Project Title:	Vegetation impacts of recurring fires on sagebrush ecosystems in Washington: Implications for conservation and rehabilitation
Announcement for Proposals and task statement this proposal is responding to:	Joint Fire Sciences RFA 2008-1 Task 5: 2007 Fires – Re-measurement opportunities
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Duration of Project:	2 calendar years and 4 months (01/2009 through 04/2011); across 3 fiscal years
Start Date End Date	01/02/2009 04/30/2011
Annual Funding Requested:	FY2009: $ 154,850 FY2010: $ 183,074 FY2011: $ 99,813
Total JFSP Funding Requested:	$ 437,738
Total Value of In-Kind Contributions:	$ 100,347

Abstract:
Thousands of hectares of high quality shrub steppe burned in large fires in 2000 and 2007 in the Arid Lands Ecology (ALE) Reserve on the Hanford Reach National Monument. Extensive permanent vegetation monitoring plots were established throughout this area in the mid-1990s, and many of these plots were remonitored following the 2000 fire. In addition, rehabilitation efforts to control invasive species (e.g., *Bromus tectorum*) and establish native species took place following this fire. This combination of monitoring and rehabilitation treatments provide a unique opportunity to better understand the individual and cumulative effects of recurring fires in this landscape. These fires may have significantly altered the trajectory of

vegetation recovery of these systems by removing dominant species and stimulating invasive taxa. We propose to resample these permanent plots to address key questions regarding the interactions of native vegetation, invasive species, rehabilitation actions, and repeated fires. The results of this study will inform immediate management decisions regarding present and future post-fire habitat rehabilitation measures on the ALE Reserve, the National Monument and other shrub steppe sites, and will provide a critical understanding of the long-term dynamics of these significant shrub steppe systems.		
Signature of PI:	(see attached signature page)	
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Signature of Co-PI:		
Signature of Federal Cooperator:	(see attached signature page)	
Signature of Federal Fiscal Representative:	(see attached signature page)	

Vegetation impacts of recurring fires on sagebrush ecosystems in Washington: Implications for conservation and rehabilitation

I. Introduction

1. Project Justification

Sagebrush steppe ecosystems in the western United States are among the most imperiled in the United States (Noss et al. 1995). Degradation of these systems generally involves the loss of native herbaceous species and increased dominance of non-native annual grasses such as cheatgrass (*Bromus tectorum*). Invasion by non-native annual grasses is facilitated by and leads to a change in the fire regime, characterized by greater fire frequency and extent (Whisenant 1990), the net result of which is the practical elimination of the shrub components of this system. This positive feedback between invasive species and fire leads to the conversion of diverse plant communities with distinct shrub, herbaceous, forb and cryptogammic crust layers, to monocultures of cheatgrass (West 2000) with little habitat value for other species.

In Washington, this ecosystem is at even greater risk because most of the deep-soil communities dominated by big sagebrush (*Artemisia tridentata*) have been converted to dryland and irrigated agricultural production (Vander Haegen et al 2000). The loss of this ecosystem component increases the urgency to conserve these systems, and to understand how best to manage them in the face of the above mentioned threats and, potentially, the synergistic effects of climate change.

The Hanford Reach National Monument was established in 2000 to protect some of the most extensive and ecologically significant shrub steppe habitats in Washington, including large expanses of deep-soil communities (Soll et al. 1999; Evans et al. 2003). The Fitzner-Eberhardt Arid Lands Ecology Reserve (hereafter referred to as the ALE Reserve), a 77,000 acre portion of the National Monument, comprised the highest quality examples of shrub steppe remaining in the state at the time. Ecological management of the ALE Reserve requires a thorough understanding of the forces that shape this dynamic, arid ecosystem. Although a detailed picture of the historical distribution, extent, and composition of shrub steppe communities can be helpful in identifying potential management and restoration goals, it is becoming increasingly clear that changing fire regimes may be altering many of the fundamental attributes of this ecosystem. Decisions regarding restoration and management actions must be made within this changing ecological context. Changes in the range of variability in frequency, severity, or extent of key ecological processes such as fire or drought have critical implications regarding ecological states and transitions, the rates, extent, and duration of changes in community composition and structure, and ultimately, in determining what are reasonable ecological goals for managing the site. Managers must ensure that ecological goals are not based on outdated models. Therefore, detailed

information is needed about how the natural communities are responding to current environmental conditions and disturbances, to set realistic goals and take meaningful actions to restore and maintain viable systems.

