Appendix B

Bayesian Eagle Collision Risk Model

Draft Environmental Assessment - Eagle Incidental Take Permit

Lower Snake River / Hopkins Ridge Wind Facilities

Puget Sound Energy

Lower Snake / Hopkins Ridge Eagle Risk Analysis Summary

Prepared by the U.S. Fish and Wildlife Service National Eagle Support Team

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Facility Information

Facility: Lower Snake / Hopkins Ridge Wind

Location: Garfield and Columbia Counties, WASHINGTON, USA

Latitude & Longitude: 46.4937248, -117.8184388

Date Online: Lower Snake Operational in Feb 2012; Hopkins Ridge Operational in Nov 2005

Number of Turbines: 236

Turbine model: Vestas V80-1.8, Siemens SWT-2.3-101

Hub Height: 67, 80 m

Rotor Diameter: 80, 101 m

NOTE: Fatality estimates are specific to the turbine specifications of the individual wind facilities as provided.

Facility Overview

Lower Snake / Hopkins Ridge is located in Eastern Washington. The Project was constructed in two phases, adjacent to eachother. One facility is named Hopkins Ridge Wind (87 turbines total; 83 became operational in Nov 2005, 4 additional turbines became operational in July 2008). The other facility is named Lower Snake Wind (149 turbines; became operational in Feb 2012). Together they make up a 236 turbine wind energy development project owned by Puget Sound Energy. The Region has requested an analysis of estimated take for bald (*Haliaeetus leucocephalus*) and golden (*Aquila chrysaetos*) eagles.

Eagle Use Survey Summary

Eagle use data was collected in the vicinity of this project, however it did not meet our standards for use in modelling. Therefore no pre-construction data was used to update exposure prior distributions when estimating eagle take.

Mortality Monitoring Summary

Post-construction mortality monitoring includes: standardized carcass searches, searcher efficiency trials, and carcass persistence trials. We used these data with the Evidence of Absence (EOA) program (Dalthorp et al. 2017 (https://pubs.er.usgs.gov/publication/ds881)) to estimate eagle fatalities at Lower Snake / Hopkins Ridge Wind during the years that mortality monitoring occurred. EOA estimates the total eagle mortality from the number of fatalities detected, the total area where fatalities could have been found that was searched, carcass persistence, and searcher efficiency trial data. This estimate accounts for biases from imperfect searcher efficiency, unsearched areas, and carcass removal rates. The post-construction fatality estimate is used to update collision probability in the Service's CRM with monitoring data collected from the wind facility.

The mortality monitoring data provided for analysis in support of an eagle take permit application for Lower Snake / Hopkins Ridge Wind was adequate for use in updating the collision probability prior when estimating fatalities.

Turbine searches: 2012: The number of turbines searched and the area searched within each square, when extrapolated across all turbines, covered 19.3% of the total area where eagle remains could have fallen using the Service's model to estimate the percentage of total eagle remains within the area searched based on Hull and Muir (2010) 2017: In 2017 all turbines were monitored at both project (236 turbines total) but there were essentially 3 distinct methods being deployed at the same time. All turbines at Hopkins Ridge were surveyed using Method A, 50 turbines at Lower Snake were surveyed using Method B, and 99 turbines at Lower Snake were surveyed using Method C. I used the single class module to come up with the parameters (Ba and Bb) and g-value for each class. Then used the multiple class module to arrive at an estimate for 2017.

Searcher efficiency (SE) trials: 2012: Inputs were calculated from 2012 SE data (reported in 2012 spreadsheet). It's not ideal that 2012 data was collected using mallards, pigeons, and other game birds. But we elected not to use 2017 SE data because it was collected using turkey skins only and because it was done 5 years after 2012 surveys occurred. 2017: Inputs were calculated from 2017 SE data specific to this method (reported in 2017 spreadsheet). Trials were conducted with turkey skins.

Carcass persistence (CP) trials: Inputs for both 2012 and 2017 fatality estimates were calculated using 2017 data. That data was collected using raptor carcasses and, although it was taken after 2012, we thought it was more representative than using CP data collected using mallards, pigeons, etc. The persistence rate of domestic chicken carcasses may be generally shorter than large-bodied raptor remains (Urquhart et al. 2014, Hallingstad et al. 2018).

Detected fatalities in monitored years:

Bald eagle: 0

Golden eagle: 0

Estimating Fatalities for Monitored Years: Since only two years of fatality monitoring were performed after the project was fully constructed (all 236 turbines), we only used data from those 2 years. During 2012 monitoring efforts, the applicant achieved a probability of detection (g-value) of 0.11 across the whole project. During 2017 monitoring efforts, the applicant achieved a probability of detection (g-value) of 0.53. Fatality estimates during the 2012 and 2017 data collection periods, extrapolated out to one year, are 3.99 and 0.39 eagles, respectively. We used the weighted average (weighted by g-value) of the estimates for both years and used that value to update the collision probability prior. This weighted average was 1.01 eagles per year and this value was used to update the collision probiity prior for all final model runs.

