DRAFT PROPOSAL
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Spatial and temporal abundance and distribution of the Common Raven (*Corvus corax*) in relation to anthropogenic resources and subsidies in the Gunnison Basin

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Background:

The Common Raven (*Corvus corax*) is native to the Gunnison Basin and its abundance has increased over the last five decades, as it has in the sagebrush ecosystem in other parts of the American West (Howe 2012). Historic Christmas Bird Counts conducted in the Gunnison Basin in the 1950s and 60s documented 21 or less ravens in each of 7 counts. The peak count in the first decade of the 21st Century the peak reached 591. These counts document a 100 fold increase in ravens locally in the last 50 years, which is consistent with the overall increase of 320% throughout the western United States (Sauer et al. 2011). The rapidly increasing population of ravens in the west has been attributed to changes in the landscape associated with human activities. Ravens have benefitted from roads (increased carrion for scavenging), irrigation and agriculture (increased water and grains or fruits), the construction of bridges, power lines, oil derricks, windmills, billboards, railroad trusses (used for roosts and/or nest sites), afforestation (trees used by ravens for roosts and/or nest sites), and the increase in food resources (urbanization, landfills, agricultural crops) (Boarman and Heinrich 1999, Bui et al. 2010). The increase in raven populations has resulted in conflicts with humans for economic and conservation reasons. Ravens nest predation has been causally linked to lower reproductive success of endangered California condors, least terns, and marbled murrelets, as well as desert tortoises (Boarman and Heinrich 1999, Austin and Mitchell 2010). The abundance of common ravens in Idaho has been correlated with predation of greater sage-grouse eggs and nestlings (Coates et al. 2008, Coates and Delehanty 2008). Ravens are drawn to areas with anthropogenic subsidies (food and roosts) and when these areas are saturated, ravens possibly expand their populations to adjacent habitats such as core sagebrush habitat (Bui et al. 2010).

Study Objectives

The purpose of this study is to better understand the distribution and abundance of common ravens in the upper Gunnison Basin, within the Gunnison Sage-grouse elevation contour. The emphasis is on relating raven distribution and abundance to anthropogenic features of the landscape including food, roost and nest subsidies such as roads, powerlines, exurban and urban development, and the landfill. Specifically, the goals are to:

1. determine the abundance and distribution of common ravens in association with anthropogenic resources and in areas lacking human alterations to the landscape
2. determine the influence of time and season on raven distribution and abundance

Study Area

The study will be conducted in the Gunnison Basin, Colorado within Gunnison Sage-grouse habitat. The study sites will occur within a sagebrush-steppe landscape at an elevation of approximately 2500-2600 m msl. This landscape has been altered by humans and includes the following infrastructure: urban and exurban developments (residential, commercial and light industrial), conversion of native vegetation to

parks and a golf course (lawns), a landfill and tree dump, a wastewater treatment plant, roads, and powerlines, among other anthropogenic features. Reference habitat is dominated by Wyoming big sagebrush (*Artemesia tridentata wyomingensis*) in relatively remote locations 5 km from paved roads. Common ravens are common within the town of Gunnison and in surrounding areas; their numbers have increased over the last 5 decades in the Gunnison Basin.

Methods

Ravens will be counted twice per month at approximately bi-weekly intervals beginning in July 2013 and extending through June 2014 (12 months, 24 surveys). Counts will be conducted at seven sites dominated by human landscape features including the landfill, wastewater treatment plant, highway/transmission line corridor, agricultural field, the university campus, a residential neighborhood, and the golf course, and at 2 sites relatively unmodified and at least 5 km from a paved road or powerline. The start site will be randomly selected and then sites will be visited in similar order each survey period. Each of the nine sites will be counted three times per survey day in the morning (0600-1000), midday (1000-1400), and in the afternoon (1400-1800, variable up to sunset). In the event that ravens are responding to observer presence, counts during different time periods will be done on different days. Raven presence and abundance will be measured by sight and sound in 10-minute point counts and all birds within 100 m of the count center will be recorded (birds outside of 100 m will also be recorded separately). Distance to each raven will be measured with a rangefinder. Raven group size will be noted for each detection and categorized by social aggregations (solitary bird, pair, group). The exceptions to this sampling will be in the residential neighborhood and along the highway/transmission line corridor where ravens will be counted along a driving transect about 1.6 km in length (Boarman et al. 2005). All ravens within 100 m of the transect will be counted as the observer moves along the transect; the time required to complete the transect will be 10 minutes. All nine counts will be completed within the four hour count periods. Timing of the afternoon/evening time period will be adjusted seasonally and the completion of the survey will coincide with sunset.

Data analyses

Based on similar studies of ravens in the desert southwest (Boarman et al. 2005, Boarman et al. 2006), I hypothesize that raven numbers will be highest at the sites most altered by anthropogenic features, followed by sites with intermediate anthropogenic resources, and raven numbers will be lowest in the sagebrush reference sites.

The null hypothesis that there is no difference in abundance of ravens among sites will be tested using a nested repeated measures ANOVA ($\alpha = 0.05$). Month will be nested within season and survey nested within month. Tukey's post-hoc test will be used to determine significant difference in raven numbers if the overall ANOVA is significant.

Expected Benefits

The main emphasis of this study is to provide baseline data of raven abundance and distribution in relation to human features of the landscape. These data may be useful in assessing current and future raven management strategies. This pilot project could be expanded to more adequately address raven resource selection, but that is beyond the scope of this one year pilot project. The current proposal will provide relatively intensive data at a few locations and help to determine patterns of use daily and seasonally at these sites, including the Gunnison County landfill.

Budget

Budget Item	Expense	Expense	Source
Researcher field surveys	24 surveys @$200 per survey	$4800	NFWF
Data analysis	10 days @$200	$2000	NFWF
Report preparation	10 days @ $200	$2000	NFWF
Travel Reimbursement	150 miles per survey * 24 = 3,600 miles @ $0.51/mile	$1836	NFWF
Total request		**$10,636**	

Timeline

Task	Dates	Responsible Party
Pre-proposal prepared and discussed with Gunnison County Strategic Committee and CPW	January 2013	Magee!
Full proposal and NFWF application prepared and submitted to CPW	May 2013	Magee!
Bi-weekly field surveys completed	July 2013 – June 2014	Magee!
Data analysis	July-August 2014	Magee!
Final report	December 2014	Magee!
Presentation to CPW and Strategic Committee	January 2015	Magee!
Presentation at CCTWS meeting	February 2015	Magee!

Literature Cited

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