Grassland Landscape Conservation Design Pilot

A cooperative project between

Great Plains Landscape Conservation Cooperative and Playa Lakes Joint Venture

Cooperative Agreement # F14AC01111

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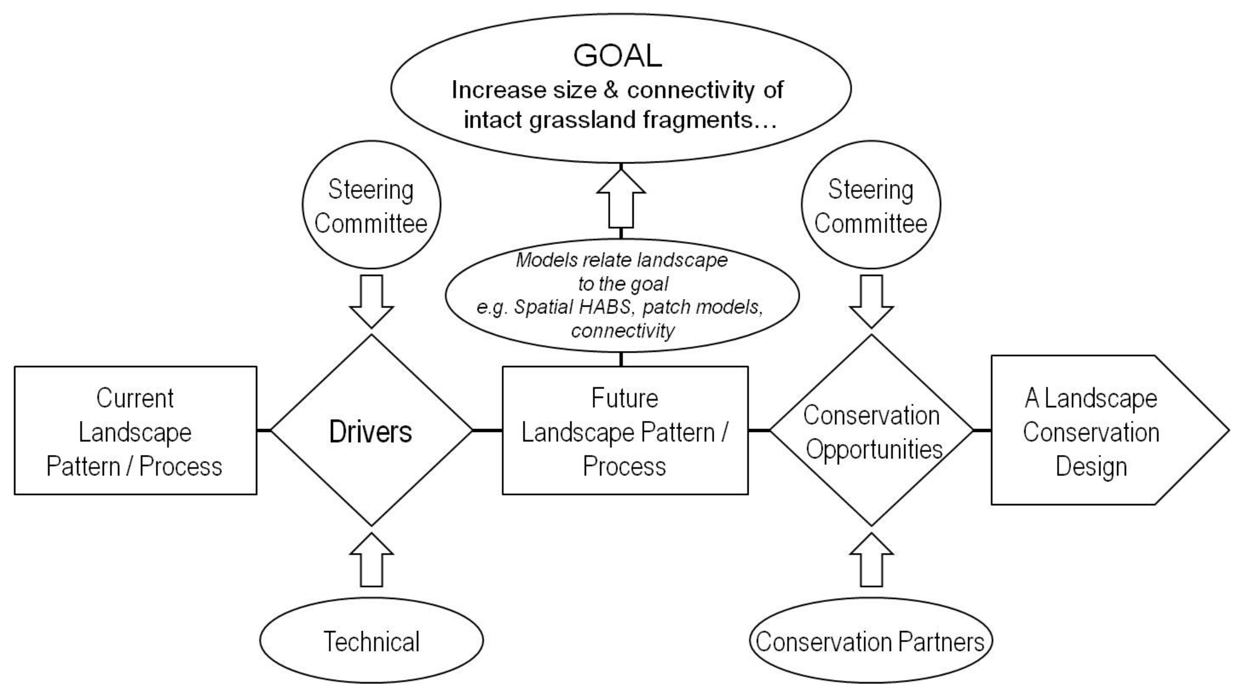
Summary

Landscape Conservation Design scales landscape level goals down to local conservation actions through a collaborative partner driven process. The Great Plains Landscape Conservation Cooperative (GPLCC) and Playa Lakes Joint Venture (PLJV) launched this project to develop a collaborative geospatial modeling platform for coordinating conservation efforts towards achieving PLJV and GPLCC conservation priorities among partners and across the landscape of the GPLCC (including all of the PLJV landscape). With a partnership of State, Federal and non-profit partners we developed both a goal ("To increase the size and connectivity of intact grassland fragments that provide sufficient habitat for Pronghorn, Swift fox, Black-tailed prairie dog, Burrowing owl, Massasauga, Ferruginous hawk, and Long-billed curlew") and a set of drivers (tillage likelihood, oil & gas development, climate change as it influences natural communities, change in CRP amount and/or quality on landscape, shrub encroachment, groundwater depletion, and wind development) that reflected the primary concerns of GPLCC partners in the pilot region.

