H., & Shah, V. B. (2009). Circuitscape User's Guide. ONLINE. The University of California, Santa Barbara.

Peterman, W. E., Connette, G. M., Semlitsch, R. D., & Eggert, L. S. (2014). Ecological resistance surfaces predict fine‐scale genetic differentiation in a terrestrial woodland salamander. *Molecular ecology*, *23*(10), 2402-2413.

Phillips, S. J., & Dudík, M. (2008). Modeling of species distributions with Maxent: new extensions and a comprehensive evaluation. *Ecography*, *31*(2), 161-175.

Rousset, F. (1997). Genetic differentiation and estimation of gene flow from F-statistics under isolation by distance. *Genetics*, *145*(4), 1219-1228.

Wildlife Action Plan Team. (2012). Nevada wildlife action plan. Department of Wildlife. (http://www.ndow.org/Nevada_Wildlife/Conservation/Nevada_Wildlife_Action_Plan/).

Wilson, T. L., Odei, J. B., Hooten, M. B., & Edwards Jr, T. C. (2010). Hierarchical spatial models for predicting pygmy rabbit distribution and relative abundance. *Journal of applied ecology*, *47*(2), 401-409.

Xian, G., Homer, C., Meyer, D., & Granneman, B. (2013). An approach for characterizing the distribution of shrubland ecosystem components as continuous fields as part of NLCD. *ISPRS Journal of Photogrammetry and Remote Sensing*, *86*, 136-149.

Yang, J., Weisberg, P. J., & Bristow, N. A. (2012). Landsat remote sensing approaches for monitoring long-term tree cover dynamics in semi-arid woodlands: comparison of vegetation indices and spectral mixture analysis. *Remote Sensing of Environment*, *119*, 62-71.

MARJORIE DENISE MATOCQ

Expertise relevant to this proposal

- Population and evolutionary genetics of small mammals
- Simulation modeling of population genetic processes
- Behavioral and field ecology of small mammals
- Application of genomic tools to non-model mammalian systems

Professional Preparation

Institution	**Major Area**	**Degree & Year**
California Polytechnic State Univ.	Ecology and Systematic Biology	B.S. 1992
San Francisco State University	Biology/Conservation	M.S. 1995
University of California, Berkeley	Integrative Biology	Ph.D. 2000

Appointments

University of Nevada, Reno	Associate Professor	2008-
Idaho State University	Associate Professor	2007-2008
Idaho State University	Assistant Professor	2002-2007
Smithsonian Institution	Postdoctoral Fellow	2001-2002

Products (* student author)

(i) Products most closely related to the proposed project (5)

2014. *Shurtliff, Q.S., P.J. Murphy, **M.D. Matocq**. Ecological segregation in a small mammal hybrid zone: habitat-specific mating opportunities and selection against hybrids minimize gene flow at a fine spatial scale. Evolution 68: 729-742.

2013. *Shurtliff, Q., P.J. Murphy, J. Yeiter*, and **M.D. Matocq**. Experimental evidence for asymmetric mate preference across a woodrat (*Neotoma*) hybrid zone. BMC Evolutionary Biology, 13:220.

2012. **Matocq, M.D.**, P.A. Kelly, S.E. Phillips, J.E. Maldonado. Reconstructing the evolutionary history of an endangered subspecies across the changing landscape of the Great Central Valley of California. Molecular Ecology 21: 5918-5933.

2007. **Matocq, M.D.** and P.J. Murphy. Fine-scale phenotypic change across a species transition zone in the genus *Neotoma*: disentangling independent evolution from phylogenetic history. Evolution 61: 2544-2557.

2002. **Matocq, M.D.** Morphological and molecular analysis of a contact zone in the *Neotoma fuscipes* species complex. Journal of Mammalogy 83: 866-883.

(ii) Other Products (5)

2013. *Hornsby, A.D. and **M.D. Matocq**. Patterns of evolutionary divergence and convergence in the bushy-tailed woodrat, *Neotoma cinerea*, across Western North America. Journal of Mammalian Evolution, doi: 10.1007/s10914-013-9232-7.

2011. *Hornsby, A.D. and **M.D. Matocq**. Differential regional response of the bushy-tailed woodrat (*Neotoma cinerea*) to late Quaternary climate change. Journal of Biogeography 39: 289-305.
2009. **Matocq, M.D**. A microarray's view of life in the desert: adding a powerful genomics tool to the woodrat's midden. Invited Perspectives article. Molecular Ecology, 18: 2310-2312.
2004. **Matocq, M.D.** Reproductive success and effective population size in woodrats (*Neotoma macrotis*). Molecular Ecology 13: 1635-1642.
2000. **Matocq, M.D**., M.N.F. da Silva, and J.L. Patton. Population genetic structure of two ecologically distinct Amazonian spiny rats: separating history and current ecology. Evolution 54(4): 1423-1432

Synergistic Activities

1) Undergraduate Mentoring. In the past 5 years, my graduate students and I have mentored 28 undergraduates in on-campus or field research, 19 of them women. I currently supervise 6 undergraduates. Students are engaged in professional activities including grant writing and presentation of their research results at local and regional meetings.

