Boom, bust: linking trends in greater sandhill crane abundance to patterns of rural land use change and wetland condition

Principal Investigators

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Contributing Partners (to date):

Executive Summary

Plan of work outlines implementation of a spatially explicit monitoring project to document landscape change impacting the Rock Mountain population (RMP) of greater sandhill cranes (*Grus canadensis tabida; herein cranes*) by mapping range wide fragmentation rates in keystone summer and staging habitats. The study will identify key stressors driving bird distribution and abundance trends on private and public lands by linking regional population data to patterns rural land use change and annual wetland condition over time and space. Results will provide decision support to Flyways and partners that inform species management through evaluation of habitat conditions that structure crane distributions. Products provided will outline a spatial game plan to maximize the long term viability of cranes by prioritizing conservation actions that strategically mitigate landscape level stressors impacting the RMP.

Justification

Low density rural home development is the fastest growing form of land use in the United States (Brown et al. 2005) and in the arid west water scarcity is a major driver of this expanding human footprint. Agriculture and ranching traditionally accounted for >85% of western water use (National Research Council 1982). Increased aesthetic and recreational value of this commodity now stimulates an exponential rise in rural development, placing unprecedented pressure on scarce water resources (Hansen et al. 2005). Sustainability of flood irrigated rangeland and biologically diverse wetland habitats are at risk as water demand shifts from agricultural to domestic and industrial uses. Predicted long-term increases to rural development coupled with fluctuations in climate patterns portend future impacts in already stressed systems.

RMP cranes utilize palustrine and riparian wetlands in the Northern Rocky Mountains during summer breeding periods (Figure 1). High climate driven variation in wetland conditions are characteristic of these habitats, a known factor influencing population recruitment (McWethy and Austin 2009, Ivey and Dugger 2008). Percentage of juveniles in the RMP average 8.1% (1972–2013; Kruse et al. 2013), the lowest production rate recorded for any hunted avian species in North America (Drewien et al. 1995). Cranes occupy traditional breeding sites to hatch and fledge young prior to gathering in adjacent staging areas in late summer. Summer habitats occur in riverine valleys and basins above 1500 m and are often associated with flood irrigated rangeland and cattle production (Littlefield et al 1994). Staging areas exhibit similar characteristics, but include small grain production in proximity to wetland roost (Drewien and Bizeau 1974). Cranes are a long lived avian species with known individuals of the RMP exceeding 40 years in age (Drewien – personal communication, September 2014). This trait is supportive of a *K*-selected life history strategy in cranes that is adapted to exploit periodically favorable wetland conditions to maintain long term population viability (Bårdsen et al. 2011).