Virtually all of the ALE Reserve burned in 2000 in the 24 Command Fire (27 June - 2 July 2000), which consumed 163,000 acres (Figure 1). This fire was by far the largest and most severe fires to have burned in this area in recorded history. An extensive array of permanent vegetation plots was established in the 1990s in and around the ALE Reserve (Figure 1). Resampling of these plots in 2001-2004 (Evans and Lih 2005) helped managers understand the impacts of the 2000 fire on the vegetation of the ALE Reserve. In addition, restoration seeding and shrub planting treatments were carried out after the 2000 fire, and the effects of these treatments were evaluated through 2004 on newly established permanent plots. This work documented the almost complete loss of the shrublands that once dominated the ALE Reserve (Evans and Lih 2005).

In August 2007 two fires – the Milepost 17 Fire (13 August 2007) and the Wautoma Command Fire (16-17 August 2007) – burned across the ALE Reserve and surrounding lands, together blackening approximately 77,000 acres of shrub steppe (Figure 1). This repeated disturbance may accelerate the degradation documented after the 2000 fire, and may also presage long-lasting changes in the state of this ecosystem that have enormous implications for the viability of many of the species that occur in the ALE Reserve. Documenting the impacts of these fires is critical if the management of the National Monument is to successfully attain their goals to "conserve and restore the plants, animals and shrub-steppe and other upland habitats native to the Columbia Basin", and to "enhance Monument resources by establishing and maintaining connectivity with neighboring habitats" (Hanford Reach National Monument, 2006). The permanent vegetation plots therefore provide an outstanding opportunity to examine the effects of *repeated fires* on this exemplary ecosystem, and may provide valuable insights into the long-term trajectory of changes that these frequent, large fires may be causing in this system.

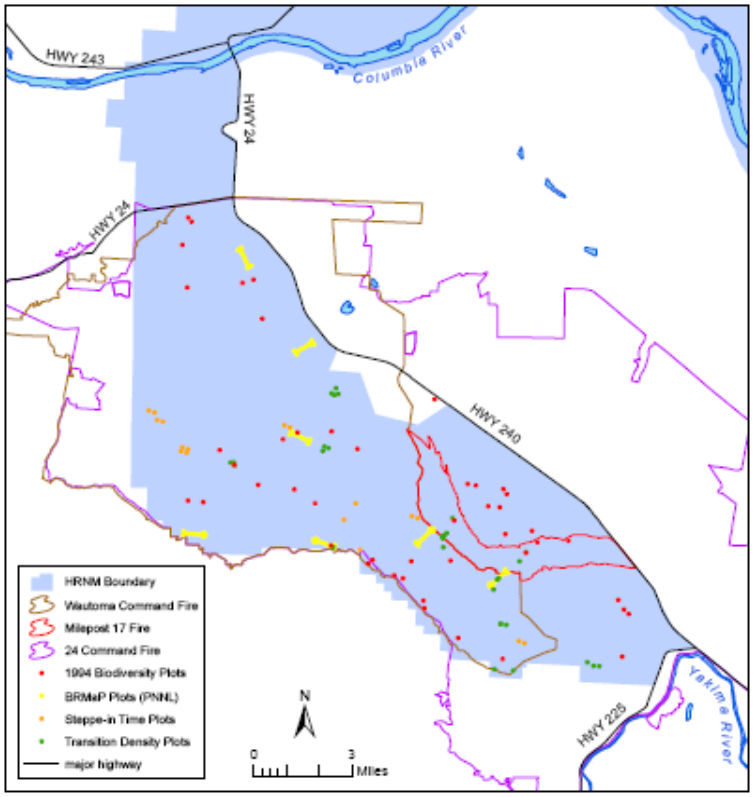

Figure 1. Fire perimeters and vegetation monitoring plots at the ALE Reserve.

Two disturbances are insufficient to characterize a shift in fire regime, but their extent, particularly relative to the extent of remaining shrub steppe in the area, is highly consistent with expectations based on our

understanding of the dynamics of the system (West 2000). The occurrence of these two massive fires within seven years has created conditions that are likely to severely compromise many components of the shrub steppe communities. These communities may be rapidly shifting these habitats towards states that are dramatically different from those that have existed for many decades, if not millennia. In particular, these new states are characterized by a nearly complete absence of shrubs, an increasing dominance of non-native grasses and forbs, and significant alterations to the suite of native herbaceous species, the microbiotic crust, and animals that depend on these components of the shrub steppe.