2) Graduate and Postdoctoral Mentoring. I currently supervise 1 PhD student, 2 M.S. student, and 3 Postdoctoral Associates. My students and postdocs regularly present their research at regional and national meetings and either have already published their research or are preparing manuscripts for submission to peer-reviewed journals. Two of my graduate students have been involved in the NSF GK-12 program and two of my PhD students have had NSF-DDIG awards.

3) Professional Service: I am an elected member of the Board of Directors for the American Society of Mammalogists (ASM), I am an Associate Editor for the Journal of Mammalogy, I am Chair of ASM's Grinnell Committee, and serve on two committees: Grants in Aid of Research and Student Honoraria. I regularly serve as a reviewer for a wide range of journals and funding agencies.

4) University Service: I currently serve as Chair of my University's Institutional Animal Care and Use Committee after serving as Associate Chair. I am a member of my Department's Executive Committee. I served as Director of the Molecular Research Core Facility at Idaho State University for 5 years. This position entailed overseeing the facility manager and lab technician, setting fee structure, and obtaining extramural support for instrumentation and service augmentation. I established a graduate and undergraduate seed grant program to stimulate molecular genetic research and external funding for student projects.

5) I continue to design and implement a high school outreach program that brings a molecular genetic research experience to Nevada classrooms.

PETER J. WEISBERG

Expertise relevant to this proposal

- Landscape ecology of the Great Basin
- Remote sensing of vegetation and habitat
- GIS and geospatial analysis
- Habitat modeling and landscape connectivity
- Great Basin vegetation ecology and disturbance regimes

Professional Preparation

1992	B.S.	Forest Biology, SUNY College of Env. Science and Forestry, Syracuse
1994	M.S.	Biogeography; University of Wyoming, Laramie
1998	Ph.D.	Forest Ecology; Oregon State University, Corvallis
1998-2000		Postdoctoral Research Associate, Ecological Modeling; Natural Resource Ecology Laboratory, Colorado State University, Fort Collins
2000-2001		Postdoctoral Research Associate, Ecological Modeling; Mountain Forest Ecology, Swiss Fed. Inst. Technology, Zurich

Appointments

2001-2003	Research Scientist, Mountain Forest Ecology, Swiss Fed. Inst. Technology, Zurich
2003-2009	Assistant Professor, Dept. of Natural Resources and Env. Sci., Univ. Nevada - Reno
2009 – present	Associate Professor, Dept. of Natural Resources and Env. Sci., Univ. Nevada - Reno
2011 – 2013	co-Director, Ecology, Evolution and Conservation Biology Interdisciplinary Program

Products (* student author)

(i) Products most closely related to the proposed project (5)

2014. **Weisberg, P.J.**, T. Dilts, M.E. Becker*, J.S. Young, D.C. Wong-Kone, W.E. Newton, E.C. Ammon. Guild-specific responses of avian species richness to LiDAR-derived habitat heterogeneity. Acta Oecologica 59: 72-83.

2014. Bristow*, N.A., **P.J. Weisberg**, R.J. Tausch. A 40-year record of tree establishment following chaining and prescribed fire in pinyon-juniper woodlands. Rangeland Ecology and Management 67: 389-396.

2014. Nelson*, Z.J., **P.J. Weisberg**, S.G. Kitchen. 2014. Influence of climate and environment on post-fire recovery of mountain big sagebrush. International Journal of Wildland Fire 23: 131-142.

2012. Yang, J., **P.J. Weisberg**, N.A. Bristow*. Landsat remote sensing approaches for monitoring long-term tree cover dynamics in semi-arid woodlands: Comparison of vegetation indices and spectral mixture analysis. *Remote Sensing of Environment* 119: 62-71.

2007. **Weisberg, P.J.**, E. Lingua, R.B. Pillai. Spatial patterns of pinyon-juniper expansion in central Nevada. *Rangeland Ecology and Management* 60: 115-124.

(ii) Other Products (5)

2013. **Weisberg, P.J.**, O. Shandra, M. Becker*. 2013. Landscape influences on recent timberline shifts in the Carpathian Mountains: Abiotic influences modulate effects of land-use change. Arctic, Antarctic and Alpine Research 45: 1-11.

2013. **Weisberg, P.J.**, S.G. Mortenson, T.E. Dilts. 2013. Gallery forest or herbaceous wetland? The need for multi-target perspectives in riparian restoration planning. Restoration Ecology 21: 12-16.

