Protecting rare grassland birds from extreme weather events

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REPORT SUMMARY

The Biodiversity Management and Climate Change Adaptation project is intended to provide knowledge and tools necessary to manage biodiversity in a changing climate. This report provides a summary of work completed to date on assessing the vulnerability of two rare grassland birds, the Burrowing Owl and Ferruginous Hawk, to extreme weather. For both species, this research is creating essential knowledge that will ultimately be incorporated into species at risk recovery plans at both the provincial and federal levels.

SUMMARY ABSTRACT OF RESEARCH EXAMINING BURROWING OWL REPRODUCTIVE ECOLOGY UNDER EXTREME WEATHER

1. Climate-change scenarios predict that the frequency and intensity of extreme weather will increase. Many avian studies have examined how reproductive output could be influenced by changes in average temperature or precipitation under various climate change scenarios, yet few have determined empirically how reproductive output is affected by extreme weather. In addition, human landuse practices may also buffer or exacerbate susceptibility of breeding birds to extreme weather.

2. Using a long-term monitoring study in Canada we examined how burrowing owl (*Athene cunicularia*) nest survival (N=754) varied in response to daily temperature and precipitation, habitat type, and soil texture. In addition, we compared burrow reoccupancy rates the year following nest flooding, nest depredation, and successful nesting. Using a supplemental feeding experiment over three years and individual marking (N=604), we also examined whether food limitation could be one of the mechanisms underlying owlet mortality during inclement weather.

3. Burrowing owl nest survival decreased during 1-day extreme precipitation events, but there was no buffering or exacerbation of precipitation effects in different nesting habitat types. Flooded nests had a significantly lower reoccupancy rate (8%) compared to nests that were successful (27%). In unfed broods, owlet survival was reduced by extreme precipitation; however, almost all owlets that received supplemental food survived bouts of inclement weather.

4. Increases in the intensity and frequency of heavy precipitation events in North America during the breeding season could have adverse consequences on population growth of burrowing owls and potentially reduce the pool of available nesting burrows. Our results also suggest that food

limitation could be one of the main mechanisms causing reduced reproductive output in many birds during bouts of inclement weather.

This paper will be submitted shortly to the Journal of Animal Ecology once approval has been granted from the CCEMC. All co-authors are aware that this manuscript will be submitted to the Journal of Animal Ecology and that it has been submitted to the CCEMC for review.

STATUS REPORT ON FIELD ACTIVITIES RELATED TO EXTREME WEATHER AND PRAIRIE BIRDS

FERRUGINOUS HAWK BREEDING ECOLOGY UNDER ADVERSE WEATHER CONDITIONS

Background

Our study on Burrowing Owl breeding ecology highlighted the vulnerability of a small prairie raptor to extreme precipitation events in terms of nest survival (i.e., the probability that a nest produces ≥1 young) and the number of offspring a nest produces (see above). The Ferruginous Hawk (*Buteo regalis*) is a large grassland raptor that breeds in the mixed and moist-mixed grassland ecosystems of Alberta. Ferruginous hawks (~2500 g) are substantially larger than the Burrowing Owl (~150 g) and build large, open, stick nests in trees and human-made structures, whereas Burrowing Owls nest underground in burrows previously excavated by other mammals. These differences in life-history between Ferruginous Hawks and Burrowing Owls suggest that the threshold at which extreme weather may influence Ferruginous Hawk reproductive output is mostly likely different than that of Burrowing Owls. For example, precipitation may not be as influential on Ferruginous Hawk reproduction as compared to other weather parameters such as wind and temperature.