This history of past research, rehabilitation efforts and disturbances on the ALE Reserve provides a unique opportunity to address **Task 5: 2007 Fires – Re-Measurement Opportunities**, as outlined in JFSP Request for Applications (RFA) 2008-1. Due to the existence of vegetation data from the 1990s and from the period between the fires (2001-2004), we will be able to address questions relating to the *effects of fire on shrub steppe vegetation*, and expand these to questions about the *cumulative effects of two extensive burns in short succession*. Photographs of plots before the 2000 and 2007 fires, combined with efforts currently underway to map fire severity (see Methods, below) will provide information on *fuels and subsequent fire effects*. Finally, measurement of vegetation change in areas where rehabilitation treatments were implemented after the 2000 fire will help quantify the *effect of these treatments* in the face of another large fire. This study will therefore address three of the four questions this RFA Task is directed towards, while having the unique capacity to evaluate not only the response to the 2007 fires, but also the response to the combined 2000 and 2007 fires.

The results of the proposed study will provide land managers with extensive, on-site information about the direction, rate, and magnitude of changes in vegetation composition and structure that have occurred over the last two decades and after two large fires. This information will improve their understanding of changes and help in the development of goals. It will also supply critical data for evaluating the success of previous rehabilitation efforts, and help guide decisions regarding future post-fire management actions. These results will be of use to a broad spectrum of land managers working in shrub steppe systems in eastern Washington, including those agencies that have made explicit their support of the proposed study (US Fish and Wildlife Service (USFWS), Department of Defense (DoD), Bureau of Land Management (BLM), Washington Department of Fish and Wildlife (WDFW) – see attached letters).

2. Project Objectives

The objectives of this project are to take advantage of this unique opportunity to:

A. Quantify the effects of two successive fires on shrub steppe vegetation. Specifically, we want to address the following questions:

1) How did the 2007 fires alter the various biological components of the system?
2) Have the trends in community composition and structure that were noted following the 2000 fire continued, or did a second fire in short succession modify the direction, rate and/or magnitude of these changes?
3) Do these trends suggest that a fundamental change in state has occurred in the ecosystem?
4) How do the observed changes in vegetation composition relate to pre-fire fuel characteristics and to measures of fire severity for the 2000 and 2007 fires?

B. Determine if rehabilitation treatments after the 2000 fire affect the recovery of shrub steppe communities after a second fire. Specifically:

5) How did the 2007 fires affect the rehabilitation plantings that were carried out following the 2000 fire?
6) What do these findings suggest regarding the nature and value of post-fire habitat rehabilitation measures at this site, considering long-term vegetation trajectories?

3. Background

The 24 Command wildfire in 2000 had significant impacts on the shrub steppe communities on the ALE Reserve. These impacts were monitored from 2001 to 2004 by resampling three sets of permanent vegetation plots established during the 1990s (Evans and Lih 2005). During this resampling, two new series of plots were

added to sampling protocols to facilitate tracking the abundance and distribution of the alien annual cheatgrass (*Bromus tectorum*) (Evans and Lih 2005).

Changes in stand structure, species abundance, and community composition were strongly evident four years after the wildfire. Both Wyoming big sagebrush (*Artemisia tridentata* ssp.*wyomingensis*) and spiny hopsage (*Atriplex* [= *Grayia*] *spinosa*) were nearly entirely killed, resulting in the removal of most of the last remaining high-quality, large, and contiguous stands of big sagebrush within the ALE Reserve. Other shrub-dominated communities, including those dominated by winterfat (*Eurotia lanata*) and threetip sagebrush (*Artemisia tripartita*), also suffered significant declines in shrub cover. All other structural layers of the big sagebrush plant community – hemishrubs, grasses, forbs, and microbiotic crusts – exhibited evidence of decline and mortality. By 2004, recovery of native perennial vegetation in former big sagebrush shrublands was still far below pre-fire levels. In most cases, increases in the abundance of perennial forbs and hemishrubs amounted to only a few percent in absolute cover and failed to compensate for large declines in perennial grasses and the complete absence of dominant shrubs. Tumble mustard (*Sisymbrium altissimum*) and other disturbance-oriented annual forbs colonized many plots. Cheatgrass abundance increased annually since 2001, underscoring serious concerns about the trajectory of ecological succession in these communities.

