Appendix B

Bayesian Eagle Collision Risk Model

Elkhorn Valley Wind Project

1. Overview

This Appendix describes the details and assumptions of our modelling efforts that resulted in our predictions for both eagle species for the Elkhorn Valley Wind project (hereafter collectively referred to as 'Project').

Model details in this Appendix are applicable to Alternative 2 and 3 in the associated EA. Annual predictions are the same for both Alternatives; however, for Alternative 2, 5-year predictions were derived by multiplying the annual take prediction by 5 years and rounding up to the nearest whole integer. For Alternative 3, 30-year predictions were derived by multiplying the annual take prediction by 30 years and rounding up to the nearest whole integer.

1.1. Background

The Service uses explicit models in a Bayesian statistical framework to predict eagle fatalities at wind facilities while accounting for uncertainty. This model is hereafter referred to as the Collision Risk Model (CRM). The analysis presented below follows the Service's Eagle Conservation Plan Guidance version 2 (ECPG, USFWS 2013); a more detailed background on the Service's model and modelling framework are presented in Appendix D of the Technical Appendices of the ECPG.

The Service CRM is based on the assumption that there is a predictable relationship between pre-construction eagle exposure events (λ; eagle-minutes below 200m / hr·km^2) and subsequent annual fatalities resulting from collisions with wind turbines (F), such that:

$$F = \varepsilon \cdot \lambda \cdot C$$

where C is the probability of a collision given one minute of eagle flight within the hazardous area (see definition in the ECPG technical appendices), and ε is the expansion factor, a constant that describes the total area (or volume) and time within a project footprint that is potentially hazardous to eagles; this is used to expand λC, the number of birds killed per minute of exposure, into the annual number of predicted fatalities.

One advantage of using a Bayesian modelling framework is the ability to incorporate existing knowledge directly into the model by defining an appropriate prior probability distribution (hereafter "prior"). The Service has defined a prior distribution for eagle exposure (Gamma (0.97, 2.76)) based on the exposure rates across a range of projects under Service review and others described with sufficient detail in Whitfield (2009), and has defined a prior for collision probability (Beta (2.31, 396.69)) based on information from projects presented in Whitfield (2009). These prior distributions can be updated with data collected from the wind facility under consideration to obtain posterior distributions (hereafter "posterior") that provide the project specific estimates of λ and C. Specifically, the exposure prior can be updated with pre-construction eagle use data collected at a site (note: when adequate pre-construction survey efforts are performed, the relative influence of the λ prior distribution on the resulting posterior λ becomes negligible). The collision probability prior can also be updated with post-construction fatality estimates if/when a project becomes operational. Details on these priors and how to update them can be found in this Appendix or in the ECPG (USFWS 2013).

2. Calculating Model Variables

2.1. Exposure Rate Calculation (λ)

The exposure rate (λ) is defined in Appendix D of the Technical Appendices of the ECPG as the number of exposure events (eagle-minutes) per daylight hour per square kilometer. The Service's original exposure prior is defined in the ECPG as:

$$\textbf{Prior } \lambda \sim \textbf{\textit{Gamma}}\ \textbf{(0.97, 2.76)}$$

This prior assumes that the eagle use surveys at the project in question collected data on the eagles flying between 0-200m above ground level, as recommended in the Service's ECPG. However, because many projects were constructed, or their pre-construction data collection completed, prior to the publication of the ECPG, pre-construction eagle survey methods are not always consistent with this assumption. Exposure values calculated from data born from these surveys, especially where the 200m survey height was not achieved, may not be appropriate for use with the exposure prior as defined in the ECPG. Thus, a new, Volumetric Prior was derived, which allows for deviations from the recommended survey height (i.e. survey ceilings less than or greater than 200m, or data only collected within a rotor swept zone) to be accounted for by re-defining the exposure rate as the number of exposure events per daylight hour per unit **volume (km^3)**, instead of unit area. When running the model with this three-dimensional exposure, the new exposure prior was adjusted as below:

$$\textbf{Volumetric Prior } \lambda \sim \textbf{\textit{Gamma}}\ \textbf{(0.968, 0.552)}$$

This Volumetric Prior was recently updated for each eagle species, utilizing new data available to the Service since the publication of the 2013 priors. For reasons explained in the FEA, these 2021 priors were not used when running the CRM for Elkhorn. The 2013 priors were used when running the CRM, as described below.

Site specific exposure rates (i.e. site-specific data) can be used to update exposure priors and determine a posterior distribution specific to a species and a specific project area. The resulting posterior distribution is defined as:

$$\textbf{Volumetric Posterior } \lambda \sim \textbf{\textit{Gamma}}\ \left(\mathbf{0.968} + \sum_{i=1}^{n} ki,\ \mathbf{0.552} + n\right)$$

where *ki* is the summed number of species-specific eagle-minutes within the surveyed cylinder and where *n* represents the survey effort put forth (in $hr{*}km^3$).

2.2. Pre-construction surveys

For this Project, the Volumetric Priors were used throughout the modelling effort and was updated with site-specific and species-specific data.

