Project Title: Habitat Model Development and Connectivity to Potential New Habitats for Greater Sage-Grouse in the Columbia Plateau Ecoregion.

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Partners: University of Washington—Analysis and interpretation of genetic data; Yakima Training Center (YTC), Department of Defense—Genetic assessment of tissue samples for Greater Sage-Grouse from the YTC. Washington Wildlife Habitat Connectivity Working Group (WHCWG)—Production of map layers and products for landscape analysis and GIS support. Support for the WHCWG is provided by the GNLCC (Great Northern Landscape Conservation Cooperative).

Project Summary: We are requesting funding to support the second year of a two-year project that builds upon our work funded by the Great Northern LCC (GNLCC) during FY2012. A model validation project of the Columbia Plateau Ecoregion analysis (WHCWG 2012) is currently ongoing using occurrence, movement, and genetic data collected for Greater Sage-Grouse (*Centrocercus urophasianus*) in Washington. This project is currently funded by the GNLCC. We are requesting additional support to develop and evaluate a habitat model for Greater Sage-Grouse for the Columbia Plateau Ecoregion.

Specifically, this project will:

Develop a resource selection function to predict the presence of Greater Sage-Grouse in the Columbia Plateau Ecoregion based on telemetry observations and habitat covariates. This model will be used to test the assumption that the only suitable habitat is adjacent to known lek locations. If new potential habitat areas are identified by this model, the connectivity analysis will be extended to include them. The focus of this effort will be to determine whether natural re-colonization or translocation may be required to expand the range of the population to include these areas, and which, if any, barriers to migration could be mitigated to improve connectivity to newly identified habitats. We will also seek to understand which habitat factors in the Columbia Plateau are most influential in shaping current patterns of sage-grouse occupancy.

Need: The Greater Sage-Grouse is a landscape species for shrub-steppe ecosystems, a Candidate for listing under the Endangered Species Act, a Species of Concern in all states and provinces within the GNLCC boundary, and a focal species in the GNLCC. Greater Sage-Grouse populations have declined significantly range-wide because of the cumulative impact of many stressors; climate change has the potential to exacerbate many of these impacts. Greater Sage-Grouse were once widely distributed throughout sagebrush (*Artemisia* spp.)-dominated habitats of central and eastern Washington. Habitat loss, degradation, and fragmentation resulting from a myriad of stressors threaten the persistence of Greater Sage-Grouse in the state. Current estimates place the state population at 1047 birds (2012 estimate; Schroeder et al. 2012) that occupy approximately 8% of the historical range (Schroeder et al. 2000). There are two established populations in Washington; one is located in the Moses Coulee area in Douglas/Grant counties and one is on the Yakima Training Center (YTC) in Yakima/Kittitas

counties. The Washington Department of Fish and Wildlife (WDFW) initiated a translocation project (2008 to present) to release Greater Sage-Grouse in the Swanson Lakes Wildlife Area, Lincoln County, Washington (Schroeder et al. 2008). It is too early to know if this translocation project is successful. Populations of Greater Sage-Grouse in Washington are isolated from each other by approximately 50 km and from populations in Oregon and Idaho by about 250 km and 350 km respectively.

Connelly et al. (2004) modeled anthropogenic disturbance factors in sagebrush habitats throughout Greater Sage-Grouse range: variables included railroads, powerlines, roads, campgrounds, rest stops, landfills, irrigation canals, oil-gas wells, human-induced fires, agricultural land, and populated areas. These spatial data sets were used to develop a human footprint model. The Columbia Plateau in Washington had high human footprint influence compared to other parts of Greater Sage-Grouse range. Additionally, human footprint intensity was higher in areas where Greater Sage-Grouse were extirpated. Extirpation of Greater Sage-Grouse range-wide was most likely in areas having at least four people/km^2, 25% cultivated cropland or the presence of three or more severe droughts per decade. Extirpation was most often explained by the combined effects of peripherality (within 30 km of range edge) and lack of sagebrush cover (<25% within 30 km) (Aldridge et al. 2008). A range-wide connectivity analysis of Greater Sage-Grouse leks concluded that the lowest level of connectivity occurs in the Columbia Basin Greater Sage-Grouse Management Zone (Washington), due to the small number of leks and the longer than average distance and fewer linkages among leks (Knick & Hanser 2011). This low level of connectivity was likely a primary reason for the low genetic heterogeneity of sage-grouse in Washington (Benedict et al. 2003; Oyler-McCance et al. 2005).

A range-wide quantitative analysis of environmental factors most closely associated with range contraction of Greater Sage-Grouse concluded that "The Columbia Basin had the highest percentage of environmental similarity to extirpated range", but provided little insight into why sage-grouse are still present in Washington (Wisdom et al. 2011). The unique aspects of the Columbia Basin likely contribute to the poor performance of habitat models developed in other parts of the range when applied to Washington. By focusing our analysis on Washington, and using additional spatial data layers developed by the WHCWG for the Columbia Plateau, we hope to gain insight into the pattern of Greater Sage-Grouse occupancy in this ecoregion.

Products from this analysis have the potential to help state and federal agencies identify Greater Sage-Grouse priority areas under current conditions as well as under future climate change scenarios. They will also help address conservation and management issues put forth in the Greater Sage-Grouse Comprehensive Conservation Strategy produced by the Western Association of Fish and Wildlife Agencies (Stiver et al. 2006). Deliverables from this project will help to (1) advance the GNLCC's objective to develop a science-based decision support system for landscape-scale conservation efforts, and (2) further connectivity conservations efforts for Greater Sage-Grouse.

