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Review and Assessment of Compensatory Mitigation Options for Golden Eagle Take Permits in the Northeastern USA

Task 4

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Summary

Permitted take of Golden Eagles at wind energy facilities east of the 100th meridian was prohibited until 2016 when changes in regulations allowed such permits to be authorized. Any facility that is granted a take permit must off-set predicted take with compensatory mitigation. To date, permits have only been authorized in the western USA, where the only type of compensatory mitigation used has been retrofitting of power poles to reduce frequency of electrocution of eagles. Because of the differences in behavior and habitat use by eagles in the east and west, it is important to assess the applicability of that and other possible mitigation actions to Golden Eagles in the eastern USA. I reviewed sources of mortality and assessed possible mitigation measures that could be implemented to offset take. I compared mitigation actions to the U.S. Fish and Wildlife Service requirements for compensatory mitigation. I found that in eastern North America, electrocutions have not been reported and that the most pervasive sources of mortality in the region are lead poisoning and by-catch in traps set for mammals. Among potential mitigation actions, only lead abatement programs meet the Service's requirements and are likely to have the desired affect of reducing mortality to offset take.

Introduction

Wind power is an important part of international strategies to reduce carbon emissions to combat climate change (American Wind Energy Association [AWEA]). As such, it has expanded considerably over the last two decades. However, this expansion has come at a cost to wildlife, especially eagles and bats (Smallwood and Thelander 2008, Tabassum-Abbasi et al. 2014). To minimize the effects of wind energy on eagles, and because both Bald and Golden Eagles are federally protected under the Bald and Golden Eagle Protection Act (BGEPA), the United States Fish and Wildlife Service (USFWS) introduced strategies outlined in an Eagle Permit Rule (USFWS 2009 and USFWS 2016*a*) and an Eagle Conservation Plan Guidance (ECPG; USFWS 2013). These frameworks provide wind energy companies the ability to obtain a permit to incidentally "take" (in this case, incidentally cause the mortality or injury of) eagles west of the 100th meridian. The 2016 revision of the Rule allowed for the establishment of an Eagle Management Unit (EMU; a geographic area "where permitted take is regulated to meet the population objective") delineated by the Mississippi and Atlantic Flyways for take of Golden Eagles east of the 100th meridian. The 2016 revision also modified the BGEPA to "maintaining the persistence of local populations."

The USFWS conducted analyses and reviews of nationwide Golden Eagle population trends and causes of mortality (Katzner et al. 2012, Millsap et al. 2013, USFWS 2016*b*) and determined that the existing level of unpermitted take (estimated at 10%) was the maximum that the species could incur without declining. Thus, permitting additional take in any EMU was not compatible with the USFWS objective of increasing or sustaining populations at current levels. The USFWS, therefore, instituted a policy of "no net loss" for the species, which means that take limits are set to zero unless take is compensated for by mitigation. Compensatory mitigation is a specific conservation action that decreases mortality or increases productivity, such that the result is "no net loss" of individuals.

There are several requirements for a conservation action to meet USFWS requirements of compensatory mitigation (USFWS 2016*a*).

1. Mitigation must occur in the same EMU as the wind facility where the permit was authorized, unless take includes individuals that likely use another EMU seasonally.
2. Actions must be monitored using the best available science to demonstrate long-term effectiveness.
3. Actions must be quantifiable to ensure that the action is achieving the intended goals; adaptive management actions should be taken when necessary to meet the intended goals.
4. There must be credible evidence that an action will result in the desired effect of “no net loss” of individuals, such that the result would not have occurred without compensatory mitigation.
5. The action must maintain its intended purpose for the duration of the authorized take.
6. The action must include a means to account for and address uncertainty and possible failure of the measure.

