Project title: Understanding the causes and consequences of cheatgrass die-offs in the Great Basin

Project Leaders:

Elizabeth Leger, University of Nevada, Reno, ealeger@gmail.com, 775 784 7582
Peter Weisberg, University of Nevada, Reno, pweisberg@cabnr.unr.edu, 775 784 7573
Owen Baughman, University of Nevada, Reno, owbaughman@gmail.com, 775 784 4111

Cooperators/Partners:

This project is part of a grant funded by the Bureau of Land Management, Don Major principle contact, dmajor@blm.gov. The BLM has contributed funding for the overall project, $428,000.

The main PI on the larger project is: Susan E. Meyer, Research Ecologist, USFS Rocky Mountain Research Station, Shrub Sciences Laboratory, 735 North 500 East, Provo, Utah 84606; 801-356-5125. Additional co-PIs: Julie Beckstead (Gonzaga University), Zachary T. Aanderud (BYU), and Bradley D. Geary (BYU).

Co-PIs E. Leger and P. Weisberg are funded at $92,913 and $61,355, respectively, and are applying for additional supplemental funds for their portions of the larger project.

Additional funds are being provided to support the field component of the project by the Nevada Department of Wildlife, principal contact Lee Turner, leeturner@ndow.gov, with NDOW providing support of $35,000 for fence building, labor, and supplies.

The University of Nevada, Reno, provided support for this project by funding the TAship of co-PI O. Baughman, who is currently working on the restoration component of the project.

If funded, we would anticipate this project be in collaboration with the Great Basin CESU, principal contact Mike Collopy, mcollopy@unr.edu.

Project summary:

Cheatgrass die-offs are unexplained instances of stand failure observed in areas of Nevada and Utah, where cheatgrass fails to grow even though it has been a dominant component of plant communities in the past. The goals of this project are to 1) provide information on the size and extent of historic (1985 – 2012) die-offs in the Winnemucca area using satellite imagery, and 2) determine if die-offs are restoration opportunities by planting and monitoring local and commercially available native grasses in die-off areas. Support is requested to fund monitoring of the restoration project through a second growing season and to develop predictive spatial models of die-off from analysis of satellite imagery and GIS models, which will result in enhanced predictive capacity for locating die-offs at local management scales, and information on species and seed sources that can be used to restore die-offs.

PROJECT PROPOSAL

Background and need:

Few opportunities exist to successfully restore land invaded by cheatgrass, which is one of the most aggressive invasive species in the Great Basin (Knapp 1996, Davies et al. 2011). Naturally occurring stand replacement failures, or die-offs, in cheatgrass near-monocultures reduce cheatgrass cover to essentially zero for one or more years (Baughman & Meyer 2013), and may be an opportunity for restoration if native species can establish within these areas and benefit from the lack of competition. This project will determine how well, and under which conditions, native species can be successfully restored into areas of recent cheatgrass stand failure. Additionally, spatial modeling of where and when die-offs are likely to occur, calibrated using cheatgrass cover classifications from satellite imagery, will lead to a better understanding of what causes die-off, and the ability to forecast future die-off events in order to inform restoration efforts.

The diversity and ecological complexity of native Great Basin plant communities are drastically decreased as cheatgrass invades and, promoted by more frequent wildfires, eventually becomes the dominant species (Stewart & Hull 1949, Brooks et al. 2004). Many current conservation and management predicaments in the Great Basin are linked to the far-reaching consequences of cheatgrass invasion (Pellant 2004, Davies et al, 2011). Thus, this project has direct management implications. There are no studies that have compared the ability of native plants to establish from seed in die-off vs. non-die off sites, nor have efforts been made to develop management-scale predictive die-off models.

This project is an opportunity to leverage current funding from federal (BLM) and state (NDOW, UNR) partners. We are requesting funding for E. Leger and graduate student O. Baughman to work on the restoration project for an additional 6 months, which will result in an additional season of monitoring. We also request funding for a remote sensing specialist, an undergraduate hourly image processing technician, and P. Weisberg to extend the project to predictive modeling of die-off patterns; current funding will only be adequate for mapping and descriptive analysis of historical die-off events. This project is well underway and is on track to be completed by June 2014. This funding will also allow for presentation of these results at additional regional and national conferences.

Objectives

We will determine whether cheatgrass die-off areas are opportunities for restoration with two native grass species, determine which seed sources are best able to survive in die-off areas, and extend an ongoing die-off mapping study to statistically model die-off patterns according to biophysical variables. Preliminary restoration results (described in greater detail below) indicate that while establishment is lower in die-off areas, native plants are nonetheless establishing. Additional funding will allow this project to monitor second-year survival of these seedlings, and give a better picture of likely restoration outcomes that are not apparent from first-year results. For example, while emergence of native species was lower in die-off areas, it may be that survival into the second year might be greater due to reduced competition from cheatgrass in die-off areas, resulting in equal or greater stands of native grasses in die-offs relative to nearby controls. The results of this project will help managers understand the relative costs and benefits

of seeding native species into recent die-off areas, and will also provide managers with predictive information about areas that are likely to experience die-off.