Pre-construction collection of eagle-use information in and around the Project began in March 2003 and continued through October 2003. For a variety of reasons, the most notable of which are listed below, these surveys were inconsistent with pre-construction survey recommendations in the ECPG and requirements in regulation (50 CFR 22.26(d)(3)(ii)).

1) Surveys were conducted for less than two years. At least 2 years are recommended in the ECPG and are required by regulation.
2) They 11 survey plots did not encompass the required 30 percent of the project footprint.
3) Survey duration at each point was 20 minutes, which is short of the required minimum of 60 minutes.
4) Surveys were designed to document use of <u>all</u> avian species and not eagles specifically. A design that has the observer looking specifically for large raptors is recommended.

Typically, such short-comings in pre-construction monitoring efforts would raise concerns about the accuracy of resulting fatality predictions and would likely result in the Service deciding to use un-updated exposure priors for the model run. However, considering the following, the Service has decided to issue a waiver of pre-construction survey requirements (50 CFR 22.26(d)(3)(ii)) for this project. Further, the Service has decided to use site-specific pre-construction eagle use data to update the exposure prior.

1) The Project was constructed in 2007, well before the publication of the Service's ECPG and the most recent regulation.
2) The applicant has nearly 6 years of post-construction fatality monitoring data that they have provided to the Service and that are usable in predicting fatalities.
3) Eagle exposure from pre-construction surveys appears to be relatively high, despite the aforementioned short-comings in survey methodology, and
4) The Service agreed to the adequacy of this fatality prediction and the use of the pre-construction eagle exposure data prior to the most recent rule revision.

When modelling future take predictions at this Project (e.g. if/when Telocaset applies for another eagle take permit or during an administrative check-in), current Service data standards will apply.

Surveys documented three bald eagle observations and 136 golden eagle observations during surveys. According to Telocaset's ECP, this translated to three bald eagle minutes and 70 golden eagle minutes within an 800m radius and within 200m height of each point. Surveys were conducted for just under 92 total hours.

Table 1: *Eagle Observations and Eagle Minutes for each eagle species. Eagle-minutes listed (yellow cells) are for observations that occurred only within 800m (radius) and 200m (height), These values were used to update the exposure prior for each species.*

Survey Dates	# of Surveys	Survey Length (Mins)	Bald Eagle		Golden Eagle	
			# Obs	EMins	# Obs	EMins
Mar 2003 – Oct 2003	275	20	3	3	136	70

The code presented in Attachment A to this Appendix is written to calculate posterior distributions for exposure, using the values in Table 1 and realized search plot dimensions; however, the posterior can also be calculated by hand as described for each species below.

BALD EAGLE

Volumetric Posterior $\lambda \sim$ *Gamma* (0.968 + 3 EMins, 0.552 + (275 counts · 0.33hr · π(0.8km)^2 · 0.2km)))

Volumetric Posterior $\lambda \sim$ *Gamma* (3.968, 37.38)

GOLDEN EAGLE

Volumetric Posterior $\lambda \sim$ *Gamma* (0.968 + 70 EMins, 0.552 + (275 counts · 0.33hr · π(0.8km)^2 · 0.2km)))

Volumetric Posterior $\lambda \sim$ *Gamma* (70.968, 37.38)

2.3. Collision probability calculation (C)

The probability of collision (*C*) is the probability of an eagle colliding with a turbine for each minute of exposure (eagle-minutes in the hazardous area). The collision probability prior distribution is defined in Appendix D of the Technical Appendices of the ECPG as:

Prior *C* ~ *Beta* (2.31, 396.69)

This prior was recently updated for each eagle species, utilizing new data available to the Service since the publication of the 2013 priors. For reasons explained in the FEA, these 2021 priors were not used when running the CRM for Elkhorn. The 2013 priors were used when running the CRM, as described below.

After construction, site- and species-specific estimates of fatalities, based on post-construction fatality monitoring, can be used to update the collision probability prior. The posterior distribution (after updating of the new prior) can be simply expressed[1] as:

Posterior $C \sim Beta\,(2.31 + f, 396.69 + g)$

where f is the number of fatalities estimated to have occurred at the project and g is the estimated number of exposure events (represented by the exposure distribution) that did not result in a fatality. Once determined, this posterior distribution replaces the national collision probability prior in the model and can serve as a new prior for subsequent updates as new post-construction fatality monitoring data is collected and fatality estimates derived.

Several years of post-construction fatality surveys were conducted at the Project – one during 2008, another during 2010, and yet another spanning from 2011 through 2014. Over the course of this fatality monitoring several different survey methods were used. As a result of these changing methods, we developed three separate fatality estimates from the fatality monitoring data (done in Fatality CMR; FCMR) and did three serial updates of the collision probably prior with those estimates. One update was performed using the estimates derived from 2008 data, another was performed using the estimates derived from 2010 data, and yet another was performed using the estimates derived from the 2011-2014 data. Inputs and bias trial data files used in the creation of these estimates are provided in Attachment B of this Appendix. The FCMR software and details on the FCMR estimator can be downloaded online at https://www.mbr-pwrc.usgs.gov/software/fatalityCMR.shtml.

