Review of Whooping Crane Risk Assessment Documents Regarding the Collision Risk for Whooping Cranes with NPPD's R-Project

Prepared for: U.S. Fish and Wildlife Service

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Task 1: Review the Service 2018(b) (Table1) Whooping Crane Risk Assessment and offer an independent assessment of FWS conclusions.

In my first review of the whooping crane risk assessment documents associated with the draft environmental impact statement for the R-Project transmission line (Davis 2018), it was clear that there was considerable uncertainty about the impact of this project on migrating whooping cranes. Several factors such as 1 documented transmission line collision for the Aransas-Wood Buffalo (AWB) population over 60+ years, reliance on historical, opportunistic whooping crane sighting data, and limited data on whooping crane flight behavior near powerlines contributed to this uncertainty. U.S. Fish and Wildlife Service (2018b) attempted to address these concerns by using other whooping crane collision data (Brown et al. 1987) not used in previous risk assessments, incorporating more recent and appropriate location data (i.e., location data from 58 AWB whooping cranes fitted with satellite transmitters from 2010-2016), and relying on approaches described in Faanes (1987) and Loss et al. (2014) to estimate the risk of the R-Project transmission line to whooping crane collisions. Using these data and approaches, U.S. Fish and Wildlife Service (2018b) reported an expected take of 40-84 whooping cranes over the 50-year life of the R-Project transmission line, which is exceptionally high compared to take estimates (0.422 to 0.619 whooping cranes) reported in the previous U.S. Fish and Wildlife Service assessment (U.S. Fish and Wildlife Service 2017). Based on this analysis, U.S. Fish and Wildlife Service (2018b) concluded that take of whooping cranes is reasonably certain to occur over the 50-year life of the R-Project transmission line. Below, I evaluate the methodology, assumptions, logic, and scientific justification provided by U.S. Fish and Wildlife Service (2018b) to arrive at this conclusion.

The U.S. Fish and Wildlife Service (2018b) used whooping crane collision data reported in Brown et al. (1987). This research was from a study conducted from 1983-1984 to evaluate crane and waterfowl collision mortality in the San Luis Valley (SLV), Colorado. The whooping cranes migrating through the SLV were from a cross-fostering program to establish a whooping crane population west of the AWB population (Grays Lake Experimental Population; French et al. 2018). During the study, Brown et al. (1987) documented 5 whooping crane collisions with powerlines. Three of the collisions (2 from transmission line and 1 from distribution line) resulted in mortalities. The other 2 collisions resulted in one whooping crane apparently being unhurt and the other being injured (the bird was captured, its wing amputated, and transferred to Paxtuxent Wildlife Research Center). The transmission mortalities occurred in each of the years with the mortality in 1983 being reported from 25 km (15.5 mi) of surveyed transmission lines and the 1984 mortality being reported from 8.3 km (5.2 mi) of surveyed transmission lines. Eighty percent of the whooping cranes that collided with powerlines within the SLV were juvenile. Brown et al. (1987) also observed 1,694 crane flights (primarily flocks of sandhill cranes) over powerlines and reported no crane collisions.

In my opinion, the use of the whooping crane collision data from the SLV is inappropriate and problematic for determining a collision risk of the R-Project transmission line for the AWB population. Despite the U.S. Fish and Wildlife Service (2018b) stating that situation at SLV in which transmission lines bisect roost and foraging habitats makes the Brown et al. (1987) study applicable for assessing collision risk for the R-Project transmission line, this is clearly not the case for the following reasons:

1. The SLV is considered a staging area for greater sandhill cranes and their cross-fostered whooping cranes, while the AWB population uses wetlands along its migration route as stopover sites. Given the longer stay (i.e., potentially 3-4 months during spring and fall; Brown et al. [1987]) as well as the constant hazard posed by the presence of transmission lines in the SLV, the risk of whooping cranes collisions would be expected to be much higher in SLV.
2. The fact that a high percentage (80%) of the whooping cranes that collided with powerlines in the SLV was juveniles is a considerable problem. This high percentage of juvenile whooping crane collisions can be attributed to the high proportion of juveniles that were in the population (range: 36-59%; Brown et al. 1987) and the higher vulnerability of juvenile cranes to powerline collisions. Furthermore, the percentage of juvenile whooping cranes in the SLV population is considerably higher than the long-term percentage for the AWB population (13%; Wilson and Bidwell 2018), which would result in a considerable overestimation of the number of strikes when applied to the AWB population.
3. Although I do not think use of these data is appropriate, it is not clear to me why U.S. Fish and Wildlife Service (2018b) did not include further research of crane collisions in the SLV conducted by Brown and Drewien (1995). Brown and Drewien (1995) evaluated the effectiveness of powerline markers to reduce crane and waterfowl mortality. Although the data from marked powerlines may be problematic, data from the unmarked powerlines certainly could have been used by U.S. Fish and Wildlife Service (2018b). Brown and Drewien (1995) reported no whooping crane collisions over 38.4 km (23.9 mi) of surveyed transmission lines when the Grays Lake Experimental Population ranged from 13 to 14 whooping cranes. Omitting data that would result in a lower collision rate is curious.
4. A critical component of U.S. Fish and Wildlife Service's (2018b) calculation of take in Method 1 is collisions/crossing which according to U.S. Fish and Service (2108b) is based on the data and map provided by Brown et al. (1987). I was able to back-calculate and arrive at the total number of crossings (0.4375 crossings/crane-day X 2,205 crane-days/year = 965 whooping crane crossings/year at SLV), but it is not clear how this value was determined as the data and map in Brown et al. (1987) were not particularly informative for determining number of crossings. Brown et al. (1987) did conduct bird flight observations from 8 Oct -12 Nov and recorded 1,694 sandhill crane flights over powerlines, but it would be highly speculative to somehow extrapolate from these data 965 whooping crane crossings/year. This is especially an issue since Brown et al. (1987) did not provide any information about whooping crane flights over powerlines. Without a clear explanation of the scientific basis and assumptions that led to this value, the collisions/crossing calculation is meaningless. Moreover, this issue further highlights the problem with using Brown et al. (1987) as a basis for calculating whooping crane collision strikes for the R-Project.