Take permits for Golden Eagles have been authorized at only a few wind facilities in the western USA (Allison et al. 2017). None have been issued for projects east of the 100th meridian. At this time, only one type of mitigation action, power pole retrofitting to prevent electrocution of eagles, has been used and approved by USFWS. However, the Service noted the need for additional mitigation options (USFWS 2016*a*). Other options are mentioned in the ECPG and the Eagle Rule Revision include removal of road-killed wildlife to reduce eagle collisions with vehicles, lead abatement, habitat-based conservation banks, and support of eagle rehabilitation centers (USFWS 2013, 2016*c*, *a*).

The purpose of this report is to provide an expert opinion of useful compensatory mitigation options for the eastern Golden Eagle EMU. This opinion is based on expert knowledge of this population (Appendix A), literature review, the Eagle Rule and Rule Revision, and the ECPG (USFWS 2009, 2013, 2016*a*).

Methods

I took a multi-step approach to assess potential mitigation options for Golden Eagles in eastern North America. To understand which anthropogenic causes of mortality affect the eastern population, I conducted a literature review, an informal survey of wildlife rehabilitators, and a review of mortality data and other information from telemetered eagles that my research group and I have collected in eastern North America since 2005 (authors unpublished data). I then ranked causes of anthropogenic mortality by number of reported deaths or injuries and other metrics describing the pervasiveness of the problem (see below for details). I linked each type of mortality to a plausible compensatory mitigation actions and assessed each action to determine if the USFWS requirements for compensatory mitigation were met.

Causes of Mortality

Research summaries

The USFWS analyzed mortality data for 139 satellite tagged Golden Eagles from 1997-2013 (USFWS 2016*b*). They summarized and extrapolated that information across the entire North American population, which assumes that all types of mortality are equal across the population. The top sources of anthropogenic mortality for the entire North American population in order of estimated deaths per year were shooting, poisoning (non-lead), collision with vehicles, electrocution, incidental capture in mammal traps, and lead poisoning.

However, there is geographic variation in causes of mortality. This is illustrated by a report by Russell and Franson (2014) on the causes of mortality of Bald and Golden Eagles from across the USA submitted to the National Wildlife Health Center (NWHC) in Madison, WI from 1975-2013. This data set consisted of 1,427 records including 28 Golden Eagles from the Atlantic Flyway and 79 from the Mississippi Flyway. To compare among regions, they calculated the proportion of individuals that died from each cause. Causes of death (ranked in order of abundance) for the Atlantic Flyway are shooting/trapping, trauma (vehicle collisions, etc.), and poisoning (including lead poisoning). Poisoning included all types of poisoning with lead accounting for 58.1% of all poisoned individuals. No electrocutions were submitted from the Atlantic Flyway. In contrast data from the western USA indicated that electrocutions represented >25% of mortalities.

It is important to consider this geographical variation when assessing potential mitigation options for eastern North America. The one paper on conservation status of eastern Golden Eagles (Katzner et. al 2012) specifically mentioned risk from incidental capture in mammal traps, lead poisoning, and collision. Over the past 13 years, the author's research team has tracked 95 eagles in eastern North America. We have documented 14 mortalities and determined the cause of death for 9 of those (some of these were included in the FWS report above (USFWS 2016b). These causes of death are similar to those of Russell and Franson (2014). Three eagles died from natural causes and 6 from anthropogenic causes. Of those six, four were killed in traps in Canada and 2 died of lead poisoning, one in Canada and one in West Virginia. None of these birds were electrocuted on power lines.

Similarly, we surveyed wildlife rehabilitators in Pennsylvania, Virginia, and West Virginia about Golden Eagles they received. Injuries they incurred included collision with power lines and trains, and incidental capture in leg-hold or snare traps, and lead poisoning (W. Perrone, personal observation). None of these birds were electrocuted and they reported no knowledge of any electrocutions of Golden Eagles in their area.

Detail on causes of death

Here, I briefly summarize causes of death of eagles and discuss how those causes of death vary in eastern and western North America. I focus on the causes of death highlighted by USFWS (2016).