General assumptions made during FCMR fatality estimation:

1) That each 220 x 220m search plot encompassed 99% of the area where an eagle carcass could be found around each turbine. This value was based on conclusions in Hull and Muir (2010) and was used when running FCMR.
2) That actual eagle carcass removal rates at the Project are closely simulated by carcass persistence bias trials conducted in 2008 and 2010. This may be a conservative assumption, as the carcasses used in these trials were non-raptors (e.g. pheasants, mallards, and rock pigeons).

[1] Values in the equations are simplified to promote understanding. Actual parameters used in updated collision probability distributions were calculated using the R code attached below with functions provided with New *et al.* (2015) – see supporting information (Hyperlink: https://doi.org/10.1371/journal.pone.0130978.s001).

Table 2: Summary of post-construction fatality monitoring efforts and resulting eagle fatality estimates (yellow cells) used to update the collision probability prior.

Survey	Turbines Searched	Search Plot Dimensions	Search Frequency [$]	BAEA Carcasses Found	GOEA Carcasses Found	BAEA Annual Fatality Estimate[*]	GOEA Annual Fatality Estimate[*]
2008	61	220m x 220m	monthly	0	0	0.095	0.095
2010	31	220m x 220m	Semi-monthly	0	2	0.203	4.617
2011-2014	61	220m x 220m	monthly	0	7	0.044	2.326

[$] Lists target search frequencies. Actual search frequencies varied slightly by turbine and with weather and other logistics at the site that occasionally made searches difficult/impossible/dangerous.
[*] Estimates account for biases from imperfect searcher efficiency, unsearched areas, and carcass removal rates – site-specific data on these biases were collected during monitoring efforts.

Three serial updates to the collision probability prior were performed using the species-specific fatality estimates in Table 2. Parameters of the resulting posterior distributions are listed below, by species. The final set of parameters listed (Posterior C3) describe the collision probability posteriors after the final update for each species, which was used during the final model run.

<u>BALD EAGLE</u>

Posterior C1 ~ *Beta* (2.41249, 428.6241)

Posterior C2 ~ *Beta* (2.617888, 453.046)

Posterior C3 ~ *Beta* (2.661615, 476.7551)

<u>GOLDEN EAGLE</u>

Posterior C1 ~ *Beta* (2.395708, 938.2406)

Posterior C2 ~ *Beta* (7.012353, 1478.494)

Posterior C3 ~ *Beta* (9.354387, 2023.049)

2.4. Expansion Factor Calculation (ε)

2.4.1. Background Information

The expansion factor (ε) scales the resulting per unit fatality rate (fatalities per hr per km^3) to the daylight hours in one year (or other time period if desired) and total hazardous volume within the project footprint. The expansion factor is defined as the product of the total hazardous volume ($\delta = \pi \cdot r^2 \cdot h$, where r is the turbine rotor radius, h is 200 meters) and δ is summed across all turbines (nt = number of turbines) and daylight hours (τ).

$$\boldsymbol{\varepsilon = \tau \cdot \sum_{i=1}^{nt} \delta i}$$

For this Project we calculate one expansion factor that applies to both eagle species.

2.4.2. Calculating The Expansion Factor

The total number of daylight hours over any 1-year period at the Project is estimated to be 4464.1 hours. If each turbine (n = 61) operates for all daylight hours, the total amount of hazardous daylight hours at the Project would be 272,310.1 turbine·hours. Although it seems likely that Project turbines are not operating during all daylight hours, we do not have data to quantify the actual number of hours turbines are spinning and putting eagles at risk. Thus, we conservatively assume that all Project turbines operate for 4464.1 daylight hours per year. Another variable that factors into the expansion factor is the hazardous volume (cylinder with 41m radius and 200m height).

The following expansion factor was used to run the CRM for both bald and golden eagles.

$$\boldsymbol{\varepsilon = 272{,}310.1 \text{ turbine·hours} \cdot (\pi \cdot (0.041\text{km}^2) \cdot 0.200\text{km}) = 287.61 \text{ hr·km}^3}$$

3. RUNNING THE BAYESIAN MODEL

3.1. Background

As described in Appendix D of the Technical Appendices of the ECPG, the Service's CRM calculates predicted fatalities using Gibbs sampling. As a result, the mathematical form of the posterior distribution is known because the distributions specified for the data and the prior are in the same family (known as conjugacy). To make an inference on the parameters of interest (exposure and collision in this case), values are drawn from the mathematical representation of the exposure posteriors and collision probability posteriors described above (*n* = 1,000,000 for this Project) in order to obtain the posterior distribution of predicted fatalities. Distributions of predicted fatalities for both species at the Project are depicted in the Figures below. Model results for both species, including the mean, standard deviation (SD), median (Q50), and 60th, 80th, 90th, and 95th quantiles (Q60, Q80, Q90, and Q95, respectively) are depicted in Table 5 and 6. R-code for the CRM runs described in this document are provided in this Appendix's Attachment A, using functions provided with New *et al.* (2015) – see supporting information (Hyperlink: https://doi.org/10.1371/journal.pone.0130978.s001