   [Note about calculations: U.S. Fish and Wildlife Service (2018b) noted that Brown et al. (1987) reported 1 whooping crane killed per year on 20.7 mi of transmission line, when it actually was 1whooping crane killed per year on 15.5 mi of transmission line in 1983 and 1 whooping crane killed per year on 5.2 mi of transmission line in 1984 or 0.097 cranes killed per mi of transmission line/year]

5. The fact that Brown et al. (1987) and Brown and Drewien (1995) reported 78 and 90 sandhill crane strike mortalities in the SLV in 1983-1984 and 1988-1991, respectively, indicates that this region was a unique situation where higher numbers of collisions occurred due to the high concentrations sandhill cranes in areas containing several transmission lines and numerous distribution lines. This type of situation does not reflect the conditions (high concentrations of whooping cranes + many powerlines) that would occur near the proposed route for the R-Project transmission line.
6. Finally, relying on one study from one site over a short period of time (as is the case for the Brown et al. [1987] study) to estimate collision mortality of whooping cranes by the R-project is highly problematic and speculative. Loss et al. (2014) noted the policy and management to mitigate avian powerline collision and electrocution mortality should be based on scientific studies that implement randomized and replicated sampling schemes (i.e., rigorously collected data). Brown et al. (1987) provides an excellent index of collision mortality for the SLV (as noted by the authors), but the study was not designed to provide an estimate of whooping crane mortality at a larger scale (e.g., R-Project area). Yet, U.S. Fish and Wildlife Service (2018b) used a collision rate of 1 whooping crane strike mortality/20.7 mi of transmission line [See note above about the issue with this calculation] as a basis for their estimate of collision mortality rate for the R-Project transmission line. Clearly, such a rate does not represent the true rate of whooping crane strike mortality for AWB population because if it did, the annual whooping crane strike mortality from transmission lines would be extremely high (e.g., >2,000 annual strike mortalities throughout the AWB migration corridor which is bisected by 45,000 mi of transmission lines). Obviously this is not the case, but it highlights the issue with relying on data collected from a single, unreplicated study that is an outlier in terms of powerline hazards to whooping cranes.

Overall, the 2 methods used to calculate whooping crane collision mortality are both scientifically indefensible and provide unrealistic estimates of whooping crane collision mortality because of reliance on data from Brown et al. (1987). However, there are other aspects of these 2 methods that are problematic. I highlight them below:

1. It is not clear how Method 2 follows Loss et al. (2014) and based on my conservation with the author, who is a faculty member in my department, it was inappropriate to cite the paper as the basis for this approach (S. L. Loss, Oklahoma State University, personal communication). Furthermore, the Loss et al. (2014) model was developed for estimating bird mortalities from electrocution and collision for the U.S., not for calculation of collision mortalities at a specific site. Method 2 had several errors in the calculation which made the estimate of collision mortalities for the R-Project transmission line suspect. First, the initial component of the calculation [(53.86 crane stopovers*4.47 average days/stopover)/3.35 stopover miles = 71.82 crane days/year/3.35 radius circle] is incorrect. It is not clear to me why they divided by 3.35 stopover miles. It is the radius of the stopover site, but I am not sure what this actually means…per stopover mile? Even if it is per stopover mile, this makes absolutely no sense. This would seem to suggest that the authors considered the 3.35 mi radius from the roost site to be exposure to 3.35 mi of transmission line. This

could be possible, but this is not how the authors calculated their take estimate as they divided by 3.35 instead of multiplying by 3.35. There is no explanation or biological reason to divide by 3.35 stopover miles. The authors then continue the calculation by multiplying the value from the first component by R-Project miles then by the mortality estimate (0.000021977613) and finally by a correction factor (3.25) to obtain an expected take of 0.54 whooping crane collision in the first year of the project. Given that the initial component was based on stopover miles, I believe further multiplying by 106.37 miles (R-Project miles within 95% of the migration corridor) is inappropriate and further created a problem by producing an inaccurate estimate of whooping crane collisions for the first year.

As I worked through their calculation, I found the units confusing. The authors report the units as number of whooping crane collisions, but actually the units are collisions/stopover radius (if my interpretations of their calculation are correct). This certainly is an issue because collisions/stopover radius/year is much different from number collisions/year. To be honest, I really cannot follow the logic in the calculation and until the authors clearly explain the logic and justification behind their calculations and provide a step-by-step description of how the calculations were conducted, this calculation should not be considered plausible or scientifically valid.

Finally, the use of the 3.35 mi radius as the risk zone to the powerline is not well founded and there is quite a bit of debate on what distance actually constitutes a hazard to whooping cranes. Currently, U.S. Fish and Wildlife Service recommend 1 mile distance on both sides of powerlines, but others have suggested 3.35 mi (Ecosystem Advisors 2017) and 0.45 mi (Headwaters 2018). A key factor in determing the hazard zone is the flight altitude of birds relative to proximity to the hazard, but other factors such as weather conditions, visibility, distance to foraging or roosting site, and habitat type also will play a role. The U.S. Fish and Wildlife Service's recommendation is based on direct observations of crane flight behavior, while the other recommendations are based solely on movement distances and assumptions about whooping crane flight behavior. Because distance to the hazard is such a critical component to estimating the zone of influence of a hazard (i.e., distance to the hazard influences the number of whooping cranes considered at risk and the number of stopover sites considered within the hazard zone), its use in determining risk of collision must be scientifically defensible. At this time, I cannot say that use of the 3.5 mi hazard zone is scientifically defensible.