2012. Liu, Z., J. Yang, Y. Chang, **P.J. Weisberg**, H.S. He. 2012. Spatial patterns and drivers of fire occurrence and its future trend under climate change in a boreal forest of Northeast China. *Global Change Biology*, 18: 2041-2056.

2010. Mortenson*, S.J., **P.J. Weisberg**. 2010. Does river regulation increase dominance of woody species in riparian landscapes? *Global Ecology & Biogeography* 19:562-574.
2008. Greenwood*, D.L., **P.J. Weisberg.** 2008. Density-dependent tree mortality in pinyon-juniper woodlands. *Forest Ecology and Management* 255: 2129-2137.

Synergistic Activities

6) Mentorship: I have mentored 18 graduate students (13 M.S., 5 Ph.D), 3 postdoctoral fellows, 9 staff scientists, 5 visiting international researchers, and numerous (28) undergraduate research assistants who have worked directly with me or with graduate students in my lab. In addition, I have served on graduate committees for 37 students (16 M.S., 21 Ph.D.), not including those for whom I have been committee chair, spanning 10 different graduate degree programs. In 2013 I received the "Mentor of the Year" award from the PhD program in Ecology, Evolution and Conservation Biology.

7) Presentations and Conference Participation: I have given 12 invited academic presentations over the past five years, including international talks in China, Israel, Italy, Switzerland, and Ukraine. I have authored or co-authored 44 contributed conference talks over the past five years.

8) Professional Service: I have been panel reviewer for proposals for the Joint Fire Science Program (2011, 2012) and for the National Science Foundation's Graduate Research Fellows Program (2013). I have been an ad hoc proposal reviewer for various funding agencies including NSF (Environmental Biology, Hydrologic Science), Joint Fire Sciences Program, Bureau of Reclamation, CRDF Global, Natural Sciences and Engineering Research Council of Canada, European Union Marie Curie Fellowships Program, Kearney Foundation of Soil Science, Pierce's Disease Control Program, and for the national science foundations of several foreign countries (China, Ireland, Italy, Portugal). I have served as ad hoc reviewer for numerous professional journals (n=28, including many high-impact publications) and as guest editor for Forest Ecology & Management.

9) University Service: I currently serve as Graduate Program Director for the NRES Department's M.S. degree program, and served as co-Director for the Ecology, Evolution and Conservation Biology Ph.D. program for three years. I am a member of my University's Promotion and Tenure Committee, have chaired the University Research and Grants Committee, and have served on numerous other committees at university, college and departmental levels (University Strategic Plan committee, UNR Academic Standards committee, CABNR Awards committee, NRES Executive committee, NRES Peer Review committee, numerous search committees, etc.)

10) Interactions with the Natural Resource Management Community: I have actively interacted with the resource management community at local, regional and national levels, including serving as guest instructor for a training course for fire professionals (Nevada Division of Forestry); providing Science Consistency Review for FEISs (USFS LTBMU); serving as Technical Expert for planning processes (e.g. The Nature Conservancy Walker Lake Conservation Action Planning process); providing workshops and webinars to convey project results in accessible formats to diverse audiences including BLM, Lake Tahoe Basin Management Unit, California Energy Commission, Nevada State Forests, Nevada Department of Transportation, Death Valley National Park, etc.; and through development of GIS-based decision support tools (Death Valley National Park, US Fish and Wildlife Service).

JAMES STONE SEDINGER

Professional Preparation:

Ph.D. University of California, Davis, Ecology (1983)
B. S. (Cum Laude) University of Washington, Electrical Engineering (1971)

Appointments:

Professor, Natural Resources and Environmental Science, University of Nevada Reno (2002-present)
Associate Professor, Environmental and Resource Sciences, University of Nevada Reno (2001-2002)
Interim Director, Institute of Arctic Biology, University of Alaska Fairbanks (1998-2001)
Professor of Wildlife Ecology, University of Alaska Fairbanks (1994-2001)
Associate Professor of Wildlife Ecology, University of Alaska Fairbanks (1990-1994)
Assistant Professor of Wildlife Ecology, University of Alaska Fairbanks (1986-1990)
Adjunct Assistant Professor of Wildlife Ecology, University of Alaska Fairbanks (1985-1986)
Research Wildlife Biologist, U.S. Fish and Wildlife Service, Anchorage, AK (1984-1986)
Electrical Engineer, Bonneville Power Administration, Portland, OR (1972-1974)

Great Basin Publications:

Gibson, D. V., E. J. Blomberg, M. T. Atamian, and J. S. Sedinger. 2014. Lek fidelity and movement among leks by male Greater Sage-grouse: a capture-mark-recapture approach. Ibis:in press.