3.2. Bald Eagle Prediction

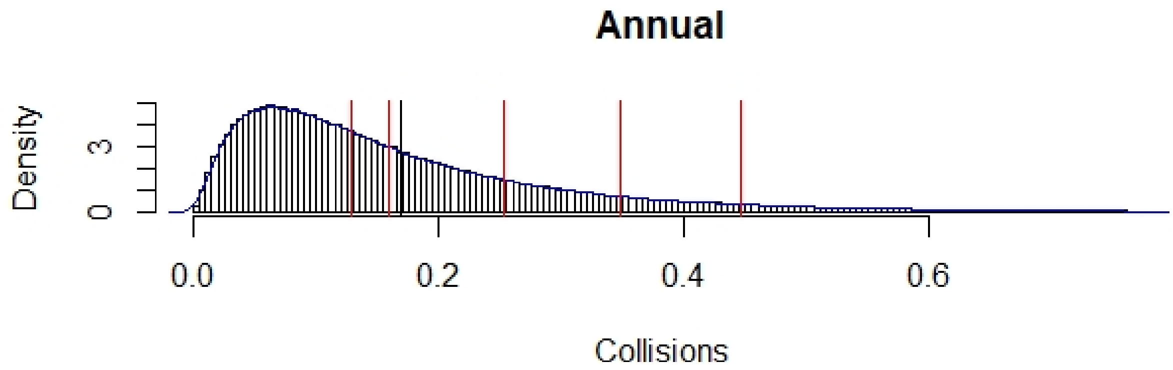

Figure 1 (above): Predicted eagle fatalities (for bald eagles) at the entire repowered project. The red vertical lines represent the 50th, 60th, 80th, 90th, and 95th quantiles (from left to right) of the distribution. The black line in each graph depicts the mean annual fatality prediction. The 80th quantile is the value the Service used as a prediction of bald eagle fatalities.

Table 5: Summary of model outputs (take predictions in units 'eagles per year') for bald eagles at the entire project. Outputs include the mean, standard deviation (SD), median (Q50), 60th quantile (Q60), 80th quantile (Q80), 90th quantile (Q90), and 95th quantile (Q95). The yellow output is the predicted annual bald eagle take at the Project.

	Mean	SD	Q50	Q60	Q80	Q90	Q95
Annual Prediction	0.17	0.14	0.13	0.16	0.25	0.35	0.45

3.3. Golden Eagle Prediction

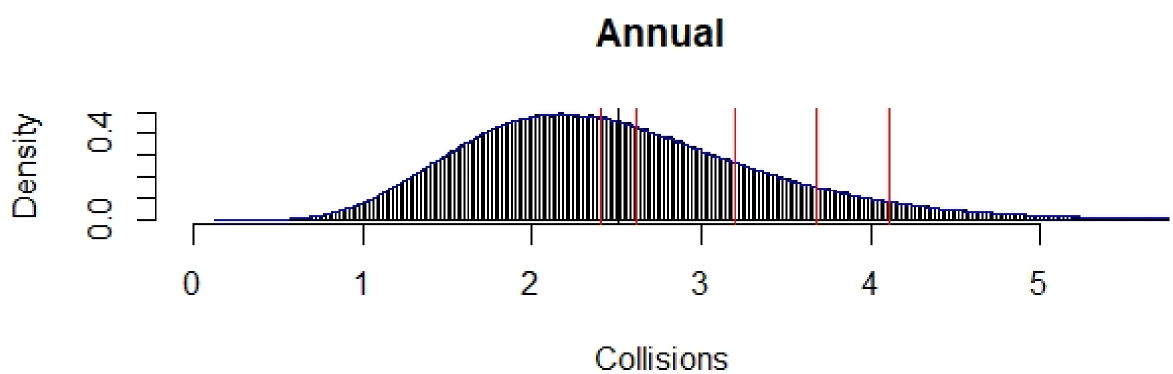

Figure 2 (above): Predicted golden eagle fatalities at the Project. The red vertical lines represent the 50th, 60th, 80th, 90th, and 95th quantiles (from left to right) of the distribution. The black line in each graph depicts the mean annual fatality prediction. The 80th quantile is the value the Service uses as a prediction of golden eagle fatalities.

Table 6: Summary of model outputs (take predictions in units 'eagles per year') for golden eagles at the entire project. Outputs include the mean, standard deviation (SD), median (Q50), 60th quantile (Q60), 80th quantile (Q80), 90th quantile (Q90), and 95th quantile (Q95). The yellow output is the predicted annual golden eagle take at the Project.