2. In both methods, U.S. Fish and Wildlife Service (2018b) include a correction factor of 3.25 to account for biases associated with crippling and nocturnal use (Murphy et al. 2016). Accounting for biases such as scavenger removal bias, searcher detection bias, crippling bias, and habitat bias are necessary to obtain more realistic collision mortality estimates (Loss et al. 2014). However, estimating these biases requires standardized monitoring over numerous years and under a wide range of environmental conditions. Furthermore, correction factors should be applied to sites that represent similar conditions (e.g., habitat conditions, roost site conditions, flock numbers, type of powerlines, etc.) as the original study used to determine the correction factor(s). Use of Murphy et al. (2016) is problematic because it is based on one season and conditions that would not be similar to the R-Project area.

Specifically, Murphy et al. (2016) conducted their study at a major sandhill crane nocturnal roost on the Platte River that involves a 69-kv transmission crossing the river near the roost. This stretch of the river typically contains several tens of thousands of sandhill cranes roosting so we would expect high numbers of cranes colliding with the powerlines (even despite avian collision reduction devices being installed on the powerline). Moreover, Murphy et al. (2016) found that most (94%) of the sandhill crane collisions occurred at night and two-thirds of the collisions occurred when sandhill crane flocks suddenly flushed upward from the roost and flew into the powerline due to an unknown disturbance. These types of conditions are not representative of potential conditions that may be experienced by migrating whooping cranes using stopover sites near the proposed route of the R-Project transmission line. Although whooping crane numbers at roost locations will not approach these types of numbers, sites where larger congregations of whooping cranes occur during migration are not located near the proposed R-Project route. Additionally, whooping cranes rarely migrate at night (especially in the central portion of their migration flyway; A. Pearse, USGS, personal communication) and they appear to exhibit avoidance of human structures (e.g., wind turbines) which suggests that whooping cranes may not roost near powerlines (A. Pearse, USGS, personal communication). Inclusion of this correction factor will further overestimate the collision mortality estimates.

3. The use of the 2 Methods are reported as a range (i.e., 0.26 to 0.54 whooping crane collisions) when these were 2 different approaches and they should be reported as such. Otherwise, presenting the results as the authors did is quite misleading. Furthermore, it is not clear how the authors actually estimated error (i.e., 95% confidence intervals). Were they able to calculate confidence intervals by bootstrapping or some other approach? Again, no explanation is provided.

U.S. Fish and Wildlife Service (2018b) further infers a high likelihood of whooping crane collisions during the life of the R-Project transmission line by presenting data on the amount and distribution of whooping crane habitat in the project area and amount and use of habitat by whooping cranes in the project area, and describing the unique characteristics of whooping cranes that make them vulnerable to powerline collisions. In terms of amount of wetland habitat, I do not disagree this area in the Sandhills Region contains numerous wetlands that could provide stopover habitat, however, I would caution that occurrence of those wetlands within the R-Project area alone does not necessary indicate a likelihood of whooping crane use as other factors such as wetland size, water depth, vegetation coverage in the wetland, surrounding landscape characteristics, and proximity to other wetlands will also influence use by whooping cranes. A more detailed examination of habitat selection by the GPS-marked whooping cranes would provide additional insight on the potential stopover sites used by whooping cranes in the R-Project area.

Based on the occurrence of GPS-marked whooping cranes in the R-Project area, U. S. Fish and Wildlife Service (2018b) extrapolated the potential number of whooping cranes that may use stopover sites in the R-Project area. I do not have any problems with the authors using this approach (which does rely on the best available data [i.e., GPS locations of whooping cranes]) to determine potential occurrence of whooping cranes in the R-Project area, but I would also caution that use of these wetlands will be highly variable depending on weather conditions, distance from previous stopover locations, and timing of flight through the Sandhills Region. Further, it appears that whooping cranes do not have a strong site fidelity for these sites unlike other major stopover sites along the migration route (e.g., Salt Plains NWR in Oklahoma, Cheyenne Bottoms WMA in Kansas, Platte River in Nebraska) (A. Pearse, USGS, personal communication).

Finally, it is clear that the unique characteristics of whooping cranes (i.e., decreased flight maneuverability due to its large body size; Urbanek et al. 2015) make them vulnerable to powerline strikes, and whooping cranes have collided with powerlines and have been killed by powerline collisions. However, the importance of powerline collisions as a source of mortality is still not well-understood due to the lack of a comprehensive dataset on mortality factors for the AWB whooping crane population. The fact that there have only been 10 documented whooping crane power line collisions (9 distribution lines, 1 transmission line) over the last 60+ years certainly plays a role in the uncertainty of assessing the risk of whooping cranes colliding with the R-Project transmission line. Further, it appears that none of the GPS-marked whooping cranes collided with transmission lines over the 6 years of the study (A. Pearse, USGS, personal communication). The uncertainty of our knowledge about the risk of powerline collisions to whooping cranes is still considerable and approaches that attempt to assess the risk of powerlines for whooping crane collisions must consider the level of uncertainty or measure of error for all data sources. For U.S. Fish and Wildlife Service (2010b), I did not find that they adequately addressed the level of uncertainty of their data and this played a role in their calculation of unrealistic estimates of whooping crane collisions for the R-Project area.