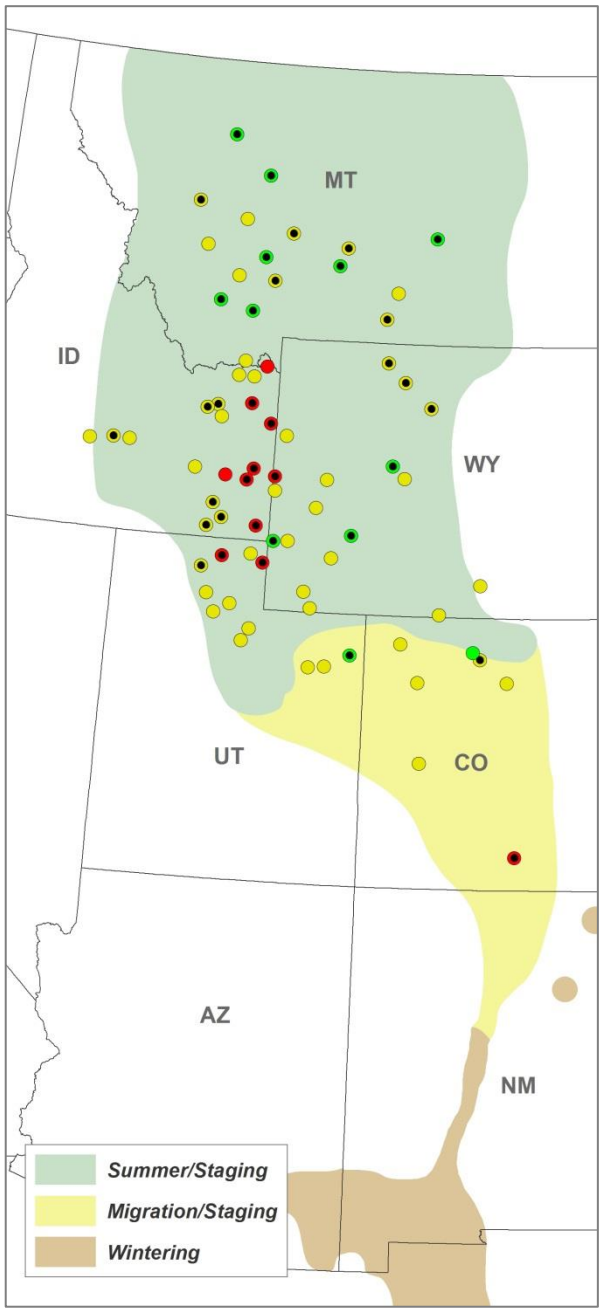

Figure 1 RMP seasonal distribution and study area map. Locations representative of fall staging sites. Colors indicate population trends from 1996 - 2013; green = increase, yellow = stable, and red = decline. Black points identify highest bird densities and represent >90% of the known population. Rates of rural land use change will be measured in these areas (black points) and proximal breeding habitats to examine factors impacting crane distribution and abundance.

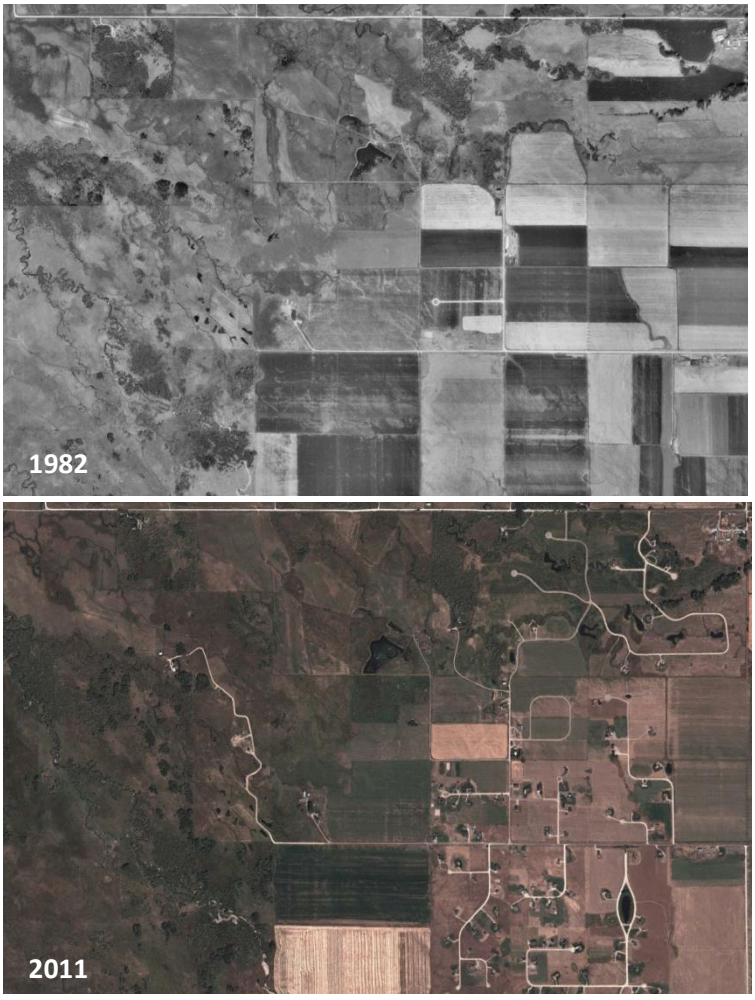

Figure 2 Example of rural land use change in Teton Basin, Idaho between 1982 (top) and 2011 (bottom). In past decades Teton Basin has experienced significant decline in RMP fall staging numbers.