	Mean	**SD**	**Q50**	**Q60**	**Q80**	**Q90**	**Q95**
Annual Prediction	2.51	0.877	2.40	2.62	3.18	3.68	4.11

4. CONCLUSIONS

4.1. Authorized Take at the Project

Annual fatality predictions calculated and depicted in Tables 5 and 6 were used to calculate the amount of eagle take to be authorized over the tenure of a 5-year and 30-year Eagle Incidental Take Permit. Our modelling conservatively predicts, at the 80th quantile (for bald eagles) and the 80th quantile (for golden eagles), that 0.25 bald eagles and 3.18 golden eagles will be killed annually under both Alternatives. Over 5 years, these annual predictions equate to 1.25 bald eagles and 15.9 golden eagles. Over 30 years, these annual predictions equate to 7.5 bald eagles and 95.4 golden eagles. If a permit is issued for this project, the Service would round these numbers up to the nearest whole number and authorize the incidental take of 2 bald eagles and 16 golden eagles over the 5-year permit term under Alternative 2, or 8 bald eagles and 96 golden eagles over the 30-year permit term under Alternative 3.

4.2. Administrative Check-ins

As outlined in the EA, if Alternative 3 is selected, the Service may amend the fatality prediction calculated here as project-specific eagle fatality data becomes available or as more is learned about species-specific eagle collision risk at wind projects. Such amendments would occur at scheduled administrative check-ins – not to occur less frequently than once every five years.

LITERATURE CITED

Hull, C.L., and S. Muir. 2010. Search areas for monitoring bird and bat carcasses at wind farms using a Monte-Carlo model. *Australian Journal of Environmental Management* 17: 77-87.
New, L., E. Bjerre, B.A. Millsap, M.C. Otto, and M.C. Runge. 2015. A collision risk model to predict avian fatalities at wind facilities: an example using golden eagles, Aquila chrysaetos. PLoS ONE 10(7): e0130978.

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USFWS. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. U.S. Fish and Wildlife Service Division of Migratory Bird Management, Washington D.C., USA.

Warren-Hicks, W., J. Newman, R. Wolpert, B. Karas, and L. Tran. 2013. Improving method for estimating fatality of birds and bats at wind energy facilities. Public Interest Energy Research (PIER) Program, Final project report. California Energy Commission. Berkely, CA, California Wind Energy Association: pp. 136.

Whitfield, D. P. 2009. Collision avoidance of golden eagles at wind farms under the 'Band' collision risk model. Report from Natural Research to Scottish Natural Heritage, Banchory, UK.

ATTACHMENT A: R-Code

This attachment presents the R-code used to run the Service's CRM for golden eagles. Sourced files can be found in New *et al.* (2015) – see supporting information (Hyperlink: https://doi.org/10.1371/journal.pone.0130978.s001). Code is presented for golden eagles only. The same code was used for bald eagles, except that bald eagle minutes and fatality estimates were used to update the exposure and collision probability priors, respectively.