Summary:

As I describe above, the U.S. Fish and Wildlife Service (2018b) take assessment and underlying assumptions is for the most part not based on the best available science. The major issue with the report's take assessment is the use of data from the cross-fostered whooping crane population that used the SLV as a staging area. The assumption that this population represents a comparable surrogate to the AWB whooping crane population is incorrect. Specific differences for the cross-fostered population include much higher numbers of juveniles in the population, much longer exposure times to powerlines [staging area for SLV vs. stopover site for R-Project area], different behavior responses to human structures (i.e., more tolerant to human structures, larger numbers of cranes [greater sandhill cranes and whooping cranes] occurring together), and different types of habitats used by cranes in SLV compared to the R-Project area. The report relied on the GPS data from marked whooping cranes (i.e., Pearse et al. (2018) determined that whooping cranes in AWB population on average traveled 3.5 miles between roost sites and foraging areas during migration) to arrive at their 3.35 mile hazard zone. Reliance on the GPS data is appropriate, but the assumption that 3.35 miles is an appropriate hazard zone for whooping crane collisions with the R-Project transmission line is not appropriate as there is no scientific consensus on flight altitudes of whooping cranes relative to short distance flights from roost sites to foraging areas. More specifically, the 3.35 mile hazard zone is unsubstantiated and has no scientific underpinnings to justify its inclusion in the report's model for determining whooping crane collision risk. As I stated in Davis (2018), future assessments of collision risk for the AWB population should incorporate data generated from the GPS-marked whooping cranes so that the best available science is considered. In this case, U.S. Fish and Wildlife Service (2018b) did use the best available science, however, a more detailed examination of stopover sites would provide important information on selection of stopover sites in the R-Project area. Additionally, although the GPS data represent the best available science, use of the data to estimate crossings of the proposed R-Project transmission is problematic given the low number of GPS locations per day (4-5 locations) and the unreliable flight altitude data generated by the GPS transmitters (A. Pearse, USGS, personal communication). However, in the recently initiated Phase II of the whooping crane GPS study, the number of locations will be recorded at a much higher frequency (e.g., 1 location per 30 minutes and in special circumstances every 30 seconds over a short period of time; A. Pearse, USGS, personal communication). Consequently, the questions about number of crossings and collision hazard zone may be better answered from this new GPS data. The report assumes that using the correction factor based on Murphy et al. (2016) is appropriate. However, the assumption that data generated from sandhill cranes roosting at night on the Platte River near a powerline crossing the river is incorrect as the conditions at this site are much different than whooping cranes experience at the R-Project area (e.g., number of birds, proximity to the powerline, river crossing, and nocturnal collisions). Finally, I found no problems with the report's determination of population growth estimates to generate the risk of whooping crane collisions over the 50-year life of the R-Project transmission line.

In their current form, I did not find the calculations used in both methods to estimate whooping crane take mathematically correct. For both methods, the issues with the underlying assumptions described above make the calculations provide unrealistic estimates for take. Specifically, the calculations result in considerable overestimations of take. Now, that said, if the issues with these assumptions were considered and the methods modified, the take estimates may be more realistic and scientifically defensible. Further, as I worked through the calculations I found issues with incorrect units, rounding errors, and a lack of logic in some of the calculations. In some cases when I back-calculated to determine how a number was generated (e.g., number of crossing for the cross-fostered population), I still was left with no explanation on how or why the numbers were used in the calculation. Better documentation and a step-by-step description of how the calculations were derived and numbers in the calculations were generated would have allowed me to better understand approaches used for calculating take.

In conclusion, I found the report's final conclusion that during the 50-year life of the transmission line we can expect 40 (Method 1) or 84 (Method 2) whooping crane collisions to be unrealistic due to incorrect assumptions and mathematical errors within the calculations. Consequently, these conclusions to some degree do not match with the biology of the species (e.g., demographics of the AWB population, avoidance behavior of structures, migratory behavior, and flight behavior). However, initiation of the Phase II component of the whooping crane GPS study should reduce speculation about these aspects of whooping crane biology. In terms of our understanding of the future growth of the AWB whooping crane population, I do not disagree with the use of the 3 growth scenarios provided by Wilson et al. (2016). So, in terms of this approach in calculating whooping crane collisions over the life the R-Project transmission line, I think they match up with our scientific understanding of population growth for the AWB population (excluding climate change impacts or major anthropogenic impacts such oil spills). Overall, I found that the report's final conclusion that the R-project transmission line presents a significant threat to the AWB whooping crane population is unfounded as the collision estimates are not scientifically defensible. Further, the estimates are unrealistic and not biologically justifiable.

Task 2: Review the Service 2018(c)—corrected b (Table 1) Whooping Crane Assessment and offer and independent assessment of FWS conclusions.

U.S. Fish and Wildlife Service (2018c) evaluated the scientific merits and plausibility of the 2 methods used by U.S. Fish and Wildlife Service (2018b) to calculate take of whooping cranes for the proposed R-Project transmission line and presented 2 different risk analyses using strikes per crossing based on sandhill cranes surrogate data and a null-hypothesis approach scaled down to the state of Nebraska. I found the review of U.S. Fish and Wildlife Service (2018b) by U.S. Fish and Wildlife Service (2018c) to be very thorough, scientifically rigorous, and based on the best available science. Below, I provide a summary and assessment of the plausibility, scientific basis, and appropriateness of the key points in U.S. Fish and Wildlife Service's (2018c) review.

1. U.S. Fish and Wildlife Service's (2018b) reliance on Brown et al. (1987) is not scientifically defensible and results in substantial overestimations of take for whooping cranes (for both Method One and Method Two) from the R-Project transmission line.