Wind storms cause destruction of a substantial proportion of Ferruginous hawk nests both on their breeding grounds in the United States (Lokemoen and Duebbert 1976, Gilmer and Stewart 1983) and in Canada (Troy Wellicome pers. comm.). Ferruginous Hawk nest trees on the prairie are likely becoming older and more vulnerable to wind damage because they are either lone trees or in small unprotected patches (Hogg and Hurdle 1995). If nesting structures are being damaged and destroyed at increasing rates (and not being regenerated due to increased drought conditions; Hogg 2001), weather could have an important influence on the number of hawks breeding within Alberta. However, several non-government agencies, as well as industry, construct artificial nesting platforms for Ferruginous Hawks either as a means of increasing potential nesting structures (Migaj et al. 2011) or as a mitigation tool (Alberta Ferruginous Hawk Recovery Team 2009). Anecdotally, nests on these artificial nesting platforms may be less vulnerable to "blow-outs" and, depending on construction and upkeep, may be less vulnerable to degradation and destruction over time (Steenhof et al. 1993, Tigner et al. 1996). In addition to wind storms, variation in the timing and intensity of local weather can influence a multitude of Ferruginous Hawk behaviours (e.g., foraging and delivery of food to the nest) that can in turn affect breeding success (e.g., exposure of nestlings and juveniles to inclement weather, the probability of a nest producing young). For example, one study suggested that heat stress coupled with low food availability can cause substantial mortality of Ferruginous Hawk nestlings (Tomback and Murphy 1981). Other studies on large raptors conducted during the post-fledging period (i.e., the time between when young chicks leave the nest and when they migrate) suggest that inclement weather could also reduce post-fledging survival (Wiens et al. 2006). Understanding if, how, and when weather influences reproductive output of Ferruginous Hawks is essential for suitable management strategies to be implemented for recovery of this species (COSEWIC 2008, Alberta Ferruginous Hawk Recovery Team 2009).

Most ecological, weather-based studies in Canada rely upon Environment Canada weather stations for data on hourly, daily, or monthly weather parameters (temperature, precipitation, wind speed, and direction; see Burrowing Owl study above). Unfortunately, these weather stations are typically distributed non-randomly across the landscape, mainly occurring in urban centres and long-established, but fixed positions. While these Environment Canada weather stations likely provide an acceptable index of local weather for some parameters (precipitation and temperature), they cannot provide high resolution weather data (i.e., <1 hour intervals) nor can they provide an exact representation of weather that nests are experiencing. We are using portable, automated weather stations placed near nesting Ferruginous Hawks to supplement data from Environment Canada weather stations and to test the assumption that Environment Canada weather stations provide an accurate depiction of local weather. The portable weather stations also provide high temporal-resolution data (< 1 hour intervals) that can be used to complement our high resolution behavioural data on Ferruginous Hawk nesting activities.

The Ferruginous Hawk is listed as a federally Threatened species (COSEWIC 2008) and an endangered species in Alberta (Alberta Ferruginous Hawk Recovery Team 2009). Ferruginous Hawks breed in Alberta and Saskatchewan and throughout much of the United States (Bechard and Schmutz 1995). Criteria for assigning this species its Threatened status at the federal level include >50% range contraction in Canada and an approximate 64% population decline in Alberta from 1992-2005 (COSEWIC 2008). Causal factors behind population declines and range contractions remain speculative; however, habitat loss and climate change have been implicated (COSEWIC 2008, Alberta Ferruginous Hawk Recovery Team 2009). The Alberta recovery plan for this species indicates that an increasing probability of extreme weather events (specifically extreme wind storms) may become an issue for Alberta Ferruginous Hawk populations and that mitigation and conservation strategies need to be developed in response to these predicted changes in extreme weather (Alberta Ferruginous Hawk Recovery Team 2009). The research done by our group will contribute valuable information and potential conservation strategies for Alberta Environment and Sustainable Resource Development, the Alberta Ferruginous Hawk Recovery Team, and Environment Canada. It should be noted that Dr. Troy Wellicome (Environment Canada wildlife biologist and lead biologist working on the Ferruginous Hawk recovery plan) is one of the principal investigators on this project. Therefore, our results and management suggestions will have immediate impact on the conservation of this species and will be communicated to individuals involved with “on-the-ground” conservation of this species.

Our research will implement a long-term nest monitoring approach, similar to the Burrowing Owl project, to monitor nest-structure longevity (number of years a nest remains habitable), nest reoccupancy by Ferruginous Hawks, and nest survival (i.e., the probability that a nest produces ≥1 young). Fine-scale studies using video-monitoring and telemetry will address questions related to prey delivery rates, adult movement and foraging, and juvenile survival in relation to several weather parameters. This is part of a larger project examining Ferruginous hawk breeding ecology in prairie Canada in response to industrial activities. We will collaborate with several graduate students to examine how weather affects the following:

(1) nest survival and whether artificial nesting platforms could be a useful tool for mitigation of weather-caused nest failures (J. Ng, Ph.D candidate). In addition, we will compare longevity of nests in natural structures (trees/shrubs) and different artificial nesting platform designs.