To date, half of all wetland resources in the Western U.S. have been lost (Dahl 1990) and those remaining are under threat of land use change. High private ownership of these resources (>70%) inextricably links migratory bird conservation to private lands in the West (Donnelly and Vest 2012). Despite encompassing only a small fraction of the landscape (<2%), wetland habitats act as keystone features that drive crane distribution and abundance. Rural development in significant portions of the RMP summer range has increased 350% in recent decades (Gude et al. 2005). RMP population levels are considered stable, however bird longevity may mask lag effects in future declines resulting from habitat degradation that has already occurred. Regional population trends suggest patterns of crane redistribution that correspond to disproportionately high rates of incompatible land use change in some areas (Figure 1). Correlations among expanding rural development and regional population trends are currently unknown due to a lack of data depicting crane habitat extent and rates of land use change through time.

To address the threat of wetland habitat loss the Intermountain West Joint Venture (IWJV) has invested in a systematic approach to conservation science and decision support that sought to identify useful and efficient methods of mapping wetland distribution and productivity through time. As a result, we have now perfected a cost effective and efficient approach that has provided the catalyst for exponential growth in broad scale habitat inventory and monitoring. The method was developed by IWJV landscape ecologist and co-PI Patrick Donnelly to map wetlands and assess annual productivity associated with sage-grouse summer brood rearing habitats across 33 million hectares in Oregon, California, and Nevada (Donnelly et al. *in review*). The IWJV and its partners now seek to expand this model to the RMP as a tool to evaluate patterns of rural land use change and wetland condition in keystone summer and staging habitats. Results will be linked to regional population data to evaluate landscape patterns affecting crane distribution and abundance over time and space. Products provided to the Flyway and partners will outline a spatial game plan that informs harvest management and maximizes the long term viability of the RMP by prioritizing conservation actions that strategically mitigate landscape level stressors impacting cranes.

Priority information need

McWethy and Austin (2009) conclude land use change as a profound and long term risk to RMP breeding habitats and identify the need for additional research to alleviate this threat. Revised information needs (2014 - Sandhill Crane Priority Information Needs Workshop II, Lafayette, LA) rank land use change as the highest priority for the RMP and second highest priority across all populations. Work outlined will complement existing Webless priorities (*see* Priority Information Needs for sandhill Cranes - 2009) and investments by collaborating with efforts already underway to document habitat bottlenecks in key New Mexico wintering sites (Collins et al. 2013). Results of these combined efforts will provide a true range wide assessment and mitigation strategy for landscape stressors impacting this population.

Out-year funding

Second year funding is likely needed to support supplemental PTT (platform transmitter terminal) deployment. Work planned will utilize locational data acquired from ~30 birds marked in collaborating wintering habitat study (PTT deployment scheduled winter 2014-15; Collins et al. 2013). Bird capture on wintering grounds will prevent known summer distribution of marked individuals. Poor spatial distribution of winter marked birds will require supplemental PTT deployment necessary to capture representative space use patterns within full summer habitat extent.

Objectives

Project seeks to measure rates of summer habitat fragmentation by quantifying patterns of rural land use change and wetland condition impacting the RMP. Availability of this data will eliminate an immense and long standing information gap that has hampered broad scale decision support necessary to address harvest management and habitat conservation needs for this population. Associated objectives include:

1. Complete range wide mapping and evaluation of RMP summer and staging habitats.

2. Measure effects of rural land use change on regional populations and range wide RMP distributions from 1996 – present.

3. Evaluate annual climate driven variation in wetland conditions as a factor in predicting trends in RMP recruitment from 1996 – present.

4. Provide enhanced decision support to Flyway that supports spatial game plan to maximize the long term viability of cranes by prioritizing conservation actions that strategically mitigate landscape level stressors impacting the RMP.

Scope and Location

Study encompasses the entirety of the RMP summer range and 74 surveyed staging areas (~73 million ha; Figure 1). Although widely distributed, crane summer habitat encompasses <2% of this landscape area. Habitat mapping and monitoring will occur in riverine valleys and basins characteristic of known breeding and staging sites. Period of study will occur from 1996 to present to coincide with availability of fall survey data necessary to examine habitat and population relationships.

The ecological setting of the region is diverse and characterized as semiarid mid-latitude intermountain valley grassland and steppe marked by warm to hot summers and cold winters. Aridity is a result of the rain shadow of the Sierra Nevada and Cascade Mountains intercepting wet air masses brought by westerly winds. Annual precipitation ranges from 15 cm to over 100 cm at higher elevations, although high annual variability is characteristic. Wetland conditions are largely driven by accumulating winter snowpack. Snowmelt in mountain streams peaks from late spring to early summer and results in intermittent and increased surface flows that feed natural wetland basins and irrigated agriculture. High evaporative rates in late summer limit the extent of wetland habitats.