U.S. Fish and Wildlife Service (2018c) provided several reasons for coming to this conclusion:

a. Brown et al. (1987) studied collisions in the cross-fostered population of whooping cranes that staged at SLV (not the AWB whooping crane population).
b. The SLV population was skewed more toward juvenile cranes (47.5%) than the AWB population (13%). U.S. Fish and Wildlife Service (2018c) noted that if the proportion for juvenile birds would have been applied to the AWB population it would have resulted in an overestimation bias of 2.4 fold for number of strikes.
c. U.S. Fish and Wildlife Service (2018b) did not incorporate additional information about powerline strikes from a follow-up study by Brown and Drewien (1995) that documented no whooping crane collisions. According to U.S. Fish and Wildlife Service (2018c), if the data from Brown and Drewien (1995) had be incorporated into U.S. Fish and Wildlife Service's (2018b) Method One, the strike-rate would have been lowered (although it still would have been high because of the high number of juvenile cranes in the population), but instead it was further inflated up to 3.6-fold. d. U.S. Fish and Wildlife Service (2018b) erroneously treated the total number transmission miles monitored during both years of the study as an annual rate thereby adding further error to their calculation of strikes.

My review of U.S. Fish and Wildlife Service (2018b) (see above) reached similar conclusions about the use of data from Brown et al. (1987). The points made by U.S. Fish and Wildlife Service (2018c) are correct and supported by scientific literature. I do not disagree with this evaluation and I provide a similar assessment above in my review of U.S. Fish and Wildlife Service (2018b).

2. Incorporating Murphy et al.'s (2016) nocturnal risk factor of 3.25 was likely not applicable for the R-Project transmission line and would considerably overestimate the nocturnal risk factor for whooping cranes in the Nebraska Sandhills.

U.S. Fish and Wildlife Service (2018c) suggests that the reason that the nocturnal risk factor is not applicable because whooping cranes would likely not need to arrive at roost sites after nightfall in the Sandhills because this region contains substantial amounts of suitable roost habitat as indicated by Pearse et al. (2017). U.S. Fish and Wildlife (2018c) also noted that Kuyt (1992) found that whooping cranes will occasionally arrive at roost sites after nightfall but this typically occurs in landscapes that have scarcity of suitable roost sites. I agree with this point as whooping cranes tend to not arrive at roost sites after nightfall. Further, GPS data from the ABW population shows that whooping cranes rarely fly at night, especially in mid-section of the migration (e.g., Nebraska) (A. Pearse, USGS, personal communication).

3. Several aspects of Method Two (the collisions per crane-day-mile approach) are problematic likely contributed to the higher overestimation of strikes for Method Two compared to Method One.

U.S. Fish and Wildlife Service (2018c) provided several reasons for coming to this conclusion:

a. U.S. Fish and Wildlife Service (2018b) had several miscalculations (e.g., strikes per crane-day-mile was miscalculated such that it actually should have had a value that was twice the value originally calculated), did not use Murphy et al.'s (2016) nocturnal risk correction factor as they did for Method One even though both methods rely on the same data, had a train of logic error in component two of the calculation, and used the wrong unit of measure (i.e., number of strikes per mile instead of number of strikes for the first year).

b. U.S. Fish and Wildlife Service (2018c) attempted to interpret the correct train of logic for calculating take for Method Two, which resulted in a take estimate of 0.02964 whooping crane strikes resulting in a projection of 5 whooping crane collisions over the 50-year life of the R-Project transmission line. This estimate was considerably less than the 84 whooping crane collisions reported by U.S. Fish and Wildlife Service (2018b).

I agree with U.S. Fish and Wildlife Service's critique of Method Two. I similarly worked through the calculations and could not follow the logic for some of the components. I also came to the same conclusion that until the logic behind these calculations are better explained and justified that the take estimates from this method are meaningless. The fact that U.S. Fish and Wildlife Service (2018c) actually attempted to correct the issues with Method Two and was able to arrive at a significantly lower (and likely more realistic) take estimate further reinforces the problematic nature of Method Two.

4. Use of sandhill crane collision data as a surrogate for whooping cranes reduced uncertainty of estimating take for Method One and produced a substantial reduction in the take estimate.

Given the availability of data documenting sandhill crane collisions from the SLV (Brown et al. 1987, Brown and Drewien 1995) and Platte River (Morkill and Anderson 1991, Ward and Anderson 1992) and the relatively large sample sizes provided by these studies, U.S. Fish and Wildlife Service (2018c) applied a sandhill crane-based strike rate to Method One to reduce the uncertainty of relying on the rare event of whooping crane collisions and increase precision in estimating take. U.S. Fish and Wildlife Service (2018c) standardized the data (only unmarked and unaltered transmission lines were included) among the studies and then pooled the results to determine number of strikes per 100,000 sandhill crane crossings based on directly observed sandhill crane crossings (a more accurate and reliable estimate of crossings). U.S. Fish and Wildlife Service (2018c) calculated a strike-rate of 2.6/100,000 crossings and then multiplied this value by 1.5 for the increased vulnerability of whooping cranes to powerline collisions relative to sandhill cranes (based on differences in wingspan ratio and body size between whooping cranes and sandhill cranes). From this calculation, the estimated strike per 100,000 whooping crane crossings is 3.9 for unmarked transmission lines, which is an 86.7-fold difference in the estimated strike rate (338 strikes per 100,000 whooping crane crossings) reported by U.S. Fish and Wildlife Service (2018b). Further, applying the 86.7-fold reduction to U.S. Fish and Wildlife Service's (2018b) would reduce the number of strikes for the life of the R-Project transmission line from 40 collisions to 0.46 collisions for unmarked lines with a further reduction for marked lines.

I found this approach to be scientifically sound and the level of uncertainty was significantly reduced. It eliminates the issues with using the cross-fostered whooping cranes as well as the other issues with U.S. Fish and Wildlife Service's (2018b) calculation of Method One (e.g., estimate of crossings, nocturnal collision factor, uncertainty of values). U.S. Fish and Wildlife Service (2018c) based these estimates from data on sandhill crane crossings and collisions from actual field observations. Further, U.S. Fish and Wildlife Service (2018c) was able to standardize the data based on type of transmission line (unmarked/unaltered vs. marked) to more accurately reflect the situation for the R-Project transmission line. It is clearly justifiable to use the vulnerability factor to more accurately reflect the increased vulnerability of whooping cranes to powerlines. Sandhill cranes are certainly not whooping cranes, but given the approach taken by U.S. Fish and Wildlife Service (2018c), I do think that the estimate provides an indication of the potential strike rate for whooping cranes by the R-project transmission line.