Rehabilitation efforts were implemented between December 2002 and February 2003, and targeted 10,000 acres of the native shrub steppe habitats on the ALE Reserve that had been most seriously affected by the 24 Command Fire. Rehabilitation measures included outplanting of nursery-grown big sagebrush seedlings, herbicide treatments for the control of cheatgrass, and aerial and drill seeding of native grasses and cultivars. Survival of big sagebrush seedlings varied widely (4-76%) between habitats, but averaged about 35% after two years. Attempts to establish this species by seed were unsuccessful. Effects of herbicide treatments and native seedings on cheatgrass abundance were slight, if any (Evans and Lih 2005).

The 2007 fires on the ALE Reserve re-burned many of the areas that had been studied and rehabilitated over the preceding decade. The National Monument has submitted a BAER plan for carrying out rehabilitation actions to mitigate impacts from the 2007 Milepost 17 Fire (First Strike Environmental, 2007). Proposed measures are similar to those taken in a portion of the habitat impacted in the 24 Command Fire in 2000. The data and analyses to be conducted in this JFSP proposal will be critical in assisting the Monument in understanding the impacts of these repeated, large scale fires, identifying those impacts that are most long-lasting and deleterious to the natural resources on the Monument, developing and refining appropriate actions to counter these impacts, and quantifying the value of rehabilitation treatments if treated areas subsequently burn again.

As mentioned above, this complex history of data collection, wildfire and rehabilitation at the ALE Reserve provides a unique opportunity to better understand the cumulative effects of recurring fire. The increase in frequency and extent of one of the key drivers of shrub steppe dynamics is expected to significantly affect the trajectory of vegetation recovery after disturbance. Data rarely exist to quantify and tease out the individual vs. cumulative effects of two recurring fires at this scale. This proposal is therefore poised to both inform immediate management decisions on the ALE Reserve and National Monument, and to provide critical understanding of the long-term dynamics of shrub steppe systems with frequent, recurring fires.

II. Methods

1. Study Site

The Fitzner-Eberhardt Arid Lands Ecology Reserve. The lands that now comprise the ALE Reserve lie within the southwestern portion of the U.S. Department of Energy site at Hanford, in Benton County, Washington. It was formally established in 1967 by the Atomic Energy Commission in recognition of the rich and relatively undisturbed character of its native shrub steppe ecosystem (O'Connor and Rickard 2003). In 2000, the ALE Reserve was incorporated into the newly designated Hanford Reach National Monument.

The ALE Reserve lies within the Columbia Basin, the hottest, driest part of Washington state (Franklin and Dyrness 1973). Environmental characteristics are summarized in Rickard et al. (1988) and Soll et al (1999). Elevations range from 435 ft. (132.5m) a.s.l. near the southeastern boundary of ALE to more than 3500 ft.

(1067m) at the summit of Rattlesnake Mountain near the western boundary. Annual precipitation varies with elevation, from 6.3 inches (16 cm) at the lowest elevations up to 13.8 inches (35 cm) along the crest of Rattlesnake Mountain (DOE-RL 2001). Most of the landscape of the ALE Reserve was dominated by sagebrush (*Artemisia*) species when the Hanford Nuclear Reservation was established in 1943. Between 1957 and 1998, wildfires reduced the shrub-dominated portion of the Reserve to less than 20 percent of its extent at the mid-point of the 20th century (Rickard et al, 1988, Soll, et al,1999). When the ALE Reserve was established in 2000, the major plant communities included shrublands dominated by Wyoming big sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) at low and middle elevations, primarily in the northern portion of the Reserve. Shrublands dominated by three-tip sagebrush (*A. tripartita*), sometimes with big sagebrush or rabbitbrush (*Chrysothamnus* spp.) as important components, occurred at middle to higher elevations, primarily on more or less northerly aspects. Other shrubland types included a small black greasewood (*Sarcobatus vermiculatus*) community and areas characterized by winterfat (*Eurotia lanata*). Shrubland understories were dominated by native bunchgrasses such as bluebunch wheatgrass (*Pseudoroegneria spicata*) and Sandberg's bluegrass (*Poa secunda*), and associated hemishrubs and forbs (Wilderman 1994). Soil surfaces in relatively undisturbed native grasslands and shrublands were characterized by a microbiotic crust composed of mosses, lichens, fungi, algae, and cyanobacteria (Link et al. 2000, Johansen et al. 1993), especially on silt-loam soils.

Where previous wildfires or human activities had cleared the sagebrush, perennial and annual grasslands dominated the landscape. Bluebunch wheatgrass-Sandberg's bluegrass was the most common perennial grassland association, occurring at elevations as low as 800' – 1000 ft. (250 – 300m) and upwards. Needle-and-thread (*Stipa comata*) dominated another perennial grassland association found from lower to middle elevations, often on sandy soils. Idaho fescue (*Festuca idahoensis*) was important at higher elevations and on more northerly aspects, often in association with threetip sagebrush and bluebunch wheatgrass.