Blomberg, E. J., D. V. Gibson, and J. S. Sedinger 2014. Individual and environmental effects on egg allocations of female Greater Sage-grouse. Auk 131:in press.

Blomberg, E., D. Gibson, J. S. Sedinger, P. Coates, and M. Casazza. 2014. Carry-over effects and climatic conditions influence the post-fledging survival of greater sage-grouse. Ecology and Evolution: in press.

Gibson, D. V., E. J. Blomberg, G. L. Patricelli, A. H. Krakauer, M. T. Atamian, and J. S. Sedinger. 2013. Effects of radio collars on male Greater Sage-Grouse survival and lekking behavior. Condor 115:769–776.

Blomberg, E. J., D. V. Nonne, J. S. Sedinger, M. L. Casazza, and P. S. Coates. 2013. Intraseasonal variation in survival and probable causes of mortality in greater sage-grouse. Wildlife Biology: 19:347-357.

Blomberg, E. J., S. R. Poulson, J. S. Sedinger, and D. V. Gibson. 2013. Prefledging diet is correlated with individual growth in Greater Sage-grouse (Centrocercus urophasianus). Auk: 130:715−724.

Blomberg, E. J., P. L. Wolff, and J. S. Sedinger. 2013. Geographic variation in liver metal concentrations of Greater Sage-grouse. Journal of Fish and Wildlife Management 4:298-302.

Blomberg, E. J., J. S. Sedinger, D. V. Nonne, and M.T. Atamian. 2013. Annual male lek attendance influences count-based population indices of Greater sage-grouse. Journal of Wildlife Management 77:1583-1592.

Gibson, D. V., E. J. Blomberg, G. L. Patricelli, A. H. Krakauer, M. T. Atamian, and J. S. Sedinger. 2013. Effects of radio collars on male Greater Sage-Grouse survival and lekking behavior. Condor 115:769–776.

Blomberg, E. J., D. V. Nonne, J. S. Sedinger, M. L. Casazza, and P. S. Coates. 2013. Intraseasonal variation in survival and probable causes of mortality in greater sage-grouse. Wildlife Biology: 19:347-357.

Blomberg, E. J., S. R. Poulson, J. S. Sedinger, and D. V. Gibson. 2013. Prefledging diet is correlated with individual growth in Greater Sage-grouse (*Centrocercus urophasianus*). Auk: 130:715−724.

Blomberg, E. J., P. L. Wolff, and J. S. Sedinger. 2013. Geographic variation in liver metal concentrations of Greater Sage-grouse. Journal of Fish and Wildlife Management 4:298-302.

Blomberg, E. J., J. S. Sedinger, D. V. Nonne, and M.T. Atamian. 2013. Annual male lek attendance influences count-based population indices of Greater sage-grouse. Journal of Wildlife Management 77:1583-1592.

Blomberg, E. J., J. S. Sedinger, M. T. Atamian, and D. V. Nonne. 2012. Characteristics of climate and landscape disturbance influence the dynamics of greater sage-grouse populations. Ecosphere 3:1-20.
Sedinger, B. S., J. S. Sedinger, S. Espinosa, M. T. Atamian, and E. J. Blomberg. 2011. Spatial- temporal variation in survival of harvested Greater Sage-Grouse. Pp. 317–328 in B. K. Sandercock, K. Martin, and G. Segelbacher (editors). Ecology, conservation, and management of grouse. Studies in Avian Biology 39.
Atamian., M. T., J. S. Sedinger, J. S. Heaton, and E. J. Blomberg. 2010. Landscape level assessment of brood rearing habitat for Greater Sage-grouse in Nevada. Journal of Wildlife Management 74:1533-1543.
Sedinger, J. S., G. C. White, S. Espinosa, E. T. Partee, and C. E. Braun. 2010. An approach to assessing compensatory versus additive harvest mortality: an example using Greater Sage-grouse Centrocercus urophasianus. Journal of Wildlife Management 74:326–332.
Atamian, M. T., and J. S. Sedinger. 2010. Balanced sex ratio at hatch in a Greater Sage-grouse (Centrocercus urophasianus) population. Auk 127:16-22.
Kolada, E. J., J. S. Sedinger, and M. L. Casazza. 2009. Nest site selection by greater sage-grouse in Mono County, California. Journal of Wildlife Management 73:1333-1340.
Kolada, E. J., M. L. Casazza, and J. S. Sedinger. 2009. Ecological factors influencing nest survival of greater sage-grouse in Mono County, California. Journal of Wildlife Management 73:1341-1347.
Sedinger, J. S. 2006. Improving understanding and assessment of sage-grouse populations. Bulletin University of Idaho College of Natural Resources Experiment Station 88: 43-56.
Sedinger, J. S., and J. J. Rotella. 2005. Effect of harvest on sage-grouse populations: what can we learn from the data? Wildlife Biology 11:371-375.