5. A null-hypothesis approach (the R-Project transmission line will be no more or less hazardous than the average level of hazard from existing transmission lines on the Nebraska landscape) that relies on our knowledge about the AWB whooping crane population, the migratory corridor landscape, and details about the R-Project transmission line (without relying upon the SLV whooping crane data) further indicates a low risk of whooping crane strikes over the life of the R-project transmission line (i.e., 0.58 whooping crane strikes).

This approach is a rather simplistic approach, but the approach relies on information that is of reasonable certainty (e.g., post-fledgling mortality for AWB population, daily mortality rates for AWB population, proportional use of migration in the U.S.) and the best available information about transmission line collisions for the AWB population. There are certainly some uncertainty about the number of collisions that occur in AWB population due to biases associated with recovery of carcasses, but it is not unreasonable to assume these estimates provide best professional judgment on the role powerline strikes play in the overall migratory mortality of the

AWB population (i.e., proportion of mortality attributed to powerline collisions). In my opinion, this approach is appropriate and mathematically and biologically valid. This exercise reinforces the estimates from the previous risk analysis and further suggests the estimates provided by U.S. Fish and Wildlife Service (2018b) substantially overestimated the risk of the R-Project transmission line to whooping cranes.

Task 3: Review the NPPD 2018 (Table 1) Whooping Crane Assessment and offer and independent assessment of NPPD conclusions.

NPPD (2018) used a mathematical approach to assess the risk of the R-Project transmission line to whooping crane collisions. Compared to the other approaches, NPPD's (2018) approach is fairly straightforward in that they relied on data such as historic collision data for the AWB population and known transmission miles for the AWB migratory corridor in the U.S. This approach is essentially the same approach that NPPD used to calculate risk in the HCP (NPPD 2017). However, NPPD (2018) noted that they did consider a risk-assessment approach that relied on exposure to power lines (i.e., relationship of mortality to number of times cranes cross power lines) similar to the approach used by Ecosystems Advisors (2017), but deemed that approach unreliable and inappropriate because of the lack of exposure-rate data for AWB population, unverified assumptions that would be required to estimate exposure from existing whooping crane GPS locations, and inconsistent results from existing literature of exposure-rates that suggest limited applicability to other areas as well as the possibility that other factors may be influencing collision rates. NPPD (2018) further indicated that use of the whooping crane GPS data could have been utilized for their analysis (as was suggested during the comment period for the draft Environmental Impact Statement), but it was not possible since no tagged whooping cranes collided with powerlines during the study. Finally, given the concerns raised in the previous reviews (U.S. Fish and Wildlife Service 2019) of the risk-exposure model developed by Ecosystems Advisors (2017), NPPD (2018) concluded that at this time no appropriate data are currently available for these types of models to be used for assessing risk of the AWB population to the R-Project transmission line. Consequently, they concluded that the most appropriate approach was to estimate risk based on number of collisions as compared to number of miles of powerlines.

For their approach, NPPD (2018) initially calculated number of whooping crane collisions based upon our current knowledge on whooping crane mortalities throughout their annual cycle (i.e., mortalities are proportional to the amount of time whooping cranes in the AWB population spend in each component of their life cycle; Pearse et al. 2018). So, given that whooping cranes spend approximately 17% of their annual cycle engaged in migration, NPPD (2018) applied that proportion to the total mortalities (546) reported in Stehn and Haralson-Strobel (2014) from 1950-2010 to arrive at 93 migratory mortalities. However, determining cause-specific mortality during migration was restricted to 28 recovered carcasses. Of those 28, only 1 of the mortalities was a confirmed transmission line collision. Based on this calculation, NPPD (2018) applied this rate to the 93 estimated migratory mortalities to arrive at an estimate of 4 whooping crane collisions occurring in the migration corridor from 1956 to 2016 resulting in a rate of 0.067 crane collisions/year. Further, NPPD (2018) then applied that collision rate to the total number of miles of transmission lines that occur in the migration corridor (0.067 crane collisions/yr/34,000 mi) to produce a collision risk of 0.00000197 whooping crane collisions/mi/year that was applied to the proposed length of the R-project transmission to arrive at annual risk of 0.00044 cranes per year (225 mi*0.00000197 cranes/mi/year) and risk of 0.022 cranes per the 50-year life of the transmission line (0.00044*50). This result assumes equal risk across the entire 225 mile route for the R-Project transmission line. NPPD (2018) further conducted a sensitivity analysis to determine how a reduction in suitable habitat near the powerline would affect risk of collision. From this sensitivity analysis, risk increased to 0.044 collisions during life of the project if 50% of the habitat within 1 mile of the transmission line was suitable and 0.22 collisions during life of the project if 10% of the habitat within 1 mile was suitable. NPPD (2018) justified this approach based on the following reasons: 1. There is no defensible method for correlating habitat quality to collision risk, 2. According to whooping crane GPS data (Pearse et al. 2015), areas of high-density habitat do not necessarily have high use by whooping cranes, 3. Collisions where land cover was documented occurred in agriculture lands (Stehn and Wassenich 2008), and 4. Wetland habitat is so plentiful within the migratory corridor that determination of suitable stopover habitat was not undertaken. Basically, NPPD (2018) argued that the uncertainty associated with including a habitat quality parameter is too great to provide reliable and meaningful collision estimates such that the results would not be scientifically defensible. Further, by including a sensitivity analysis, they argued they were still able to account for the effects of habitat quality (i.e., suitable vs. unsuitable habitat) along the proposed route for the R-Project.