(2) prey delivery rates and nestling survival (C. Nordell, M.Sc. candidate). This observational study will allow us to test whether food limitation during inclement weather is a reasonable hypothesis for nestling mortalities in this species, although we will not be supplementally feeding Ferruginous Hawk broods.

(3) movements and foraging success of adults (J. Watson, M.Sc. candidate)

(4) post-fledging survival (the time period after young hawks leave the nest until they migrate; M. Johnson, M.Sc. candidate).

Field Activities 2012

During the summer of 2012, 10 portable, automated weather stations were placed near Ferruginous Hawk nests in Alberta from May-July. To maximize the usefulness of the weather-station data, we placed the stations in central locations near nests that had multiple research activities occurring (video monitoring, satellite transmitters on adults, and transmitters on post-fledglings; Figure 1). We used two types of weather stations (4 HOBO [Onset Computer Corp] and 6 Davis Vantage Vue [Davis Instruments Corp.]; Figure 2) that recorded a suite of weather data in 15-min intervals for 1-3 months (the approximate length of the Ferruginous Hawk nesting period), specifically: temperature (°C), precipitation (mm), wind speed (kph) and direction, relative humidity (%), and barometric pressure (kPa). Because of issues with livestock in much of our study area and their potential to severely damage the weather stations, we placed weather stations in fenced areas that were usually associated with landowner homes or acreages. Weather stations were placed ≥ 200m from any tall structures (buildings, trees) and checked periodically during the summer to verify that they were still functioning. Data were downloaded from each weather station after juvenile hawks in nearby locations had departed the study area (typically late August). Weather stations were disassembled and returned to the University of Alberta.

Future Plans

Forty-seven monitored Ferruginous Hawk nests were within 10 km of Environment Canada (EC) weather stations. Using information from nest visits (nest still active or failed, numbers of nestlings) and data from the automated weather stations (supplemented with data from Environment Canada weather stations), we will examine how nest survival and the number of offspring produced at each nest vary with local, fine-scale weather (similar to that for Burrowing Owls, although the suite of variables we examine will likely be slightly different). A subset of these nests (n=29) were also monitored 24 hrs per day using video technology (Figure 3A; 11 of these also had a portable weather station within 10 km and several had an portable weather station within 500 m). The relatively high temporal resolution data from the portable weather stations (every 15 mins) and their proximity to the video-monitored nests, will allow us to test the influences of acute weather phenomena on prey delivery rates to the nest and subsequent nestling survival. Ten satellite transmitters were attached to adult hawks (Figure 3B) in 2012 that recorded the adult's position every 1 hr; 3 of these birds were within 10 km of a weather station and an additional 2 were within 15 km. Lastly, we attached radio-transmitters to 80 juveniles (Figure 3C) after they left their nest; 16 of these were within 10 km of a weather station. Using information on survival or mortality of juveniles that are relocated every 3 d and current statistical techniques to judge the relative importance of factors influencing survival during the interval between visits, we will relate juvenile hawk survival rates to temperature and precipitation and other factors such as landuse and human disturbance.

Greater than 100 Ferruginous Hawk nests have been monitored every year since 2010 and will continue to be monitored for reoccupancy rates and to monitor nest structure damage/destruction in 2013. Using these long-term data, we will compare the vulnerability of nests in trees to those in artificial nesting platforms to extreme wind blow-outs. In 2012, we monitored 114 nests in trees and 27 in artificial nesting platforms. Nests in three different artificial nesting platforms designs were monitored (Figure 4). At project completion, we hope to provide information on which artificial platform design could be most useful to mitigate potential increases in extreme weather events.

Weather stations will be erected next year and will hopefully be functional in April 2013 to capture any severe weather in the spring when hawks are establishing their nests and beginning to lay eggs. Weather stations are placed far enough away from nesting birds to hopefully cause little disturbance during this critical time period (several hundred meters in most cases). Locations of weather stations in 2013 will depend on where field activities take place and where the maximum amount of information can be gathered from the various projects. Use of the automated weather stations provided unique opportunities to foster better relationships with local landowners. Where possible, datalogging equipment was placed inside the houses of local landowners so that they could monitor local weather, while we acquired the needed data.

Several landowners were willing to have the equipment placed in their houses and all remarked how they are willing to have the equipment placed in their houses again in 2013.