A Landscape Conservation Design (LCD) is the end result of a conservation planning process that integrates societal values, sets biological goals, and uses sound science based in landscape ecology to provide a variety of scenario plans that describe where conservation can best be achieved and how it relates to measurable goals. LCD has been identified by the USFWS and the Landscape Conservation Cooperative (LCC) Network as an important component fulfilling the intent of LCCs to inform conservation decision making at local scales in order to affect conservation outcomes and the landscape scale (i.e., the scale of an LCC). The Landscape Design (LD) process facilitates communication among conservation partners and will help to identify LCC-scale information needs and priorities. Three primary objectives of this project outlined in the cooperative agreement were 1) To strengthen the PLJV and GPLCC partnerships through collaborative participation across partnerships in LCD development, 2) To support the shared missions of the PLJV and the Great Plains LCC to support wildlife conservation on the GPLCC landscape by providing decision support tools that affect conservation outcomes on a landscape scale, and 3) To strengthen awareness of and collaboration among all entities developing similar information products (through geospatial modeling and/or restoration prioritization or other related efforts) within the GPLCC geography, so as to reduce duplication of efforts and to help identify opportunities for leveraging through collaboration, data sharing, and/or cost-sharing.

To accomplish these objectives we used a Landscape Design workflow developed by PLJV as a framework for the process (see figure below). This process starts with a conservation goal (top of the workflow) and works by modeling how the landscape performs relative to that goal both today, and in the future under the influence of various drivers. In this context a driver is a human influenced process that affects landscape patterns (Nassauer and Opdam 2008; Nassauer, 1995). In a landscape design approach to conservation planning, we attempt to represent the anthropogenic components of landscape change using spatially-explicit driver models to describe land use (e.g.

agricultural development, oil & gas development, Conservation Reserve Program (CRP) enrollment and expiration, etc.). By modelling the landscape as it is today, as it might be under the influence of various drivers in the future, and as it could be given various conservation actions, this process allows us to identify environmental factors contributing to habitat loss and to assess how existing conservation efforts relate to the goal, and what needs to be done in the future to ensure the partnership meets its goal despite a variety of limiting factors (drivers).



Workflow 1. Workflow demonstrating a linear landscape design process

The pilot region study area consisted of a 147,000 km^2 extent of the Texas Panhandle, Oklahoma, Colorado, New Mexico, and Kansas between 100°W and 104°W latitude. We delineated the extent of the pilot region using a selection of the Omernik level-IV ecoregions consistent with upland grassland and low shrubland ecosystems of the southern high plains (Omernik, 1987). We used these boundaries to delineate the regional extent for our land cover analysis and habitat suitability modelling effort.

To determine landscape composition and configuration, we used PLJV's six state 30m resolution land cover supplemented with additional land cover datasets from National GAP and Texas Ecological Systems Classification, and USDA-NASS which were consistent with near-term landscape conditions. We selected land cover classes based on their majority representation (i.e., % of total area) and potential use by species of interest selected by partners for the pilot project. Our final land cover class selection included semi-natural grassland (i.e., CRP), shortgrass, mixed-grass, shinnery oak and sandsage plant communities, as well as all regional commodity crops identified by the National Agricultural Statistics Service (USDA-NASS).

We selected total area and mean patch area to represent land cover composition within the study region because both landscape metrics are intuitive, convey similar information to that of more complex metrics, and are comparatively easier for managers to implement in planning actions. We assumed that all pilot-study species respond to landscape composition and configuration in selecting habitat. We used mean patch isolation calculated at local (1650 meter) and landscape (6660 meter) scales to demonstrate the connectedness of grass patches across the southern Great Plains at multiple scales.

Assessing the health of landscapes is often accomplished by relating patterns of composition and configuration to species richness or population abundance (Walz, 2011). To limit the ambiguity and subjectivity in describing good grassland habitat conditions, we leveraged breeding range species count (i.e., abundance) and occurrence/absence data for our list of grassland species. We fit species response data to landscape composition and configuration metrics using a suite of habitat suitability models that we then extrapolated across the pilot region geography to produce a hotspot-analysis useful for identifying spatial gaps in habitat suitability related to habitat degradation (Evans et al., 2015; Scott et al., 1993).