In my previous evaluation, I had reservations about this approach because it did not incorporate an exposure rate or distinguish suitable from unsuitable whooping crane habitat associated with the proposed route of the R-Project transmission line and recommended exploring an approach described in Shaw et al. (2010). However, I recognize that approaches such as Shaw et al. (2010) require extensive collision and exposure data that are not available for the AWB population. Moreover, in the absence of such data, a considerable amount of speculation and unsubstantiated assumptions about whooping crane habitat use and flight patterns are required that will likely increase the uncertainty of producing reliable estimates. So, in the absence of such data being available, the approach taken by NPPD (2018) does provide a plausible level of risk for whooping crane collisions given the paucity of collision data for AWB population. Further, their sensitivity analysis suggests higher levels of risk when lines near suitable habitat are only considered (i.e., 0.022 increased to 0.22 if only 10% of the lines are near suitable habitat). In general, NPPD's (2018) take assessment is based on the best science available (i.e., the whooping crane satellite data, collision rate for whooping cranes). NPPD (2018) did not include the location data from the satellite study in their analysis given the limitations of interpreting the data relative to collisions, but they did use the data to determine how often whooping cranes are within one mile of a transmission line during migration and used these results to further justify their approach. This analysis did incorporate the mortality estimates from the satellite data into their calculations. Obviously, the major driver for assessing the risk of collision strikes is availability of collision data for the AWB population. Unfortunately, our understanding of whooping crane collisions with powerlines for the AWB population is very limited as there have only been 10 documented collisions for this population and only one documented transmission line collision over 60 years of monitoring (Stehn and Haralson-Strobel

2014). Additionally, none of the 58 satellite transmitter-marked whooping cranes collided with transmission lines during the 6 years of monitoring. Based on this information, I would say the NPPD (2018) used the best available collision data, but I would also caution that these data do present a level of uncertainty because of the biases associated with detecting these mortalities.

NPPD (2018) did not include a population growth parameter in their model, but rather assumed that neither the increased population of whooping cranes nor the increased number of miles of powerlines would correspond to an increase in collision mortality. NPPD (2018) based this assumption on the fact that there has not been a corresponding increase in powerline collisions over the last 60 years when both the whooping crane population and miles in powerlines increased (see Figure 2 in NPPD [2018]). Again, based on the limited amount of collision data for the AWB population, this inference can be made but the biases associated with these data limits its certainty. That said, if NPPD (2018) incorporated a population growth parameter in their model, it does not appear it would result in a significant change to their risk estimate.

Overall, NPPD's (2018) simplistic, logical, mathematical approach for calculating collision risk of the R-Project transmission line to whooping cranes is an acceptable approach that is generally based on scientifically defensible assumptions. A risk-exposure approach may be able to provide a more accurate estimate of collisions, but I really do not believe that the risk estimate would be significantly changed given our current knowledge about collisions for the AWB population.

Task 4: Review the FWS document "A Review and Critique of Risk Assessments Considered by the U.S. Fish and Wildlife Service Regarding the Collision Risk for Whooping Cranes with NPPD's R-Project" and offer an independent opinion on the conclusions reached by U.S. Fish and Wildlife Service.

It is my opinion that U.S. Fish and Wildlife Service (2019) based their conclusion that incidental take of whooping cranes is not reasonably certain to occur during the life of the R-Project transmission line is scientifically defensible and represents a thorough evaluation of the best available data, relevant literature, and understanding of whooping crane biology. I concur with U.S. Fish and Wildlife Service (2019) that the risk estimates produced by U.S. Fish and Wildlife Service (2018b) were unrealistic and highly suspect due to incorrect assumptions and mathematical errors within the calculations. Further, I agree with U.S. Fish and Wildlife Service (2019) in their acceptance of U.S. Fish and Wildlife Service's (2018c) assessment as plausible and scientifically defensible. U.S. Fish and Wildlife Service (2018c) was able to demonstrate that there was a low likelihood of whooping cranes colliding with the R-Project transmission line. Moreover, they were able to demonstrate that incorporation of the satellite data did not significantly change the risk estimate and in fact, the risk estimate was similar to an assessment that relied on existing information about the AWB population (i.e., 0.46 vs. 0.58). Additionally, NPPD's (2018) risk estimate (though they used a different approach) was similar to the estimates produced by U.S. Fish and Wildlife Service (2018c), which further indicates a low likelihood of take for the R-Project transmission line. The bottom line is that whooping crane collisions are a rare event, which also suggests that the likelihood of increased whooping crane collisions will be low. Overall, I believe U.S. Fish and Wildlife Service (2019) acted in a transparent and unbiased manner in arriving at their conclusion. I am confident that U.S. Fish and Wildlife Service (2019) relied on the best available data and information and weight of evidence to arrive at their conclusion.

References

Brown W. M., and R. C. Drewien. 1995. Evaluation of two power line markers to reduce crane and waterfowl mortality. Wildlife Society Bulletin 23:217-227.

Brown, W. M., R. C. Drewien, and E. G. Bizeau. 1987. Mortality of cranes and waterfowl from powerline collisions in the San Luis Valley, Colorado. Pages 128-136 in J. C. Lewis and J. W. Ziewitz, eds. Proceedings of the 1985 Crane Workshop, Platte River Whooping Crane Habitat Maintenance Trust and U.S. Fish and Wildlife Service, Grand Island, NE.

Davis, C. A. 2018. Review of Whooping Crane Risk Assessment Documents for the Draft Environmental Impact Statement on the Issuance of an Incidental Take Permit and Implementation of a Habitat Conservation Plan of the R-Project Line. Unpublished Report. 21 pp.