Shooting is a persistent problem for all eagles and other raptors. From 1960-1995, 15% of known eagle deaths were due to shooting (Franson et al. 1995). Similar results were reported for telemetered birds from 1997-2013 in the USFWS study (USFWS 2016*b*). Golden Eagles in the eastern US tend to occupy forested habitats in remote areas away from humans (Katzner et al. 2012, Miller et al. 2017). In contrast, western Golden Eagles occupy open areas and often perch on power poles where they are easy targets for shooting. Nonetheless, shooting of eagles is a widespread problem, but probably goes un-reported (The Wildlife Society 2018).

Trauma from collision is a source of mortality in Golden Eagles in the Atlantic Flyway (Russell and Franson 2014). Eagle mortality from collisions with vehicles in the western USA is estimated to be 1% annually (USFWS 2016*b*), although in one year more than 1,000 eagles of both eagle species were collected along Wyoming roadways (Phillips 1986). In contrast, Golden Eagle collisions with vehicles in the Atlantic Flyway are likely a very rare event considering that road-killed birds tend to be easily found and only ~7 individuals were turned in to the NWHC over a 38 year period (Russell and Franson 2014). Golden Eagles regularly feed on carrion. Because vehicles including cars, trucks and trains, hit animals crossing roadways and train tracks, carrion is regularly found in these corridors. Eagles are large and thus they are slow to get off the ground when a vehicle approaches, putting them at risk of collision with the vehicle. Even so, reports of Golden Eagles hit by cars or trains are generally rare in the Atlantic Flyway. This may be because eagles in the region Golden Eagles tend to be found in remote mountainous areas (Katzner et al. 2012), and thus are less frequently hit by vehicles than are eagles in the American west.

Incidental capture in mammal traps is a widespread problem, occurring throughout the eastern range of Golden Eagles and especially in Québec (Katzner et al. 2012, Fitzgerald et al. 2015). Incidental capture is not considered a primary threat in much of the western USA (USFWS 2016b), except for in Alaska (C. McIntyre, personal communication). Mammal trapping is legal in the USA and Canada, but some states place restrictions on some types of traps. For instance, leg-hold traps are legal in New York, but snares are not (Iossa et al. 2007). Conversely, snares are legal in New Jersey, but leg-holds are banned. Eagles can be incidentally captured in either type of trap (Bortolotti 1984). Most captures in traps occur in November and December, when eagles are migrating or on wintering grounds and when Golden Eagles rely more heavily on carrion as a food source (Bortolotti 1984). In addition to the 4 of our tracked Golden Eagles that have been killed in traps, we have put telemetry units on 2 eagles that were captured incidentally in mammals traps in New Jersey and West Virginia. We also had an adult female with a telemetry unit get captured in a leg-hold trap in Michigan. Finally, numerous eagles of both species have been observed and photographed passing hawk watches with leg-hold traps still attached or with broken-off snares dangling around their neck (T. Katzner personal communication, authors unpublished observations).

Lead poisoning from spent rifle ammunition is a well-documented cause of mortality of Golden Eagles (Kramer and Redig 1997, Wayland and Bollinger 1999, Fisher et al. 2006, Hunt et al. 2006), with additional effects on reproduction and fitness (Burger 1995). Recent analyses of lead poisoning in Golden Eagles indicated that the problem is pervasive and widespread, and the eastern population has higher exposure to lead than do western populations (Fig. 1). Moreover, lead poisoning may be an underestimated cause of mortality because birds that are opportunistically collected tend to be found close to human habitations, which may bias the actual distribution of mortalities (Crandall et al. 2019). Sub-lethal lead poisoning causes behavioral changes in birds (Ecke et al. 2017), which can increase risk of mortality from other causes, such as collision (Kelly and Kelly 2005, Helander et al. 2009). Overall, there is ample evidence that lead poisoning is a pervasive source of mortality and that sampled individuals from New York to Alabama have been exposed to lead (Fig. 2). For example, 74% of 57 individuals that our team has sampled had lead levels in excess of background levels (10 – 40 µg/dL) and 18% had sub-clinical lead levels (>40 µg/dL).