2. Sampling Design

This study involves the resampling of permanent vegetation plots throughout the ALE Reserve. Sampling methods were carefully documented by Evans and Lih (2005), permitting us to use the same methodologies as have been used for prior measurements. In general, these consist of 5x20 m plots, or transects along which around quadrats were systematically laid out and measured (see details below) (Evans and Lih 2005).

All plots were georeferenced in 2004 and can be easily relocated via GPS. Resampling will occur in spring 2009 and spring 2010. We will prioritize those plots with the most complete set of past measurements, and those that, due to their burn history, strengthen the statistical power of the proposed analyses. For example, we will sample all possible plots that i) burned in both 2000 and 2007, ii) burned in 2000 but not in 2007, burned in 2007 but not in 2000, or iv) did not burn in either 2000 or 2007.

A. We propose to evaluate vegetation change since the mid-1990s, based on percent cover and frequency data gathered by resampling permanent plots from three different studies (Figure 1):

1) Biodiversity Plots (n = 33; established in 1994, resampled in 2001-2004). Percent cover estimates of vascular plant species and microbiotic crust in 5x20m plots. Assessment of bunchgrass density.
2) Biological Resource Management Plan (BRMaP) Plots (n=7; established by 1997, resampled 2001-2004). Percent cover estimates of vascular plant species, microbiotic crust, and litter in 100 20x50cm quadrats in each plot.
3) Steppe-in-Time (SIT) Transects (ALE Reserve: 6 transects established in 1992, 3 transects in 1996; Unburned outside the ALE Reserve: 23 transects established in 1992; most plots resampled in 1993, 1997, 2001). Percent cover estimates of vascular plant species, microbiotic crust, and litter in forty 20x50cm quadrats on each transect.

B. We propose to evaluate change in cheatgrass density based on counts of individuals in 20x20cm quadrats (40 per Biodiversity and BRMaP plot), established 2001-2002 (Figure 1).

1) Transition Density Plots (n = 32; established in 2001). Cheatgrass density will be measured by counting individuals within 20x20cm quadrats at 25 m intervals along 100 m transects.

C. We propose to evaluate the legacies of post-fire rehabilitation efforts after the 2000 24 Command Fire by

resampling plots established in 2001-2004 in treated areas:

1) Rehabilitation Vegetation Plots (n = 30; established in 2002). Estimate percent cover of vascular plant species, microbiotic crust, and litter in twenty 20x50cm quadrats along 100 m transects.
2) Sagebrush Survival Plots (n = 26; established in 2003). Remonitor survival and vigor of all planted sagebrush plugs located along 100 x 12m transects.

3. Data Analysis

This study capitalizes on random disturbance events (wildfires) and therefore cannot utilize optimal experimental design techniques such as replication and randomization (van Mantgem et al. 2001). Similarly, we do not propose the implementation of any experimental treatments. However, our study has a Before-After/Control-Impact (BACI) design (Underwood 1994) allowing us to: (i) compare the post-2007 wildfire plant community with the community on the same plots in the 1990s (pre-fire) and following the 2000 24 Command Fire (2001-2004), and (ii) compare the post-2007 wildfire plant community with the community on plots that last burned in 2000 and plots that are unburned.

Objective A. Quantify the effects of two successive fires on shrub steppe vegetation.

Plots will form the experimental units for statistical analyses and quadrats will be analyzed as subsamples within them. Plots that were sampled using comparable methodologies will be combined for analyses following Evans and Lih (2005). Geographical coordinates will be included as covariates in all analyses to account for spatial autocorrelation among plots. Analyses will include five components: species richness (total and native), cheatgrass density, community composition, net change in composition over time, and Indicator Species Analysis.

Total species richness per plot will be calculated each measured year (1992-2010) as the total number of species in all quadrats. Native species richness will be calculated as the number of native species, as defined by the US Department of Agriculture Natural Resources Conservation Service (http://plants.usda.gov/index.html), in the quadrats. Analyses of species richness will be conducted using repeated measures MANOVA.