Collision Risk Model

The collision risk model (CRM) uses three pieces of information to estimate the number of annual eagle fatalities at a wind facility: (1) the pre-construction eagle use of a wind facility (eagle exposure), (2) the probability that an eagle collides with a turbine (collision probability), and (3) the hazardous space of a wind facility operating during daylight hours (expansion factor). These parameters are then modeled in a Bayesian framework where uncertainty surrounding eagle exposure and collision probability are defined by national prior-probability distributions (priors) for each parameter. Wind facility specific pre-construction use and post-construction mortality monitoring data can then be used to update these priors, respectively, reducing uncertainty in the parameter estimates and resulting in more precise estimates of annual eagle fatalities at a wind facility (New et al. 2021; USFWS 2021 (%5Bhttps://www.federalregister.gov/documents/2021/05/05/2021-09362/updated-collision-risk-model-priors-for-estimating-eagle-fatalities-at-wind-energy-facilities%5D)). (Table 1).

Table 1: Inputs to the collision risk model (± SD) used to estimate annual bald eagle fatalities for theLower Snake / Hopkins Ridge Wind in Garfield and Columbia Counties, WASHINGTON, USA.

BAEA Model scenario	Pre-construction exposure (eagle minutes/hour/km^3)	Collision probability (collisions/eagle-minute)	Expansion factor ((hours*km^3)/year)
Annual priors only (no survey data)	3.19 ± 11.54	0.007 ± 0.0055	1457.22
Annual exposure update	3.2 ± 11.56	0.007 ± 0.0055	1457.22
Annual collision update, year 1	3.19 ± 11.53	5e-04 ± 3e-04	1457.22

Table 2: Inputs to the collision risk model (± SD) used to estimate annual golden eagle fatalities for theLower Snake / Hopkins Ridge Wind in Garfield and Columbia Counties, WASHINGTON, USA.

GOEA Model scenario	Pre-construction exposure (eagle minutes/hour/km^3)	Collision probability (collisions/eagle-minute)	Expansion factor ((hours*km^3)/year)
Annual priors only (no survey data)	1.21 ± 2.26	0.0056 ± 0.0049	1457.22
Annual exposure update	1.21 ± 2.26	0.0056 ± 0.0049	1457.22
Annual collision update, year 1	1.21 ± 2.27	0.0012 ± 8e-04	1457.22

Eagle Collision Risk Estimates

The bald and golden eagle fatality estimates using the exposure prior and the updated collision probability prior (based on 2 years of mortality monitoring data are shown in Tables 3 and 4. The accompanying posterior density fatality distributions for annual risk models are presented in Figures 1 and 2.

BAEA annual priors only: 0.23 BAEA annual collision update: 0.02

(Figure 1; Table 3).

GOEA annual priors only: 11.40 GOEA annual collision update: 2.60

(Figure 2; Table 4).

Table 3: Annual bald eagle (BAEA) fatality estimates for theLower Snake / Hopkins Ridge Wind in Garfield and Columbia Counties, WASHINGTON, USA.

BAEA model scenario	Mean	Standard deviation	60th quantile
Annual priors only (no survey data)	32.52	151.40	0.23
Annual exposure update	32.71	154.30	0.23
Annual collision update, year 1	2.49	10.74	0.02

Table 4: Annual golden eagle (GOEA) fatality estimates for theLower Snake / Hopkins Ridge Wind in Garfield and Columbia Counties, WASHINGTON, USA.

GOEA model scenario	Mean	Standard deviation	80th quantile
Annual priors only (no survey data)	9.9	26.3	11.4
Annual exposure update	9.9	26.1	11.5
Annual collision update, year 1	2.0	4.7	2.6