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Figure 1: Locations of 10 weather stations placed near active Ferruginous Hawk nests in 2012.

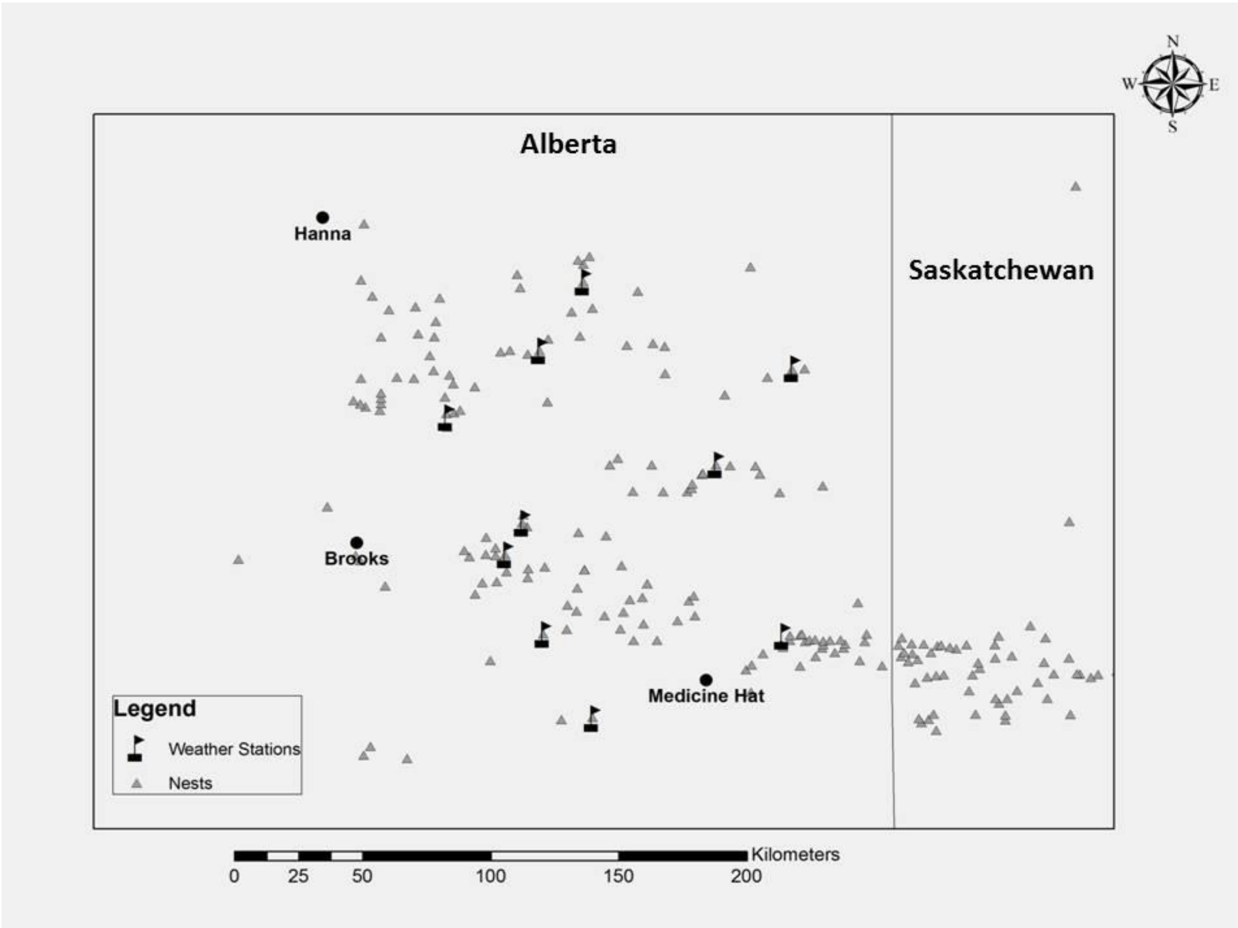

Figure 2: Two weather station types: HOBO dataloggers (Onset Computer Corp.; A) and Davis Vantage Vue (Davis instruments; B) placed near Ferruginous Hawk nests in 2012. Photos courtesy Ryan Fisher.