Cheatgrass density and community composition data are unlikely to be normally distributed. These variables will be analyzed with a distance-based permutational multivariate analysis of variance (DISTLM; see Anderson (2001) and McArdle and Anderson (2001) for analytical details and Laughlin et al. (2004, 2008) for ecological examples). This technique is a straightforward extension of MANOVA that makes no assumptions about normality or heteroscedasticity, and is applicable to multivariate response data and any linear model, including repeated measures designs. The test statistic from this test is a pseudo-*F* statistic. We will use Bray-Curtis dissimilarity as our distance measure, and 9999 permutations to calculate the significance of the pseudo-*F* statistic. For consistency with prior analyses (Evans and Lih 2005), analyses of community composition will be restricted to perennial species that occur on at least 5% of plots.

The net change in composition from 2004 to 2010 will be assessed by calculating the Bray-Curtis distance measure for each plot based on its composition in these years. This distance ranges from 0 (completely identical) to 1 (completely dissimilar).

Indicator Species Analysis (ISA; Dufrêne and Legendre 1997) will be used to identify species that have changed in abundance over time. Two biologically motivated comparisons will be made: (1) pre-fire vs post-2000 fire to examine species responses to the first fire, and (2) post-2000 vs post-2007 fire to examine species responses to the second fire. Indicator Values (IV) will be calculated independently for each species as the product of its relative abundance and frequency, and the significance of the calculated IV will be assessed using 999 Monte Carlo randomizations. Code written for R (v. 2.2.1; available from J.D. Bakker) will be used for the ISAs, which will be conducted separately for each year and combined using meta-analytical techniques to reduce the likelihood of spurious results (Bakker 2005).

We will use Non-metric Multi-Dimensional Scaling (NMDS; Clarke 1993) to illustrate differences in community composition over time. NMDS arranges data points in a configuration that minimizes the inter-point distances (stress). We will use the Bray–Curtis distance measure with random starting configurations, 100 runs with real data, a maximum of 400 iterations per run, and a stability criterion of 0.00001. A Monte Carlo test with 100 randomizations will be used to determine how likely the observed stress value of the final solution would be

by chance alone. Successional vectors will be used to visualize compositional changes from pre-fire to post-2000 fire to post-2007 fire.

Georeferenced delta Normalized Burn Ratio (dNBR) and burn severity data from the 2000 and 2007 fires will be obtained from the Monitoring Trends in Burn Severity (MTBS) project (http://fsgeodata.fs.fed.us/mtbs/). These data will be used to assign fire severity scores (one per fire) to each plot. Photos of plots taken in the mid-1990s and in 2001-2004 will be used to describe the vegetation as fuel models. We will use structural equation modeling (Grace 2006) to explore correlations between (i) fire severity in the 2000 and 2007 fires, (ii) pre-fire vegetation structure, including fuel model, and fire severity, and (iii) fire severity and post-fire vegetation data and community and environmental factors. We will also use structural equation modeling (Grace 2006) to explore correlations between post-fire (2009-2010) vegetation data and community and other environmental factors.

These analyses, in the context of what is currently known and documented about states and transitions in shrub steppe systems (e.g. West and Young 2000), will allow us to answer the four questions we pose under Objective A.

Objective B. Determine effects of rehabilitation treatments.

Areas that were rehabilitated after the 2000 fire will be resampled to assess sagebrush survival following the 2007 fire, fire severity, and the magnitude of invasion by cheatgrass and other invasive species. Analyses will use the statistical techniques described above. The results of these analyses will allow us to address the three questions we pose under Objective B.

4. Materials

This study will require relatively simple, inexpensive materials. Beyond an office computer with necessary software (e.g. GIS, statistical software) for the project coordinator, we foresee needing a handheld Global Positioning System unit (GPS), and a handheld computer (such as a Palm Pilot) to input data in the field as the only costly items. Other required materials include measurement tapes to lay out transects, PVC tubing, string and associated tools needed to construct and maintain frames for quadrats, books to help identify native and exotic flora, and plant presses to collect and store reference specimens, as needed.

III. Project Duration and Timeline

This project will last approximately 2 years and 4 months, assuming a start date in January 2009, with completion in April 2011.

First field season (January-June 2009)

- Project Milestones: Project coordinator hired and in charge of project logistics. Project website established. Masters student recruited and involved in data collection. Field crew hired and field materials collected (April 2009). First season of field data collected at all plots to be used in analyses.

Between field seasons (July2009-April 2010)

- Project Milestones: First season's data compiled, organized and quality checked. Pre existing data (1992-2004) compiled in compatible format. Fire severity data and fuel model information compiled and related to vegetation data from the field. Preliminary analyses carried out. Conduct field tours for land managers and other interested parties.