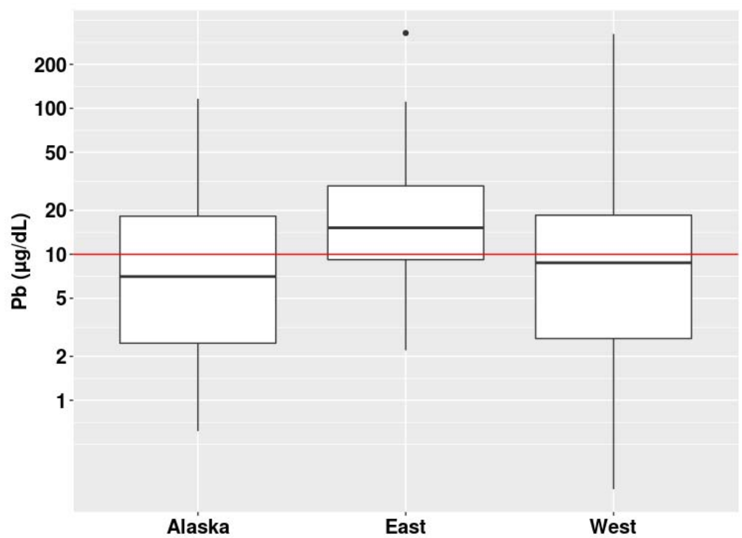

Figure 1. Boxplots of blood lead concentrations of free flying golden eagles (nestlings excluded) captured between the months of November and April from 2010 – 2018; in Alaska (n = 21), the Appalachian Mountains (East; n = 55), and the western US (west; n = 206). The red line on the y axis represents the minimum threshold for background lead levels (10 µg/dL). Boxplots are presented on a log scale to limit the y axis for graphical representation of the data. Whiskers are extended to include extreme data points. We used the Peto and Peto modification of the Gehan-Wilcoxon test for censored datasets in package 'NADA' in program R to test for differences in blood lead concentrations. There was no difference in blood lead concentrations in golden eagles from Alaska and the West ($p = 0.9$, $\chi^2 = 0$, $df = 1$). However, golden eagles from the East had higher blood lead concentrations than their counterparts from Alaska ($p = 0.01$, $\chi^2 = 6$, $df = 1$) and the West ($p = < 0.001$, $\chi^2 = 20.3$, $df = 1$). From Slabe et al. (*in prep*).