A

B

Figure 3: (A) Satellite transmitter on adult Ferruginous Hawk (photo courtesy Jesse Watson). (B) VHF radio-transmitter on juvenile dark-morph Ferruginous Hawk (photo courtesy Melynda Johnson). (C) Footage from video monitoring at a Ferruginous Hawk nest in 2012 (C; photo courtesy Cameron Nordell).

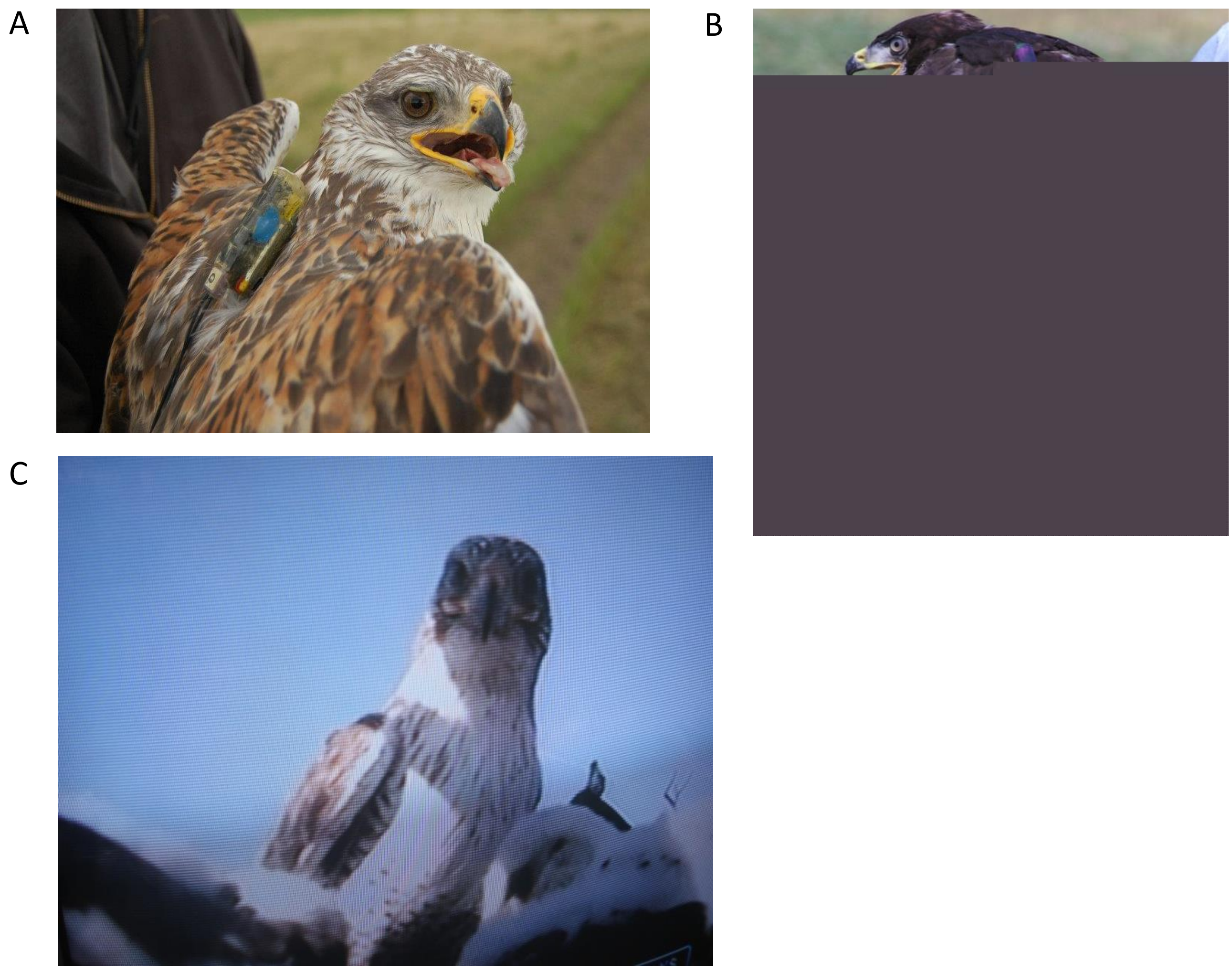

Figure 4: Three different artificial nesting structure designs used in the Canadian range of breeding Ferruginous hawks. Photos courtesy Janet Ng.