Second field season (May-June 2010)

- Project Milestones: Second field crew hired and deployed (April 2010). Second season of field data collected at all plots to be used in analyses.

Final analysis period (July 2010-April 2011)

- Project Milestones: All data compiled, organized and quality checked; data published on webpage by June 2011. Final analyses carried out. Report to Federal Sponsor finished and presented. Masters student's thesis in write up phase. Manuscripts written for submission to peer-reviewed journals. One workshop or field trip to sites has occurred, and one more is planned within the next 2 months. Results presented at professional conference.

IV. Project Compliance - NEPA and other clearances.

All projects proposed in the Wautoma Fire Burned Area that are prescribed, funded, or implemented by federal agencies on federal, state, or private lands are subject to compliance with the National Environmental Policy Act (NEPA). However, the research proposed here falls under applicable and relevant categorical exclusions (see below), so there is no need to identify a unit responsible for compliance. No commitment letter from a responsible unit is therefore included with this proposal.

APPLICABLE AND RELEVANT CATEGORICAL EXCLUSIONS

U.S. Fish and Wildlife Service: The individual actions proposed in this plan for the ALE Reserve are categorically excluded from further environmental analysis as provided for in the DOI Manual Part 516 and FWS NEPA Guidelines, Part 516 DM 6, Appendix 1. All applicable and relevant Department and Agency categorical exclusions are listed below. Department exceptions—(516) DM 2.3—do not apply to the actions proposed.

Applicable Department of the Interior Categorical Exclusions

516 DM2 App. 2, 1.6: Non-destructive data collection, inventory (including field, aerial, and satellite surveying and mapping), study, research and monitoring activities.

Applicable U.S. Fish and Wildlife Service Categorical Exclusions

516 DM 6 App. 1.4B (1):Research, inventory, and information collection activities directly related to the conservation of fish and wildlife resources which involve negligible animal mortality of habitat destruction, no introduction of contaminants, or no introduction of organisms not indigenous to the affected ecosystem.

V. Budget

The proposed budget is summarized in Table 1. Details are provided in Tables 5 and 6 (Appendix B).

Table 1. Proposal Budget Summary for FYs 2009, 2010, and 2011 (all values rounded to the nearest dollar).

Budget Item	2009		2010		2011		
	Requested	Contributed	Requested	Contributed	Requested	Contributed	**TOTAL**
LABOR	101,616	8,400	125,568	8,652	69,379	8,894	322,509
TRAVEL	10,500	250	10,748	250	4,300	250	26,298
VEHICLES	3,700	1,850	3,811	1,905	0	0	11,266
Capitalized Equipment:	0	0	0	0	0	0	0
Materials and Supplies:	3,300	6,000	700	500	700	500	11,700
Science Delivery and Application:	0	0	0	750	2,400	750	3,900
Total Direct Costs:	119,116	16,500	140,827	12,057	76,779	10,394	375,672
Indirect Costs (see details in Appendix B, Table 6)**:**	35,735	22,167	42,248	24,002	23,034	15,227	162,412
Total Contributed Funding:		38,667		36,059		25,621	**100,347**
Total Requested Funding:	154,850		183,074		99,813		**437,738**

VI. Research Linkage

Table 2 identifies the two JFSP research projects that currently use Hanford Reach National Monument and Saddle Mountain National Wildlife Refuge as study sites. These projects were implemented by numerous federal (US Geological Survey, US Forest Service) and university researchers (Oregon State University, Gonzaga University, Utah State University, Brigham Young University). Results from our research will complement results of these projects, since all three address different aspects of the challenges faced by managers of shrub steppe ecosystems: cheatgrass invasion and increased fire frequency. Hence, a unique

opportunity exists for collaboration among a wide range of disciplines aimed at identifying the best management practices for post-fire rehabilitation and habitat management in the shrub steppe ecosystem.

Table 2. Current and Pending Research Grants

Grant Program	Project or Proposal Description/Identification	Funding Amount[1]	Project Completion Date
Joint Fire Science Program	A Regional Experiment to Evaluate Effects of Fire and Fire Surrogate Treatments in the Sagebrush Biome		2012
Joint Fire Science Program	Annual Brome Biocontrol after Wildfire Using a Native Fungal Seed Pathogen		2010

[1] USFWS at Hanford Reach National Monument is not the Federal Sponsor for either of these projects, so funding amounts are not included.