Fatality Prediction for the entire repowered project:

```
require(rv)
UCI<-c(0.5,0.8,0.9,0.95)
nSim<-1000000
nTurbine<-c(61)
HazRadKm<-c(41/1000)
HazKM3<-c(0.2*pi*HazRadKm^2)
CntHr<-c(20/60)
ExpSvy<-data.frame(row.names=c("Annual"),
EMin=c(70),
nCnt=c(275),
CntKM3=c(0.2*pi*0.8^2),
DayLtHr<-c(272310.1))
Dead<-c(0.0953)
AddTot<-TRUE

setnsims(nSim)
getnsims()
PlotFile<-NULL
nSvy<-nrow(ExpSvy)
cSvy<-(rownames(ExpSvy))
SmpHrKM3<-c(ExpSvy$nCnt*CntHr*ExpSvy$CntKM3)
ExpFac<-c(ExpSvy$DayLtHr*HazKM3)
postBH1<-simFatal(BMin=ExpSvy$EMin,
Fatal = Dead,
SmpHrKm=SmpHrKM3,ExpFac=ExpFac,aPriExp=0.968,bPriExp=0.552,
aPriCPr=2.31,bPriCPr=396.69)
postCPr<-attr(postBH1,"CPr")
postCPr
```

```
estBetaParams <- function(mu, var) {
  alpha <- ((1 - mu) / var - 1 / mu) * mu ^ 2
  beta <- alpha * (1 / mu - 1)
  return(params = list(alpha = alpha, beta = beta))
}
```

```
estBetaParams(0.002546901,0.001642520^2)
```

```
require(rv)
UCI<-c(0.5,0.8,0.9,0.95)
nSim<-1000000
nTurbine<-c(61)
HazRadKm<-c(41/1000)
HazKM3<-c(0.2*pi*HazRadKm^2)
CntHr<-c(20/60)
ExpSvy<-data.frame(row.names=c("Annual"),
EMin=c(70),
nCnt=c(275),
CntKM3=c(0.2*pi*0.8^2),
DayLtHr<-c(272310.1))
Dead<-c(4.6171)
AddTot<-TRUE

setnsims(nSim)
getnsims()
PlotFile<-NULL
nSvy<-nrow(ExpSvy)
cSvy<-(rownames(ExpSvy))
SmpHrKM3<-c(ExpSvy$nCnt*CntHr*ExpSvy$CntKM3)
ExpFac<-c(ExpSvy$DayLtHr*HazKM3)
postBH1<-simFatal(BMin=ExpSvy$EMin,
Fatal = Dead,
SmpHrKm=SmpHrKM3,ExpFac=ExpFac,aPriExp=0.968,bPriExp=0.552,
aPriCPr=2.395708,bPriCPr=938.2406)
postCPr<-attr(postBH1,"CPr")
postCPr
```

```
estBetaParams <- function(mu, var) {
  alpha <- ((1 - mu) / var - 1 / mu) * mu ^ 2
  beta <- alpha * (1 / mu - 1)
  return(params = list(alpha = alpha, beta = beta))
}

estBetaParams(0.004720512,0.001777803^2)
```

```
require(rv)
UCI<-c(0.5,0.8,0.9,0.95)
nSim<-1000000
nTurbine<-c(61)
HazRadKm<-c(41/1000)
```

```
HazKM3<-c(0.2*pi*HazRadKm^2)
CntHr<-c(20/60)
ExpSvy<-data.frame(row.names=c("Annual"),
EMin=c(70),
nCnt=c(275),
CntKM3=c(0.2*pi*0.8^2),
DayLtHr<-c(272310.1))
Dead<-c(2.3260)
AddTot<-TRUE

setnsims(nSim)
getnsims()
PlotFile<-NULL
nSvy<-nrow(ExpSvy)
cSvy<-(rownames(ExpSvy))
SmpHrKM3<-c(ExpSvy$nCnt*CntHr*ExpSvy$CntKM3)
ExpFac<-c(ExpSvy$DayLtHr*HazKM3)
postBH1<-simFatal(BMin=ExpSvy$EMin,
Fatal = Dead,
SmpHrKm=SmpHrKM3,ExpFac=ExpFac,aPriExp=0.968,bPriExp=0.552,
aPriCPr=7.012353,bPriCPr=1478.494)
postCPr<-attr(postBH1,"CPr")
postCPr
```

```
estBetaParams <- function(mu, var) {
  alpha <- ((1 - mu) / var - 1 / mu) * mu ^ 2
  beta <- alpha * (1 / mu - 1)
  return(params = list(alpha = alpha, beta = beta))
}

estBetaParams(0.004602622,0.001501029^2)
```

```
require(rv)
UCI<-c(0.5,0.6,0.8,0.9,0.95)
nSim<-1000000
nTurbine<-c(61)
HazRadKm<-c(41/1000)
HazKM3<-sum(0.2*pi*HazRadKm^2)
CntHr<-c(20/60)
ExpSvy<-data.frame(row.names=c("Annual"),
EMin=c(70),
nCnt=c(275),
CntKM3=c(0.2*pi*0.8^2),
DayLtHr<-c(272310.1))
```

```
# Dead<-c(xxxx)
AddTot<-TRUE

setnsims(nSim)
getnsims()
PlotFile<-NULL
nSvy<-nrow(ExpSvy)
cSvy<-(rownames(ExpSvy))
SmpHrKM3<-with(ExpSvy,nCnt*CntHr*CntKM3)
ExpFac<-c(DayLtHr*HazKM3)
tmp<-with(ExpSvy,mapply(simFatal,BMin=EMin,
Fatal = -1,
SmpHrKm=SmpHrKM3,ExpFac=ExpFac,aPriExp=0.968,bPriExp=0.552,
aPriCPr=9.354387,bPriCPr=2023.049,SIMPLIFY=FALSE))

Fatalities<-rvnorm(nSvy)
Exp<-data.frame(Mean=rep(NA,nSvy),SD=NA,row.names=cSvy)
for(i in 1:nSvy){
  # i<-1
  Fatalities[i]<-tmp[[i]]
  Exp[i,]<-attr(tmp[[i]],"Exp")
}

rm(tmp)
names(Fatalities)<-cSvy
nSvy<-length(Fatalities)
if(is.null(nSvy))nSvy<-1
FatalStats<-RVSmry(cSvy,Fatalities,probs=UCI)
if(AddTot){
  FatalStats<-rbind(
    FatalStats,
    RVSmry("Total",sum(Fatalities),probs=UCI)
  )
}

print(ModelDescription)
print(nTurbine)
print(HazRadKm)
print(CntHr)
print(ExpSvy)
print(Exp,digits=3)
print(FatalStats,digits=3)
nPlot<-nSvy+as.integer(AddTot)
nCol<-floor(sqrt(nPlot))
nRow<-ceiling(nPlot/nCol)
xlim<-range(rvrange(Fatalities))
if(!is.null(PlotFile))jpeg(PlotFile)
par(mfrow=c(nRow,nCol))
for(iPlot in 1:nSvy){
```

```
  # iPlot<-1
  plotFatal(Fatalities[iPlot],probs=UCI, main=cSvy[iPlot])
}

if(AddTot)plotFatal(sum(Fatalities),main="Total")
if(!is.null(PlotFile))dev.off()
```

ATTACHMENT B: FCMR Inputs

This attachment presents raw searcher efficiency and carcass persistence trial data that was used to arrive at the fatality estimates using FCMR. Also included are screen shots of the inputs into FCMR. Search input files are not copied below, but rather summarized here. In 2008, zero golden eagle remains were discovered during monitoring efforts. In 2010, two golden eagle remains were discovered during fatality monitoring efforts. From 2011-2015, seven golden eagle remains were discovered during fatality monitoring efforts. No bald eagles were found during any fatality monitoring efforts at the Project through 2015.