Synergistic Activities:

Nevada Governor's Sage Grouse Task Force. (2003-2011).
Bureau of Land management, Sage Grouse Habitat management Guidelines, Technical Review Team (2005-2008)
California Energy Commission Wind Energy policy Technical Review Team (2006-2007).
Oversight Committee, Sage-grouse Research Collaborative, National Wind Coordinating Collaborative (2010-present)
Technical Team, Research protocols for assessing transmission line impacts on sage-grouse, Utah Wildlife in Need (2011)
Science Working Group, Nevada Sagebrush Ecosystem Council (2013-present)
Technical Review Group Conservation Credit System for Greater Sage-grouse in Nevada (2014)
Expert Review Team, Habitat Suitability Modeling for Greater Sage-grouse in Nevada (2014)
Peer reviewer, U.S. Fish and Wildlife Service species status assessment Bi-state distinct population segment of Greater Sage-grouse (2014)

THOMAS EARL DILTS

Expertise relevant to this proposal

- Habitat suitability/connectivity modeling
- Remote sensing
- Landscape genetics

Professional Preparation

Institution	Major Area		Degree & Year
University of Alaska, Fairbanks	Geography	B.S.	2001
University of Nevada, Reno	Geography/GIS	M.S.	2007

Appointments

University of Nevada, Reno	Research Scientist	2007-

Products

(i) Products most closely related to the proposed project (5)

2014. **Dilts, T.E.**, Weisberg, P.J., Matocq, M.D, Leitner, P., Nussear, K.E., Esque, T.C., Inman, R.D. (submitted to Biodiversity and Conservation) Landscape connectivity of the Mohave ground squirrel: a multi-scale framework for conservation prioritization in the context of development and renewable energy climate change.

2014. **Dilts, T.E.**, Weisberg, P.J., Dencker, C.M., Chambers, J.C. (submitted to the Journal of Biogeography) Functionally relevant climate variables for arid lands: using climatic water deficit modeling to predict distribution of desert shrub vegetation.

2013. **Dilts, T.E.**, Weisberg, P.J., Matocq, M.D., Leitner, P., Nussear, K.N., Esque, T.C., and R.D. Inman. Chapter 4: Landscape connectivity of the Mohave ground squirrel. In Esque, T.C., K.E. Nussear, R.D. Inman, M.D. Matocq, P.J. Weisberg, T.E. Dilts, P. Leitner. (U.S. Geological Survey). 2012. Potential Habitat Modeling, Landscape Genetics and Habitat Connectivity for the Mohave Ground Squirrel (Xerospermophilus mohavensis). California Energy Commission. Publication number: CEC-500-2014-003.

2013. Inman, R.D., Esque, T.C., Nussear, K.E., Leitner, P., Matocq, M.D., Weisberg, P.J., **Dilts, T.E.**, and A.G. Vandergast. Is there room for all of us? Renewable energy and Xerospermophilus mohavensis. Endangered Species Research, 20:1-18.

2014. Weisberg, P.J., **Dilts, T.E.**, Becker, M.E., Ammon, E.M., Young, J.S., Newton, W.E., Wong-Kone, D.C. Guild-specific responses of avian species richness to LiDAR-derived habitat heterogeneity. Acta Oecologica 59:72-83.

(ii) Other Products (5)

2012. **Dilts, T.E.**, Yang, J., Weisberg, P.J., Olson, T.J., Turner, P.L., and Condon, L.A. Direct and indirect effects of irrigated agriculture on land cover change in an arid lands watershed. Submitted Annals of the Association of American Geographers, 102(3): 531-548.

2011. Yang, J., **Dilts, T.E.,** Condon, L.A., Turner, P.L., and P.J. Weisberg. Longitudinal- and transverse-scale environmental influences on riparian vegetation across multiple levels of ecological organization. Landscape Ecology, 26(3): 381-395.

2009. **Dilts, T.E.**, Sibold, J.S., and Biondi, F. A weights-of-evidence model for mapping the probability of fire occurrence in Lincoln County, Nevada. Annals of the Association of American Geographers, 99(4): 712-727.
2010. **Dilts, T.E.**, J. Yang, and P.J. Weisberg . The Landscape Similarity Toolbox: new tools for optimizing the location of control sites in experimental studies. Ecography 33: 1097-1101.
2012. Weisberg, P.J., Mortenson, S.G., and **T.E. Dilts**. Gallery Forest or Herbaceous Wetland? The Need for Multi-Target Perspectives in Riparian Restoration Planning. Restoration Ecology, 21(1): 12-16.