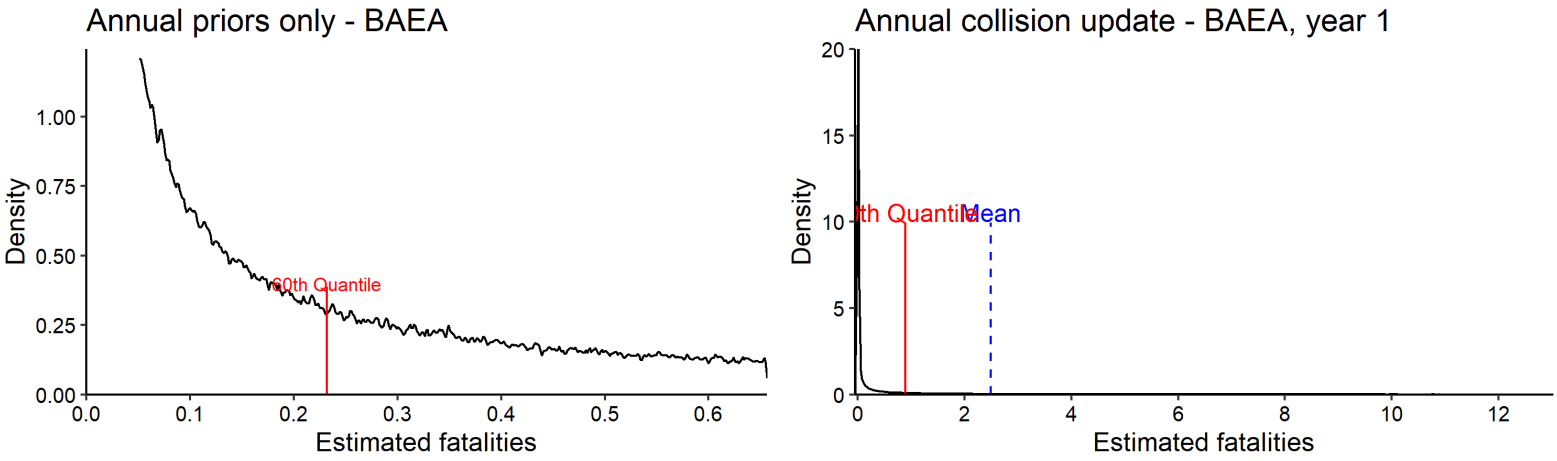

Figure 1: Collision risk estimates for bald eagles from posterior density fatality distributions for annual collision risk models at the Lower Snake / Hopkins Ridge Wind Facility, Garfield and Columbia Counties, Washington, USA.

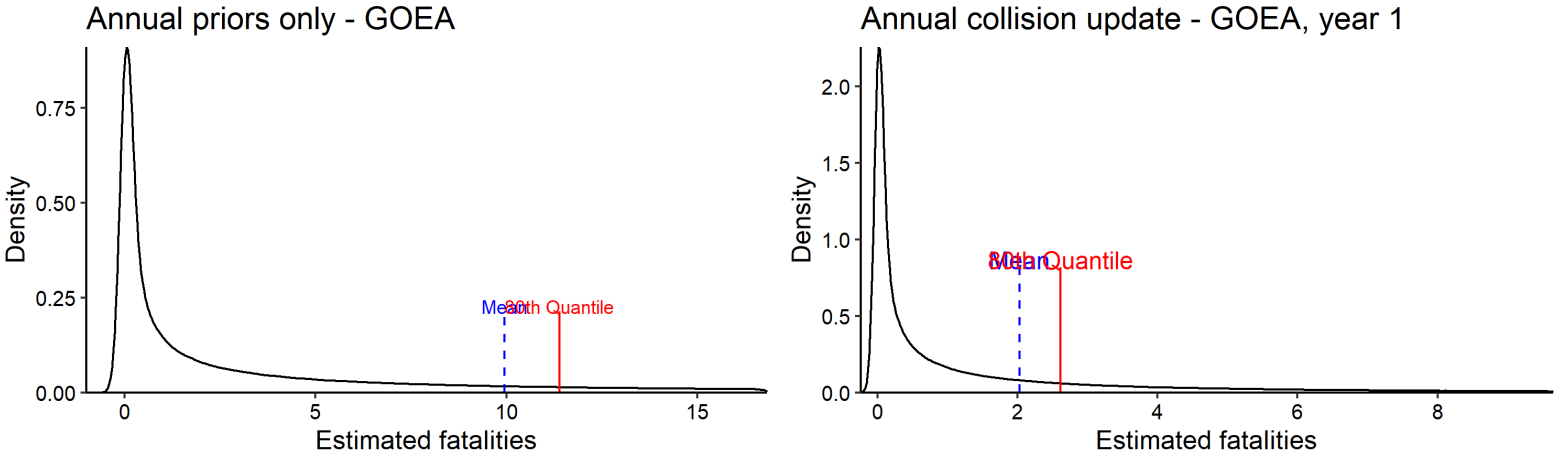

Figure 6: Collision risk estimates for golden eagles from posterior density fatality distributions for annual collision risk models at the Lower Snake / Hopkins Ridge Wind Facility, Garfield and Columbia Counties, Washington, USA.

Estimating Fatalities At Turbines Constructed After September 11, 2009: The Service only requires deductions from EMU take thresholds for authorized take that was not already on the landscape prior to Sept 11, 2009. Thus, some of the take authorized at the Lower Snake / Hopkins Ridge Wind Project (i.e. take at Hopkins Ridge, which was operational in 2005) will not be deducted from EMU take thresholds and, thus, compensatory mitiation is not requied. To estimate the take that is occurring only at the turbines that became operational after Sept 11, 2009, we ran the CRM another time. The details of this CRM run are not listed here; however, our approach to and many details between these model runs are the same. Take predictions for bald and golden eagles from only these turbines is 0.2 and 1.9 eagles per year, respectively.

Estimating Fatalities For Alternative 3: We also estimated take at the Lower Snake / Hopkins Ridge Wind Facility under Alternative 3. The details of this CRM run are not listed here; however our approach to and many details between these model runs are the same. Take predictions for bald and golden eagles under Alternative 3 are 0.02 and 2.36 eagles per year, respectively. Running the CRM for turbines operational after Sept 11, 2009, we estimate bald and golden eagle take rates of 0.02 and 1.7 eagles per year, respectively.

Literature Cited

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