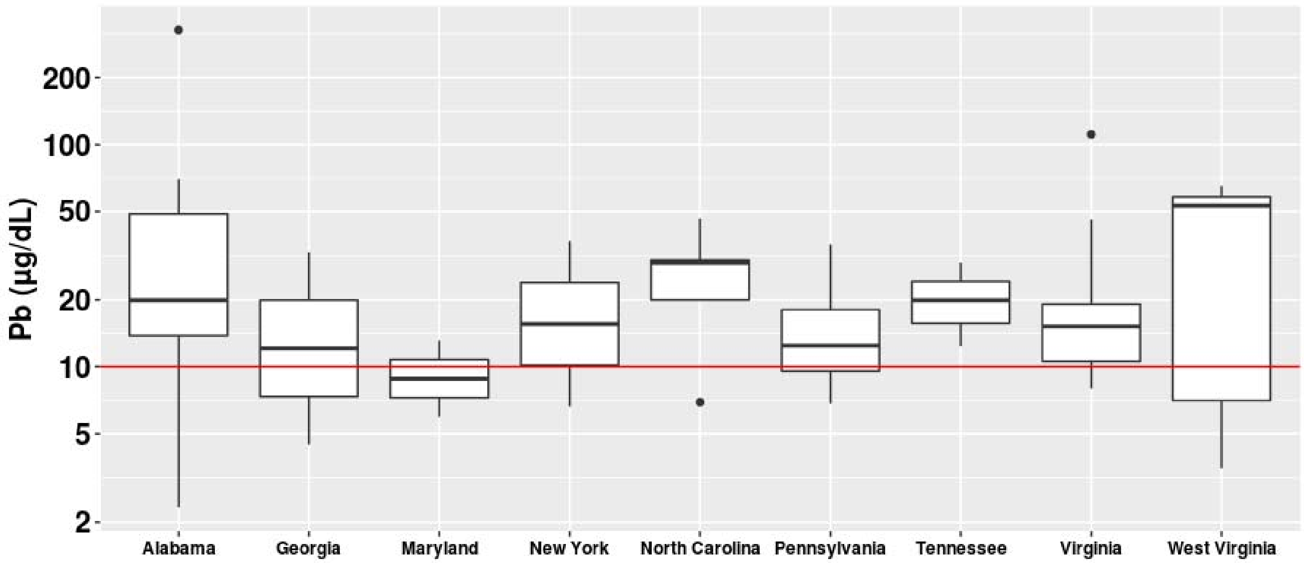

Figure 2. (a) Boxplots of blood lead concentrations of adult (n = 20) and subadult (n = 35) golden eagles captured between 2011 – 2017 in (b) Alabama (n=14), Georgia (n=2), Maryland (n=2), New York (n=2), North Carolina (n=5), Pennsylvania (n=7), Tennessee (n=3), Virginia, (n=17) and West Virginia (n=5) USA. The red line on the y axis represents the minimum threshold for subclinical lead poisoning (10 µg/dL). Boxplots are presented on a log scale to limit the y axis for graphical representation of the data. Whiskers are extended to include extreme data points. From Slabe et al. (*in prep*).

Electrocution is not a threat to Golden Eagles in the Atlantic Flyway. This is based not only on the fact that few if any Golden Eagles have been documented to be electrocuted in the Atlantic Flyway, but also because Golden Eagle behavior and habitat use in the Atlantic Flyway differs considerably from that of western populations where electrocution is an important source of mortality. In contrast to Golden Eagles that regularly perch on power poles in western regions, Golden Eagles in the Atlantic Flyway use forested habitats almost exclusively during the winter and >75% during migration (Duerr et al. *in press*, Miller et al. 2017). Because Golden Eagles in the east use forests and forest edges to such a high degree, there are an abundance of natural perches, e.g., trees, available that power poles are rarely used and thus electrocutions have not been reported.

Assessment of Mitigation Options

The review of anthropogenic sources of mortality suggest that the most important causes of concern for injury and mortality in the Atlantic Flyway are shooting, trapping, trauma, and lead poisoning. Based on this information, I considered four options for compensatory mitigation. These were education outreach to deter shooting, education outreach to decrease incidental trapping, road-kill removal programs to reduce vehicle collisions and lead abatement programs to reduce lead poisoning. Electrocution is not reported as a cause of death of eastern Golden Eagles. That said, I also considered retrofitting of power poles to reduce electrocutions because this is currently the only compensatory mitigation action that has been used to offset take at wind energy facilities.

Educational Outreach to Deter Shooting and Decrease Incidental Trapping

Educational outreach to deter shooting and educational outreach to decrease incidental trapping have not, to date, been sufficiently studied for there to be credible evidence that these are viable options for compensatory mitigation. Although incidental trapping is likely one of the highest sources of mortality and injury for the Atlantic Flyway, no current models exist to support actions to reduce trapping that would meet the USFWS requirements for compensatory mitigation. As such, I cannot at this time recommend this option for compensatory mitigation. However, if more permits are expected to be issued in the eastern US, it is be important to explore this as a mitigation option in eastern North America.

Power Pole Retrofitting to Reduce Electrocutions

Electrocution is not an important source of mortality for the population of Golden Eagles in eastern North America (Russell and Franson 2014). As such, power pole retrofitting does not meet the requirements that USFWS imposes for compensatory mitigation. Specifically, there is not credible evidence that the action will result in "no net loss" of individuals" and there is not evidence that the mitigation measure would affect individuals in the EMU population. As such, I cannot recommend this option for compensatory mitigation in eastern North America.