Eveline Séquin Larrucea
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evelarrucea@gmail.com
775-530-5881

Education

Institution	Area	Degree/Year
University of California, Berkeley	Bioresource Sciences	B.S. 1995
University of Nevada, Reno	Biology	M.S. 2001
University of Nevada, Reno	Ecology, Evolution and Conservation Biology	Ph.D. 2007

Relevant Experience

Biological Consultant, Pygmy rabbit response to Ruby Pipeline Project 2/2010-present
Pre/post construction assessment of pygmy rabbit habitat along pipeline corridor. Study behavioral reaction of rabbits and predators to construction activity. Assess extent of genetic variation of pygmy rabbit populations in Nevada.

Post-doctoral Associate, University of Nevada, Reno 1/2008-12/2008
Assessed impacts of global warming on individual habitat types found across Nevada. Prepared global warming impacts section for the Nevada Wildlife Action Plan.

Field Researcher, BLM, Surprise Valley Field Office, Cedarville, CA 5/2007-12/2007
Surveyed lands belonging to SVFO to create map with locations of current pygmy rabbit sign.

Field Researcher, BLM/ECO, Eagle Lake Field Office, Susanville, CA 5/2004-10/2004
Performed field surveys for pygmy rabbits throughout lands of Eagle Lake Field Office.

Research Assistant, Biological Resources Research Center, University of Nevada, Reno 1/2001-12/2007
Studied the distribution and behavior of pygmy rabbits in Nevada and California. Tested survey and capture techniques. Used habitat components to create a habitat model for probability of pygmy rabbit presence and determine habitat preferences.

Relevant Publications

Larrucea, E.S, and P.F. Brussard. 2009. Diel and seasonal activity patterns of pygmy rabbits (*Brachylagus idahoensis*). Journal of Mammalogy, 90(5):1176-1183.

Larrucea, E.S and P.F. Brussard. 2008. Shift in location of pygmy rabbit (*Brachylagus idahoensis*) habitat in response to changing environments. Journal of Arid Environments 72(9):1636-1643.

Larrucea, E.S. and P.F. Brussard. 2008. Habitat selection and current distribution of the pygmy rabbit in Nevada and California, USA. Journal of Mammalogy, 89(3):691-699.

Larrucea, E.S. and P.F. Brussard. 2008. Efficiency of various methods used to detect presence of pygmy rabbits in summer. Western North American Naturalist 68(3):303-310.

Larrucea, E. S., Brussard, P. F., Jaeger, M.M., Barrett, R.H. 2007. Cameras, coyotes, and the assumption of equal detectability. Journal of Wildlife Management 71(5):1682-1689.

Larrucea, E.S., G. Serra, M.M. Jaeger, and R.H. Barrett. 2007. Censusing bobcats using remote cameras. Western North American Naturalist, 67(4) 538-548.

Larrucea, E.S. 2006. Bureau of Land Management Cedarville Field Office: A survey of current pygmy rabbit locations in northwestern Nevada and northeastern California. BLM Report, Cedarville, CA.

Larrucea, E.S. and P.F. Brussard. 2006. A method for capturing pygmy rabbits (*Brachylagus idahoensis*) in summer. Journal of Wildlife Management 71(3):1016-1018.
Séquin, E.S. 2004. Bureau of Land Management Eagle Lake Field Office Pygmy Rabbit Survey. BLM report, Susanville, CA.
Séquin, E.S., Jaeger, M.M., Brussard, P.F., Barrett, R.H. 2003. Wariness of coyotes to camera traps relative to social status and territory boundaries. Can. J. Zool. 81: 2015-2025

Relevant Presentations

Larrucea, E.S. Peacock, M.M. Brussard, P.F. 2009. Patterns of genetic variation in populations of the pygmy rabbit in Nevada and California, USA. Wildlife Society Meeting, Sacramento, CA.
Larrucea, E.S and P.F. Brussard. 2008. Changing environments are putting the squeeze on pygmy rabbit habitat. Western Section of the Wildlife Society meeting. Redding, CA
Larrucea, E.S. and P.F. Brussard. 2006. Status and behavior of the pygmy rabbit (Brachylagus idahoensis) in Nevada's Great Basin desert. Wildlife Society Meeting, Sacramento, CA
Larrucea, E.S. and P.F. Brussard. 2006. Distribution and activity patterns of pygmy rabbits in Nevada and California. Annual meeting of the Western Section of the Wildlife Society, Sacramento, CA.
Séquin, E.S and Brussard, P.F. 2005. Distribution and behavior of Pygmy rabbits in Nevada. Western Section of the Wildlife Society annual meeting. Sacramento, CA, February 2005
Séquin, E.S and Brussard, P.F. 2004. Using infrared-triggered cameras to determine the current distribution and behaviors of pygmy rabbits in Nevada. Pygmy rabbit symposium, Pullman WA
Séquin, E.S and Brussard, P.F. 2004. Pygmy rabbits: methods of detection, microhabitat characteristics and distribution in Nevada. AAAS-Pacific Division. Logan, UT June 2004
Séquin, E.S and Brussard, P.F. 2004. Pygmy rabbits: methods of detection, microhabitat characteristics and distribution in Nevada. Presentation at The Western Section of the Wildlife Society meeting. Rohnert Park CA, February 2004
Séquin, E.S and Brussard, P.F. 2003. A test of the utility of cameras for use in pygmy rabbit surveys. Poster at Western Section of Wildlife Society. Irvine CA, February 2003.