Experimental Design

Summer habitat mapping

Extent and condition of RMP summer habitat will be derived from Landsat 5 satellite imagery. Mapping of summer habitats will occur range wide. Satellite indices correlated to net primary production, soil moister and open water will be used to delineate habitat patches. Patches will be extracted as GIS polygons using an automated data clustering approach[1]. Known breeding sites[2] and satellite locations from ~30 marked birds will be used to originate space use parameters necessary to inform habitat delineation models. Satellite marked birds will be provided through collaboration with a concurrent wintering habitat study (PTT deployment scheduled winter 2014-15). Planned capture and marking of birds on wintering grounds will prevent known summer distribution of individuals. Poor distribution of winter marked birds will require supplemental PTT deployment necessary to capture representative space use patterns within the full extent of summer range. Details of additional satellite marker deployment will be provided in out-year funding request once distribution of winter marked birds is known (see *Out-Year Funding* – Justification section).

Estimating habitat condition

Wetland type, land use, and ownership designations will be assigned to habitat polygons through aerial photo interpretation and ancillary GIS data. Cowardin's wetland classification will be used to designate wetland types. Habitat condition will be calculated three times annually from 1996 to present by summarizing Landsat pixel values within wetland polygons. Values will be used to estimate climate driven patterns of wetland inundation linked to water level conditions, a factor known to affect crane nest success (McWethy and Austin 2009, Ivey and Dugger 2008). Patterns of inundation within modified wetland systems (i.e. flood irrigated range lands) will be examined independently to identify effects of land use practice influencing habitat condition. Final results will be tested as a factor in estimating annual breeding conditions by comparing outputs to trends existing fall recruitment surveys.

Measuring effects of land use change

Rural land use change in areas of crane habitat will be estimated using human footprint models based on ecological effect area or zones influenced by anthropogenic features (i.e. roads, residential housing, power lines, and agriculture). Land use change will be measured in ~37 staging areas and proximal summer habitats, representing >90% of the known crane population. Human footprint models will be repeated at two to four year intervals to assess additive effects of land use change over the period of study (1996 – present). Model inputs will be derived from ancillary GIS data and photo interpretation.

[1] Existing National Wetlands Inventory (NWI) data is incomplete and out dated (mean acquisition = 1983) across significant portions of RMP summer range preventing its use as a surrogate to depict crane summer habitat.
[2] Known breeding locations provided by Rod Drewien as capture site locals in juvenile crane banding efforts – Idaho, Montana, and Wyoming.

Methods outlined in Leu et al. (2008 - The Human Footprint in the West: A Large-Scale Analysis of Anthropogenic Impacts) will be used to define model parameters. Data from fall surveys will be used to examine correlations in regional population trends and patterns of rural land use change. Results will be used to examine elements and rates of land use change affecting distribution and abundance of the RMP needed to inform management strategies.

Conservation design

Mapping products and analysis will be combined in a GIS tool to prioritize and target conservation actions. Tool will provide decision support to Flyways and partners to construct a holistic management strategy that maximizes conservation return on investment through assessment of population level benefits to cranes. Conservation targeting will focus on areas of wetland condition and land use compatible with productive summer habitats. Conservation priorities will be ranked range wide and locally within states (Colorado, Idaho, Montana, Utah, and Wyoming).

Implementation Strategy

Work will be conducted cooperatively through the University of Montana, Wildlife Biology Department, Missoula, MT. PI's Dreitz, Donnelly and Naugle will select and jointly advise a graduate student to implement the study. A spatial data technician will be hired through University of Montana, Avian Science Center (Dreitz –Director) to support the large volume of GIS data collection and processing need to complete the project.