We produced development suitability raster surfaces for all three drivers (commodity crop production, oil-and-gas, and wind energy development) using Random Forests (Liaw & Wiener, 2002). All development suitability models were fit in program R, using the 'randomForest' package (R Core Team, 2013; Liaw and Wiener, 2002). We deployed Random Forests as a traditional classifier, leveraging majority votes across trees to indicate the relative suitability of a location for each source of development (i.e., the more votes, the greater the predicted suitability). To train each of the three classification models, we fit spatially-explicit observations of development (e.g., occurrence of crops, oil-and-gas well pads, or wind turbines) and non-development (e.g., pseudo-absences extracted from kernel surfaces) to topographic and environmental variables perceived to be limiting factors in determining development suitability, using the methods of Evans et al. (2014) and Copeland et al. (2009). We used observations of commodity crop production occurrence from the NASS Cropland Data Layer (Boryan et al., 2011), wind energy production occurrence from the USGS (Diffendorfer et al., 2014), and oil-and-gas development occurrences from the proprietary IHS Wells Database (Enerdeq browser; https://www.ihs.com/). The outputs from these analyses are continuous, 30-meter resolution raster surfaces scaled from 0-to-1. Cells with a suitability score greater-than 0.5 for a particular driver are interpreted by random forest to be at-least marginally suitable for development, while values approaching 1 are considered highly suitable for development.

We interpreted the development potential surfaces whereby any area that has a development potential greater-than 2 SD from the mean observed across the pilot-region is 'highly-suitable' for development for a particular driver. To simulate crop build-out, we fit observations of mean annual crop price, mean annual drought, and year to total area planted for each majority crop indicated for the southern Great Plains using a generalized linear model. Each annual forecast of total area planted assumed that fields that are most suitable for farming will be selected first, and that on a regional scale, areas of marginal suitability will tend to be avoided by producers in an effort to maximize yield and minimize production costs.

We successfully modeled six of the seven species distributions and four of the seven landscape change drivers to predict how suitable habitat for these species is predicted to change in the future, and where conservation action can best contribute to connected grassland landscapes. In addition the tools and models developed in the process will inform a host of other conservation questions, and are immediately available to GPLCC partners. Through this process we identified the distribution of suitable habitat for focal species and determined the relative risk of changes to suitable habitat as a result of the drivers. We then prioritized areas to focus grassland conservation that effectively contribute to landscape scale goals. Overall the primary driver that will continue to have the greatest effect on grassland composition and configuration for a variety of species in this pilot region is row crop agriculture.

The data and analytical products of this project will be available on Sciencebase: https://www.sciencebase.gov/catalog/item/53ac958be4b0dad35f8e8d64 and at Github: https://github.com/PLJV and include species habitat suitability, development potential, and landscape metrics. In the second year of this project, we will focus on expanding the geography to the Bird Conservation Region 18 portion of the GPLCC and directly engaging local conservation partners whose efforts contribute to the landscape level goals of this project.

Literature Cited

Boryan, C., Yang, Z., Mueller, R., & Craig, M. (2011). Monitoring US agriculture: the US department of agriculture, national agricultural statistics service, cropland data layer program. *Geocarto International*, *26*(5), 341-358.

Copeland, H. E., Doherty, K. E., Naugle, D. E., Pocewicz, A., & Kiesecker, J. M. (2009). Mapping oil and gas development potential in the US Intermountain West and estimating impacts to species. *PLoS One*, *4*(10), e7400.

Diffendorfer, J. E., Compton, R., Kramer, L., Ancona, Z., & Norton, D. (2014).*Onshore industrial wind turbine locations for the United States through July, 2013* (No. 817). US Geological Survey.

Evans, J. S., & Kiesecker, J. M. (2014). Shale gas, wind and water: assessing the potential cumulative impacts of energy development on ecosystem services within the Marcellus Play. *PloS one*,*9*(2), e89210.

Evans, J. S., Schill, S. R., & Raber, G. T. (2015). A Systematic Framework for Spatial Conservation Planning and Ecological Priority Design: An Example from St. Lucia, Eastern Caribbean. In *Central American Biodiversity* (pp. 603-623). Springer New York.

Liaw, A., & Wiener, M. (2002). Classification and regression by randomForest.*R news*, *2*(3), 18-22.

Nassauer, J. I. (1995). Culture and changing landscape structure. *Landscape ecology*, *10*(4), 229-237.

Nassauer, J. I., & Opdam, P. (2008). Design in science: extending the landscape ecology paradigm. *Landscape ecology*, *23*(6), 633-644.

Omernik, J. M. (1987). Ecoregions of the conterminous United States. Annals of the Association of American geographers, 77(1), 118-125.

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Scott, J. M., Davis, F., Csuti, B., Noss, R., Butterfield, B., Groves, C., ... & Wright, R. G. (1993). Gap analysis: a geographic approach to protection of biological diversity. *Wildlife monographs*, 3-41.

Walz, U. (2011). Landscape structure, landscape metrics and biodiversity. *Living reviews in landscape research*, *5*(3), 1-35.