BRIAN SANDOVAL
Governor

STATE OF NEVADA
DEPARTMENT OF WILDLIFE
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TONY WASLEY
Director

RICHARD L. HASKINS, II
Deputy Director

PATRICK O. CATES
Deputy Director

July 23, 2014

Marjorie Matocq
Associate Professor
Department of Natural Resources and Environmental Science
University of Nevada, Reno

Dear Dr. Matocq:

The Nevada Department of Wildlife (NDOW) would like to reaffirm our commitment and support to your project on the ecology, demography, and landscape connectivity of the pygmy rabbit, a portion of which you are currently seeking funding for with the proposal to the Great Basin LCC: "Landscape connectivity of a sagebrush obligate: functional continuity of habitat for the pygmy rabbit." We are particularly supportive of this component of the project that will allow identification and delineation of connectivity corridors in sagebrush habitats that merit enhanced protection and restoration measures. We also reaffirm our commitment to cooperate with you, other state partners, and other federal partners as you continue to plan and implement this project to help maximize research outcomes and their integration into our management efforts.

Pygmy rabbits have been identified as a state Species of Conservation Priority in both the 2005 and 2012 Nevada Wildlife Action Plan and are listed as sensitive species for both the Bureau of Land Management and the U.S. Forest Service (Nevada Natural Heritage Program, July 2014). They are classified as extremely vulnerable under the Climate Change Vulnerability Index from The Nature Conservancy (Nevada Natural Heritage Program, July 2014). This species, in itself, is of concern to the state. As sagebrush obligates, they are critical indicators of the health of this imperiled ecosystem. The landscape connectivity analyses and development of forecasting models proposed in the project will be critical in guiding conservation priorities towards maintaining functional connectivity across Great Basin landscapes and help plan for areas of expansion and retraction.

We strongly support the overall project and, in collaboration with staff at the Winnemucca, Elko, and Surprise Field Office Bureau of Land Management, have tentatively committed funding support to this project through the Ruby Pipeline Mitigation program. In addition, other state wildlife grant funding has been requested to ensure the success of this project. While this funding provides a platform for successful project implementation, additional support must be garnered in order to ensure a multi-year and multi-location research effort that will allow correct inference across multiple habitat types and account for natural variation involved in landscape-scale conservation. Your efforts in extending partnership with state and federal agencies and augmenting funds towards the project through the Great Basin LCC are highly timely and will allow the type of broad-based, concerted, on-the-ground effort that will make this project a success.

Sincerely,

Mark Freese
Supervisory Habitat Biologist

Disclaimer regarding data sharing : We will present final analyses directly to federal and state partners including NDOW, BLM, and USFWS. All underlying databases generated through the project (distribution model, genomic data, process-modeling tools) will be provided directly to these agencies and made publicly available through other means. Any sensitive information concerning detailed locality information of particularly sensitive populations will be removed in consultation with agency personnel prior to more public release. Project outcomes will be further shared with the public through publication in the scientific literature, presentations at scientific conferences and associated databases to support these findings will be published in the Dryad digital repository (http://datadryad.org/) and other dataset-specific repositories like Genbank for the genomic data.

Data Management Plan Tables:

Project Title: Landscape connectivity of a sagebrush obligate: functional continuity of habitat for the pygmy rabbit.
Lead PI: Marjorie Matocq
Data Point(s) of Contact (if different):

DATA INPUTS – EXISTING COLLECTIONS
Existing collections include data that will be used for the purposes of creating the final data products and/or project deliverables. The collection(s) have already been obtained and have not been collected during the course of the project. Examples: PRISM data, USGS water data, remote sensing, etc.