Anticipated Products

Study will provide decision support (i.e. GIS planning tools) to Flyways and partners that prioritize conservation actions through evaluation of habitat conditions structuring crane distributions. Associated GIS data layers will be made available for download to inform other federal, state, and local conservation planning and outcome based evaluations. To close the research-implementation gap we intend to developed "How to" instructional guides and will conduct multiple web-based training sessions to inform wildlife and habitat practitioners of information and tool applications

Products include:

1. Range wide summer habitat and staging area map to include wetland type, land use, and ownership designations; GIS layer.
2. Index of range wide summer habitat condition (annual; 1996 – present; GIS layer)
3. Cumulative rate of land use change in RMP summer habitats (1996 – present; GIS layer)
4. Conservation priority and targeting tools; GIS layers
5. Effects of land use change on RMP summer breeding distributions (peer reviewed scientific literature)

Management Implications

Mapping products will provide decision support to Flyways that improve precision of RMP population and recruitment estimations. Conservation planning tools will provide a holistic framework for partners to prioritize and coordinate habitat protection that maximize conservation return on investment through assessment of population level benefits to cranes. Landscape information benefits may be extended to support conservation of ancillary migratory bird populations (i.e. cinnamon teal, trumpeter swan and white faced ibis).

Relationship to other projects

Work outlined will complement existing Webless priorities and investments by collaborating with efforts already underway to document RMP habitat bottlenecks in New Mexico wintering sites (Collins et al. 2013). Locational information from ~30 satellite marked birds from the wintering study will be used to inform space use patterns in summer habitats.

Personnel

Principle investigators are presentative of interdisciplinary skills and stakeholder interest necessary to successfully complete work outlined. PI's Donnelly, Drietz, and Naulge encompass core skills in landscape ecology, spatial modeling, and population demography necessary to implement study design and support student and technician needs. Knetter, Collins, and Thorpe will provide key input to related projects and feedback from Flyway constituents important in guiding study outcomes. Donnelly and Collins participate as observers with pilot biologist Thorpe during fall RMP surveys and are familiar with habitats across the majority of summer range.

Period of Performance: September 2015 – August 2020 or five years postdate full funding acquisition.

Year 1	Student selection and detailed work plan development Determination and planning of additional PTT deployment
Year 2	PTT deployment (if applicable) Technician hired – begin acquisition and processing of habitat mapping data
Year 3	Habitat mapping, wetland condition, and human footprint modeling Landscape effects analysis initiated
Year 4	Landscape effects analysis completed Result summaries Conservation tools and landscape planning layers delivered
Year 5	Results finalized and published in peer review literature

Budget

Project funding is split between WMGBRM request and partner contributions. Request to WMGBRM is single year funding distributed equally across three years in support of a project graduate student. Partner to WMGBRM match is **2:1**. Potential of out-year funding may be required for additional PTT deployment. Additional WMGBRM request not exceed $30,000 (see *Out-Year Funding* – Justification section).

WMGBRM Request		
Graduate student	$75,000	Graduate student - University of Montana Wildlife Biology Department ($25,000/year - 3 years)
	$75,000	**SUBTOTAL**

Partner Contributions		
PI salary	*$54,000*	Project PI (Donnelly) - Oversee project. Facilitates the incorporation of results into strategic range wide conservation actions and outcomes. (5 weeks @ $2,700/wk - 4 years).
PI salary	$16,000	Project PI (Drietz) - Oversee project. Facilitates associated administrative duties. (2 weeks @ $2,000/wk - 4 years).
Technician salary	$43,553	Spatial analyst - Responsible for acquiring and processing GIS and remote sensing data needed to support project (52 weeks @ $818/wk) Includes *$1,000* in-kind administrative cost.
Equipment	$6,000	Desktop computers (2) needed for spatial data processing and habitat modeling.
Travel	$2,000	Validation - Travel funds to support field data collection for product validation.
	$121,553	**SUBTOTAL**

italics indicate in-kind contributions

WMGBRM Direct	**$75,000**
Partner Direct	**$66,553**
Total indirect (17.5%)	**$24,772**
Partner In-kind	***$55,000***
Total	**$221,325**

Partner Contributions		
$10,000	secured	IDFG - Migratory Bird Program
$5,000	secured	IDFG - Private Lands Program
$65,000	highly probable	IDFG - Science Support Funding
$8,000	secured	Intermountain West Joint Venture/USFWS
$54,000	secured	Intermountain West Joint Venture
$1,000	secured	Avian Science Center
$5,000	requested	Colorado Parks and Wildlife
$148,000		*italics* indicate in-kind contributions

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