Searcher Efficiency Trial Data (2008 and 2010 combined):

State	Type	Nd	kd
fresh	Type1	19	16

Persistence Trial Data (2008):

State	Type	duration	transition
fresh	Type1	0	NA
fresh	Type1	3	NA
fresh	Type1	4	NA
fresh	Type1	14	NA
fresh	Type1	14	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	0	NA
fresh	Type1	3	NA
fresh	Type1	7	NA
fresh	Type1	14	NA
fresh	Type1	14	NA
fresh	Type1	21	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	1	NA
fresh	Type1	4	NA
fresh	Type1	7	NA
fresh	Type1	10	NA

fresh	Type1	21	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	2	NA
fresh	Type1	2	NA
fresh	Type1	14	NA
fresh	Type1	14	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA
fresh	Type1	30	NA

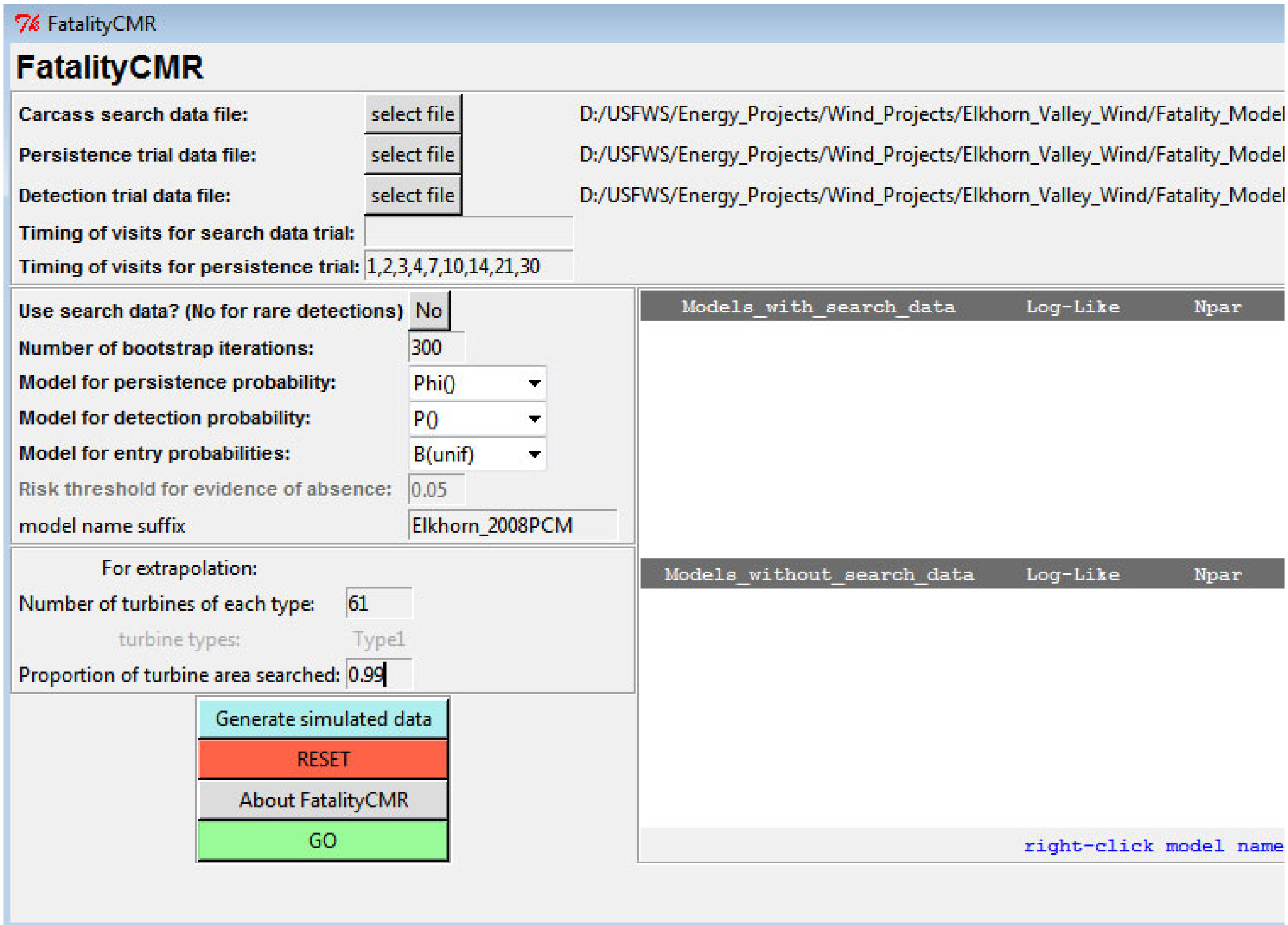
Persistence Trial Data (2010):