1 PRISM climate data
Description: 30-year normals (1971 – 2000) for temperature and precipitation, 800-m cell size
Source: The PRISM Group. (2007) *PRISM climatological normals, 1971–2000*, The PRISM Group, Oregon State University, Corvallis, OR.
Restrictions: Publicly available
Format: Raster
Fees: N/A

2 SSURGO soils data
Description: Soil characterization (qualitative and quantitative), various attribute from NRCS soil survey
Source: NRCS (2013) *Gridded Soil Survey Geographic (gSSURGO) Database for Nevada and Utah United States Department of Agriculture*, Natural Resources Conservation Service. Available online at http://datagateway.nrcs.usda.gov/
Restrictions: Publicly available
Format: ESRI Geodatabase
Fees: N/A

3 Vegetation classification
Description: Vegetation classification from Southwest Regional GAP program
Source: NRCS (2013) U.S. Department of the Interior (2004b) *U.S. Geological Survey National Gap Analysis Program, **Provisional Digital Land Cover Map for the Southwestern United States.** Version 1.0.* RS/GIS Laboratory, College of Natural Resources, Utah State University.
Restrictions: Publicly available
Format: ESRI Geodatabase
Fees: N/A

4 Landsat satellite imagery
Description: Satellite imagery from Landsat 8
Source: USGS Glovis site, http://glovis.usgs.gov/

Restrictions: Publicly available
Format: Raster
Fees: N/A

DATA INPUTS – NEW COLLECTIONS

Data that does not currently exist and will be collected or generated during the course of the project for the purposes of creating the final data products and/or project deliverables, for example, a new field data collection. New data collections must be delivered as a project deliverable at project completion and do not need to be added as a data product in the DMP.

1 Genomic dataset for pygmy rabbit
Description: We will generate a large SNP dataset from approximately 450 individual pygmy rabbit taken from throughout their core range in Nevada.
Data Management Resources: Management of the genomic data will be the responsibility of PI Matocq and the Graduate Student. Approximately 10% of personnel time will be allocated to data management.
Exclusive Use: All raw genomic data will be held until the time of publication (or within 1 year of data collection) and then posted to genetic databases including Genbank and posted on the Dryad repository. Findings will be immediately shared with federal and state partners, but the PIs request first publication rights to the data generated herein, but this will happen within one year of the end of the project.
Restrictions: There will be no restrictions to the use of raw genomic data after one year has elapsed (or the data are published, whichever is first).
Format: Raw genomic data will be maintained as text files.

MODELS

Describe the function and methodology used for any models that are part of the project. Any code developed to execute the model (if any was/will be developed by the project) should be described in the custom software/code section.

1 CDPOP model
Description: a spatially-explicit simulation of gene flow in complex landscapes
Model Version: 1.2
Source/Link: http://cel.dbs.umt.edu/cms/index.php/software/cdpop
Model Inputs: population structure, genetic variability, various biological life-history characteristics, landscape resistance to movement (cost surface)
Model Outputs: genetic variability, population structure

CUSTOM SOFTWARE/CODE AND WEB TOOLS

Describe any custom software or code used as part of this project. If a web tool (e.g., visualization, decision support, etc.), is a project deliverable that should be included in this section.
N/A

DATA PRODUCTS (E.G., DELIVERABLES)

Identify project deliverables and data products that were developed as a result of the project's funding.

1 Species Distribution Model (spatial data layer)
Description: Rangewide species distribution model
Data Management Resources: T. Dilts (GIS/RS specialist) and P. Weisberg will lead development of the species distribution model. Approximately 10% of personnel time will be allocated to this purpose.

Format: Raster GIS
Exclusive Use: These data products will be held until the time of publication (or within 1 year of data collection) and then freely shared. Findings will be immediately shared with federal and state partners, but the PIs request first publication rights to the data generated herein, however this will happen within one year of the end of the project.
Restrictions: There will be no restrictions on the data after one year has elapsed (or the data are published, whichever is first).

2 Genetic/Functional Connectivity Models (spatial data layers)
Description: maps and GIS layers showing levels of functional connectivity, including resistance to movement maps optimized using the genetic data, as well as potential habitat corridors determined by both least-cost path and circuitscape approaches.
Data Management Resources: T. Dilts (GIS/RS specialist) and P. Weisberg will lead development of the species distribution model. Approximately 20% of personnel time will be allocated to this purpose.
Format: Various
Exclusive Use: These data products will be held until the time of publication (or within 1 year of data collection) and then freely shared. Findings will be immediately shared with federal and state partners, but the PIs request first publication rights to the data generated herein, however this will happen within one year of the end of the project.
Restrictions: There will be no restrictions on the data after one year has elapsed (or the data are published, whichever is first).

A-133 Single Audit Reporting Statement
The University of Nevada, Reno is required to submit an annual A-133 Single Audit Report. UNR's fiscal year runs July – June. The 2013 Fiscal Year audit report is available on the Federal Audit Clearinghouse Single Audit Database website (http://harvester.census.gov/sac/) and can also be viewed on the institution's website here:
http://www.unr.edu/Documents/research/OSP/reports/a133/FY13_A133_AuditReport.pdf