Information Management—Lek location data is deemed Sensitive by Washington Department of Fish and Wildlife, Policy-5210 Releasing Sensitive Fish and Wildlife Information and cannot be released to the Public Domain. Genetic analyses results of samples funded by the Department of Defense are subject to Department of Defense proprietary regulations. All genetic samples for Greater Sage-Grouse are stored and maintained at the Washington Department of Fish and Wildlife Molecular Genetics Lab.

Objectives: We propose to develop a Washington-specific habitat model for sage-grouse based on occurrence data collected in the Columbia Plateau and a suite of habitat covariates. We will evaluate the performance of this model using cross-validation methods. We will compare model predictions to core habitat areas delineated in the WHCWG Columbia Plateau connectivity analysis. If new core habitat areas are identified, we will extend the connectivity analysis to include them, and evaluate the degree to which they are connected to the current extent of occupied habitat. This objective contributes to the "Testing assumptions of model projections" element in support of LCC objectives and functions.

Methods: The tasks detailed in this section will allow us to fulfill the above objective supported by the federal FY 2013 GNLCC funding requested here.

Task 1.1*— Develop and evaluate a habitat model for Greater Sage-Grouse.* We will use mixed effects logistic regression methods to relate WDFW Greater Sage-Grouse occurrence data to spatial predictors, including landcover type, road type and density, population density, Landsat imagery products (including vegetation greenness and moisture), topography (elevation, slope, landform, ruggedness, and solar insolation), climate (minimum, maximum, and mean annual temperature and precipitation), powerlines, and wind turbines. A range of plausible models will be evaluated and an optimal model will be selected using Akaike's Information Criterion and model averaging. The optimal model goodness of fit will be evaluated by several criteria, including kappa statistics, area under the receiver-operator curve, percent correctly classified, and pseudo r-squared metrics. The relative importance of each covariate to the performance of the model will also be evaluated by a jackknifing procedure. Key cooperators: WDFW, UW.

Task 1.2 *– Validate the habitat model identified in Task 1.1.* We will use a k-fold cross-validation approach to evaluate the performance of the habitat model in predicting occurrence with new data. We will also compare the predicted probability of occurrence relative to current patterns of occupancy to determine the degree of overlap. Key cooperators: WDFW, UW.

Task 1.3 *– Identify potentially suitable unoccupied core habitat areas and evaluate their connectivity to currently occupied habitat.* We will use existing WHCWG methods from the Columbia Plateau connectivity analysis to delineate Habitat Concentration Areas (HCAs) based on the habitat model and parameters such as minimum patch size, home range size, and dispersal distances for sage-grouse. We will then use WHCWG Linkage Mapper tool to model linkages between new habitat areas and currently occupied habitat areas delineated in the WHCWG Columbia Plateau analysis. We will use linkage quality/centrality indices and grouse dispersal distances to evaluate whether potential new habitats could be recolonized by the current population or whether translocations would be necessary. In addition, we will also use Linkage Mapper to model pinch points and barriers that constrain connectivity to potential new habitats, potentially identifying key areas that, with mitigation, could improve the probability of natural recolonization and connectivity of newly identified habitat. Key cooperators: WDFW, UW.

Task 1.4. *— Develop and maintain a data management plan for this project as per GNLCC requirements.*

Deliverables:

- Summary report titled "Connectivity of potential new habitat areas for Greater Sage-Grouse to existing habitat in the Columbia Plateau Ecoregion." *June 2014*

- A spatial habitat suitability model for Greater Sage-Grouse in the Columbia Plateau. *June 2014*
- Linkage model connecting new habitat areas to existing HCAs. *June 2014*
- Updated pinch point, centrality, and barrier models that incorporate the potential new habitat areas. *June 2014*

Statement of compliance: The Project Coordinator and Principal Investigators agree to comply with the Great Northern Landscape Conservation Cooperative Information Management, Delivery, and Sharing Standards if this proposal is selected for funding.

Schedule: Interim reports *January 2014*. Final reports *June 2014*.

IX. Budget Template

Project Title: Habitat Model Development and Connectivity to Potential New Habitats for Greater Sage-Grouse in the Columbia Plateau Ecoregion.

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Budget Narrative: Explain any necessary detail of the fund request, matching or in-kind.

	GNLCC	Matching	In-Kind	Comments
Personnel				
Salary 1 (Shirk, $5208/month, benefit rate = 37.7%)	$28,685.66			Spatial Analyst
Salary 2 (Schroeder)			$9,634.00 (FY12 and FY13)	WDFW staff time contribution with non-federal funds
Salary 3 (Robb))			$6000.00 (FY12 and FY13)	In-kind time.
Total for Salaries	$28,685.66			
Supplies/Equipment				
Equipment A				
Equipment B				
Total Supplies/Equipment				
Travel				
Meeting				
Training				
Total Travel				
Agreements/Contracts				
Agreement 1				
Contract 1				

Agreements/Contracts Total				
Data Collection				
Vehicle Costs				
Technician Travel (i.e., lodging, per diem)				
Data Collection Total				
Data Analysis, Management and Reporting				
Technical Support				
Metadata, Data Management, Tech Transfer				
Printing Publications				
Data Analysis, Management and Reporting Total				
Subtotal before Overhead				
Administrative				
Overhead (USFS/UW indirect = 2.5%)	$717.14			
Total Cost	$29,402.81		$15,634.00 (FY12 and FY13)	

ATTACHMENT 1 – LITERATURE CITED

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Greater Sage-Grouse: ecology and conservation of a landscape Species and its habitats. Studies in Avian Biology Series (vol. 38), University of California Press, Berkeley, California.