Methods

A die-off site near Dun Glen, in north-central Nevada, was used for the restoration experiment (no other die-off sites were found in 2011). The site has had a dynamic history of die-off since at least 2002, based on field observations by O. Baughman (Baughman and Meyer 2013) and remote sensing information (P. Weisberg, unpublished data). In June of 2012, seeds of Sandberg's bluegrass and bottlebrush squirreltail were collected from within 4 miles of the site. Commercially produced seeds of the common cultivars 'Mt. Home' and 'Toe-Jam Creek', respectively, were also obtained. All seeds were precision planted in October 2012 by fixing each to a bamboo skewer that was inserted into the soil surface to a seed-depth of one-half inch (skewers allow us identify our particular seeds in the middle of seedlings of multiple species, so we can track the fate of individual seeds without disturbing background vegetation). Six amelioration treatments (fungicide application, litter removal, and no treatment; each with and without water addition) were randomly applied to monospecific plots of 20 seeds for all species and provenances, resulting in a 24-plot array. This array was randomized and replicated 10 times each in both recent die-offs and in adjacent areas (control) that had not experienced stand failure. One inch of water was applied using a slow-dripping, overhead watering system one week and three weeks post-planting to watered treatments. All seeds have been monitored for emergence monthly since planting.

After five months, preliminary results show both species suffering a significant 17% reduction in establishment in die-off vs. adjacent controls. Nonetheless, 44% and 58% of bluegrass and squirreltail seeds have established in die-offs. Watered plots have higher established in die-offs as well as controls, but no other treatments show significant effects at this time. With current funding, monitoring and treatments will continue through November, 2013. Additional funding will extend monitoring through July, 2014. Survival data from a second growing season will greatly strengthen the value of this study to Great Basin restoration practitioners, and indicate if reduced competition from cheatgrass enhances native seedling survival within die-offs.

Our ongoing remote sensing work uses multi-temporal, archival Landsat imagery to quantify differences in relative dominance of predominantly exotic winter-spring annuals vs. predominantly native vegetation with peak greenness later in the growing season. We are also exploring use of trajectory analysis approaches. Pre-processing of Landsat TM imagery has been completed from 1999 – 2011. Calculations of NDVI, annual grass index (AGI), and cheatgrass die-off have been implemented for the 2002 – 2011 period. Annual grass index is calculated as a function of a normalized phenology index using NDVI maxima from composites of cloud-free portions of spring and summer imagery; we are refining the approach against field data, by using additional Landsat bands and their derivatives. We are differencing AGI in successive years to develop a classification for annual grass invasion, new die-off, continued die-off, and other conditions. Additional funding will support our efforts to develop predictive, statistical models for die-off occurrence as a function of climate, topography, soils, previous year's cheatgrass cover, and proximity to previous year's die-off patches. Such predictive capabilities will aid in locating new areas of die-off for potential future studies and/or restoration trials.

Key cooperators have been staff in the Winnemucca BLM office, who have expedited the process of permitting to allow the project to be implemented on the ground.

Geographic Extent

Remote sensing is being conducted across much of north-central Nevada, and restoration is occurring within Dun Glen. These die-offs are centered in this area, and results can be reasonably extrapolated to die-offs within the Winnemucca area.

Timeline of Schedules, Products, and Outcomes

2013 Spring/Summer	Restoration project: Continue monitoring of restoration seeding; analyze first year data; present preliminary results at National Native Seed Conference. Remote sensing project: Complete image analysis of cheatgrass die-off in Winnemucca study area; complete validation against field plots; collect additional field plots.
2013 Fall/Winter	Restoration project: Monitor restoration seedings for fall and winter survival; implement watering treatments in watered plots; present results at 5th World Conference on Ecological Restoration, Madison, WI and the meetings of the Society for Range Management. Remote sensing project: Complete image analysis of cheagrass die-off in Skull Valley study area; begin statistical analysis.
2014 Spring/Summer	Restoration project: Final monitoring of first-year survival; final data analysis and thesis completion; manuscript preparation and presentation of results at Ecological Society of America. Submission of final report. Remote sensing project: Develop spatial model of die-off occurrence; write manuscript, present results at US-IALE meeting. Submission of final report.

Disclaimer regarding data sharing:

None

Budget:

Additional matching funding is noted above, in the "cooperators/partners" section, where we list our cooperators and their contributions to this project.

Requests for the current proposal:

Restoration Component:

Salary for student co-PI O. Baughman, January 1 2013-July 31 2014:	11,000
Summer salary for co-PI E. Leger,	3000
Salary for undergraduate worker, 200 hours	2400
Total fringe (15% graduate student, 4% PI summer, 2% undergrad):	1818
Meeting costs for graduate student:	1600
Fuel for field visits:	800
17.5% indirect costs through the Great Basin CESU:	3608
Subtotal:	$24,226

Remote Sensing Component:

Salary for remote sensing/GIS specialist Tom Dilts, 2 months:	9,167
Summer salary for co-PI P. Weisberg	3,924
Salary for undergraduate worker, 224 hours	3,136
Total fringe (15% graduate student, 4% PI summer, 2% undergrad):	1,818
Meeting costs to present research at US-IALE:	1,000
Fuel for field visits and contribution toward remote sensing software license:	500
17.5% indirect costs through the Great Basin CESU:	3,574
Subtotal:	$23,996

Total for both project components:	**$48,222**

Literature Cited:

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