Ecosystem Advisors. 2017. Scientific analysis and comments regarding the R-Project draft habitat conservation plan and potential impacts to the endangered whooping crane: analysis of whooping crane powerline collision risk. 39 pp.

Faanes, C. L. 1987. Bird Behavior and Mortality in Relation to Power Lines in Prairie Habitats. U.S. Department of the Interior, Fish and Wildlife Service, Fish and Wildlife Technical Report 7, Washington, D.C. 24 pp.

French, J. B., Jr., S. J. Converse, and J. E. Austin. 2018. Whooping crane past and present. Pages 3-16 in J. B. French, Jr., S. J. Converse, and J. E. Austin, eds. Whooping Cranes: Biology and Conservation, Academic Press, London.

Headwaters. 2018. Whooping crane telemetry study report. Prepared for Nebraska Public Power District, February 2018. Headwaters Corporation, Kearney, NE. 24 pp.

Kuyt, E. 1992. Aerial radio-tracking of whooping cranes migrating between Wood Buffalo National Park and Aransas National Wildlife Refuge, 1981-84. Occasional Paper No. 74, Canadian Wildlife Service. 53 pp.

Loss, S. R., T. Will, and P. P. Marra. 2014. Refining estimates of bird collision and electrocution mortality at power lines in the United States. PLoS One 9:e101565.

Morkill, A. E., and S. H. Anderson. 1991. Effectiveness of marking powerlines to reduce sandhill crane collisions. Wildlife Society Bulletin 19:442-449.

Murphy, R. K., E. K. Mojica, J. F. Dwyer, M. M. McPherron, G. D. Wright, R. E. Harness, A. K. Pandey, and K. L. Serbousek. 2016. Crippling and nocturnal biases in a study of sandhill crane (*Grus candadensis*) collisions with a transmission line. Waterbirds 39:312-317.

NPPD. 2017. R-Project Draft Habitat Conservation Plan. Nebraska Public Power District, Columbus, NE. 258 pp.

NPPD. 2018. R-Project whooping crane mortality risk assessment. Unpublished Report. 18 pp.

Pearse, A. T., D. A. Brandt, W. C. Harrell, K. L. Metzger, D. M. Baasch, and T. J. Hefley. 2015. Whooping Crane Stopover Site Use Intensity within the Great Plains. U.S. Geologic Survey Open-File Report 2015-1166, U.S. Geologic Survey, Reston, VA. 12 pp.

Pearse, A. T., M. J. Harner, D. M. Baasch, G. D. Wright, A. J. Caven, and K. L. Metzger. 2017. Evaluation of nocturnal roost and diurnal sites used by whooping cranes in the Great Plains, United States. Open-file Report 2016-1209. United States Geological Survey, Reston, VA. 29 pp.

Pearse, A. T., D. A. Brandt, B. K. Hartup, and M. T. Bidwell. 2018. Mortality in Aransas-Wood Buffalo whooping cranes: timing, location, and causes. Pages 125-138 in J. B. French, Jr., S. J. Converse, and J. E. Austin, eds. Whooping Cranes: Biology and Conservation, Academic Press, London.

Shaw, J. M., A. R. Jenkins, J. J. Smallie, and P. G. Ryan. 2010. Modeling power-line collision risk for the blue crane *Anthropoides paradiseus* in South Africa. Ibis 152:590-599.

Stehn, T. V., and T. Wassenich. 2008. Whooping crane collisions with power lines: an issue paper. Proceedings of the North American Crane Workshop 10:25-36.

Stehn, T. V., and C. L. Haralson-Strobel. 2014. An update on mortality of fledged whooping cranes in the Aransas/Wood Buffalo Population. Proceedings of the North American Crane Workshop 12:43-50.

Urbanek, R. P., and J. C. Lewis. 2015. Whooping Crane *(Grus americana*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bna.153

U.S. Fish and Wildlife Service. 2017. Draft Environmental Impact Statement of Issuance of an Incidental Take Permit and Implementation of a Habitat Conservation Plan for the R-Project Transmission Line. Nebraska Ecological Services Field Office, Wood River, NE. May 12, 2017.

U.S. Fish and Wildlife Service. 2018b. Take Calculation for Whooping Cranes (*Grus americana*) for the Nebraska Public Power District's R-Project Transmission Line. September 10, 2018.

U.S. Fish and Wildlife Service. 2018c. Review of "Take Calculation for Whooping Cranes (*Grus americana*) for the Nebraska Public Power District's R-Project Transmission Line. September 10, 2018 Draft Prepared by the Nebraska Field Office (NEFO) of the U.S Fish and Wildlife Service (USFWS); and a Proposed Use of Reasonably Certain Knowledge to Assess the Risk of Power-line Strikes for the R-Project". U.S. Fish and Wildlife Service Regional Office, Denver, CO. 20 pp.

U.S. Fish and Wildlife Service. 2019. A Review and Critique of Risk Assessments Considered by the U.S. Fish and Wildlife Service Regarding the Collision Risk for Whooping Cranes with NPPD's R-Project, January 30, 2019.

Ward, J. P., and S. H. Anderson. 1992. Sandhill crane collisions with power lines in southcentral Nebraska. Pages 189-196 in Proceedings of the 1988 North American Crane Workshop, North American Crane Working Group.

Wilson, S., K. C. Gil-Weir, R. G. Clark, G. J. Robertson, and M. T. Bidwell. 2016. Integrated population modeling to assess demographic variation and contributions to population growth for endangered whooping cranes. Biological Conservation 197:1-7.

Wilson, S., and M. T. Bidwell. 2018. Population and breeding range dynamics in the Aransas-Wood Buffalo whooping crane population. Pages in J. B. French, Jr., S. J. Converse, and J. E. Austin, eds. Whooping Cranes: Biology and Conservation, Academic Press, London.