VII. Science Delivery and Application

This research will provide land managers and other end users with information evaluating success of past restoration projects in arid environments and will guide future management decisions regarding post-fire restoration efforts. We will use a variety of methods to deliver this information to end users. First, a project description and results will be available on the TNC website with downloadable versions of the project proposal, annual and final reports, and published manuscripts. We will also provide links to Joint Fire Sciences Program, U.S Fish and Wildlife Service, and University of Washington websites. Second, we will present our results at regional and national/international meetings, workshops, and symposia. Third, we will conduct field tours sponsored by the U.S Fish and Wildlife Service and professional organizations (Society for Range Management (SRM), Society for Ecological Restoration (SER)) directed toward state, federal, and private land managers. Finally, we will publish our results in peer-reviewed journals and in a comprehensive final report. Publications and reports will be sent directly to land managers working in shrub steppe systems, including but not limited to those employed by agencies that have provided letters of support of this proposal (see attached letters).

This project will be carried out by scientists from The Nature Conservancy and the University of Washington, working in close cooperation with US Fish and Wildlife Service biologists and managers at the National Monument. This collaboration will facilitate the direct incorporation of the findings of this study into rehabilitation and management actions taken by Monument staff, as well as utilizing these data in future fire management planning for the site. It will also inform the Conservancy's conservation efforts in eastern Washington. The Conservancy will work with in-house communication staff to ensure that reports, websites, and other publications resulting from this project convey key messages clearly and effectively to target audiences.

VIII. Deliverables

Results from this research will provide a detailed evaluation of impacts from repeated fires since the mid 1990s on the native vegetation and invasive species of the ALE Reserve. This information will be disseminated to land managers and other audiences using a variety of mechanisms (Table 3), including reports and publications, field trips, and presentations at regional/national/international meetings. We will also describe the project and provide links to reports and manuscripts on our website.

Table 3. Deliverable, Description and Delivery Dates

Deliverable Type	Description	Delivery Dates
Website	Project description, progress reports, final report on TNC website	03/2009, updated annually
Dataset	Data collected under this project will be made freely available on the website	6/2011
SRM Summer Field Tour	Participate in SRM chapter summer field tour	Summer 2010

Field Demonstration/Tours (at least two)	USFWS and TNC present field tour for annual SRM chapter; conduct field tours for invited state, federal, NGO's, and private land managers	06/2010, 06/2011
Conference/Symposia/Workshop, Invited paper/presentation Poster	Presentation of results at annual and regional meetings of SRM, SER, ESA and other similar conferences	2010, 2011
Regional Meetings	SER NW Chapter meeting	Fall 2010
Refereed Publications	2 papers in peer-reviewed journals (e.g., Int J Wildland Fire; Rangeland Ecol & Mgmt)	2011
Non-refereed Publication	Annual progress reports, final project report	09/2009, 09/2010, 04/2011
Masters Thesis		06/2011

IX. Expected Benefits of the Proposal

The products from this proposal will provide USFWS land and fire managers at the Hanford Reach National Monument, as well as DoD BLM, and WDFW managers, with a detailed understanding of how the shrub steppe habitats have responded to repeated, large-scale fires. These managers have identified this as a critical research need (see attached letters of support). This information will enable them to anticipate effects of future fires and plan appropriate measures and responses to such events in Fire Management Plans. In addition, it will help them anticipate and guide appropriate rehabilitation measures to be taken following future fires to ensure the long-term viability of the natural resources and habitats in this part of the state. This work will also provide other researchers with valuable data for comparing and interpreting responses of native and non-native species to repeated fires, and in understanding the conditions under which shrub steppe communities may undergo significant state changes as a result of large-scale fire events.

X. Qualifications of Investigators

The curriculum vitae of Dr. Dunwiddie, Dr. Bakker and Dr. Hall are included in Appendix C. A summary of the project personnel (including collaborators) and their responsibilities are described in Table 4.

Table 4. Personnel Involved in Project, and their Responsibility

Personnel	**Responsibility**
Dr. Peter Dunwiddie	Primary project management, scientific oversight, coordination with National Monument staff. Co-supervise graduate student.
Dr. Jonathan Bakker	Oversight of sampling design, data collection and data analysis. Co-supervise graduate student.
Dr. Sonia Hall	Project management, coordination of report preparation
Dr. Michael Gregg	Interpretation and dissemination of results to managers
Heidi Newsome	Support data collection and outreach
Project Coordinator	Project management, data collection and coordination between all personnel involved in the project
MS Student	Participate in data collection, analysis, and presentation to various audiences.

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