Road-kill Removal to Reduce Vehicle Collisions

Road-kill removal for compensatory mitigation was studied in Wyoming (Lonsdorf et al. 2018). According to the model, collision risk with a vehicle is related to road-killed carcass size and availability, carcass persistence (including natural decay and removal by road crews), eagle density, traffic volume, and collision risk. Although the authors suggest that the model could be applied to other regions, it is unlikely that this would prove to be a viable mitigation option for the Atlantic Flyway. In particular, the very low rate of vehicle collisions (see above) is problematic. Although predicted take for a wind facility is typically <1 eagle/year (Allison 2012), given the low risk of Golden Eagle vehicle collisions and the low density of eagles, effort needed to remove carcasses to even reach that level would be likely very high. Moreover, as most eastern states already have existing carcass removal programs, it is unlikely that there would be additional effects of further attempts to remove carcasses from roadways. As such, I cannot recommend this option for compensatory mitigation in eastern North America.

Lead Abatement Programs to Reduce Mortality from Lead Poisoning

Lead poisoning is one of the most important causes of death of eagles in eastern North America and there are abatement mechanisms for this threat. As such, lead abatement programs make the most logical sense as a compensatory mitigation action to offset take in the Atlantic Flyway. There are six specific reasons for this. First, there is ample sound scientific evidence that the problem causes mortality and is pervasive throughout the Atlantic Flyway. Second, high hunter compliance with voluntary switching from lead to non-lead ammunition can be achieved with proper education (Seig et al. 2009). Third, there is sound scientific evidence that lead abatement programs work to reduce exposure of scavenging birds, including Golden Eagle, to lead (Green et al. 2008, Kelly et al. 2011). Fourth, there is existing credible scientific evidence that supports lead abatement programs as a compensatory mitigation practice (Cochrane et al. 2015). Fifth, it complies with the requirements USFWS imposes for compensatory mitigation – the threat is in the same EMU as the birds and the take. Sixth, there is good science to support this action, it is quantifiable through models, there is credible evidence that the action will result in reduction in take, and it is possible to account for uncertainty in the process.

A proposed lead abatement program was developed by the American Wind Wildlife Institute (Cochrane et al. 2015). Their model uses four variables (eagle density, game harvest, percent of gut piles removed, and percent of non-lead ammunition used) to predict the number of eagle deaths. It can be used to calculate how changes in the mitigation parameters affect mortality rates. Importantly, it allows for compensatory mitigation via removal of gut piles or switching from lead to non-lead ammunition or both. The model suggests that the greatest reduction in mortality is achieved by increasing use of non-lead ammunition (an 80% reduction in mortality with 80% of hunters switching to non-lead). While the model was developed using expert opinion of base parameters with Wyoming as the study area, there is likely to be little difference in many of these parameters among regions and others can be estimated specifically for eastern North America. Those base parameters are average maximum number of gut piles eaten per eagle per month, mode of blood lead concentration increase per gut pile scavenged, blood lead concentration that would lead to 50% mortality, percent of gut piles with no lead fragments, and half-life of lead in blood. Finally, the model illustrates that even with a density of eagles similar to the eastern US, reduction in mortality can be achieved via either gut pile removal or reductions in use of lead ammunition or both.

Discussion

There are a variety of anthropogenic causes of mortality of Golden Eagles in the Atlantic Flyway. The two most important causes of mortality are incidental capture in mammal traps and lead poisoning. The highest mortality coinciding with migration and wintering times of eagles. Although trapper education and changes in laws have reduced by-catch, there is no scientifically credible evidence, to implement such programs for compensatory mitigation. In contrast, the distribution of lead poisoning in Golden Eagles is generally uniform across the Atlantic Flyway with similar temporal variation linked to the fall and winter hunting seasons. Lead abatement also best fits the USFWS requirements for compensatory mitigation in eastern North America. These characteristics as well as demonstrable evidence for lead abatement programs to reduce mortality of Golden Eagles and existing credible evidence for lead abatement as a viable option for compensatory mitigation make lead abatement the logical choice to apply to take permits in the Atlantic Flyway.

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