State	Type	duration	transition
fresh	Type1	0	NA
fresh	Type1	0	NA
fresh	Type1	1	NA
fresh	Type1	3	NA
fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	7	NA
fresh	Type1	7	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	14	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	0	NA
fresh	Type1	1	NA

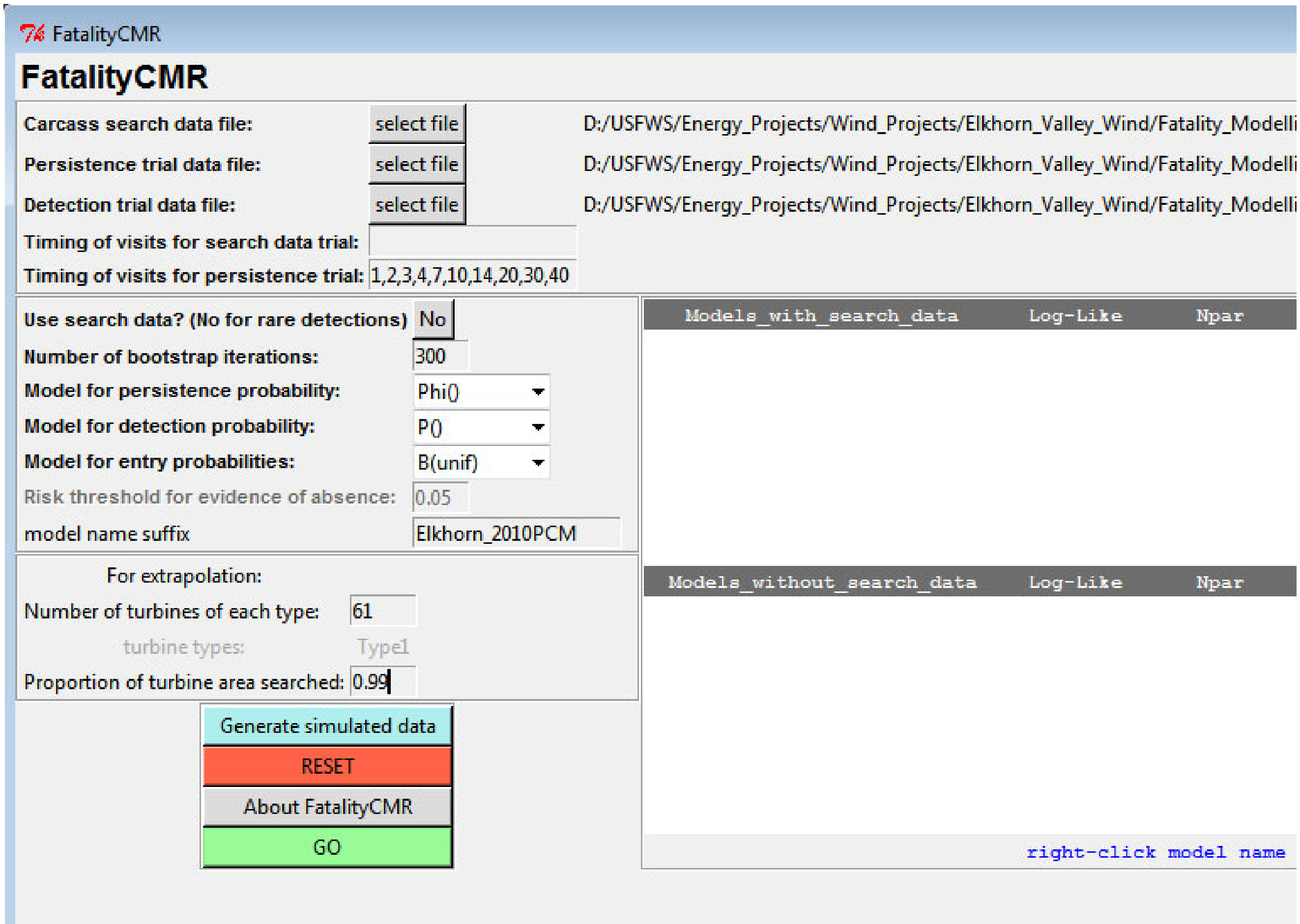
fresh	Type1	2	NA
fresh	Type1	3	NA
fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	7	NA
fresh	Type1	7	NA
fresh	Type1	7	NA
fresh	Type1	7	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	30	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	0	NA
fresh	Type1	1	NA
fresh	Type1	2	NA
fresh	Type1	3	NA
fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	7	NA
fresh	Type1	7	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	14	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	0	NA
fresh	Type1	0	NA
fresh	Type1	2	NA
fresh	Type1	3	NA

fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	4	NA
fresh	Type1	7	NA
fresh	Type1	7	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	10	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	20	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	40	NA
fresh	Type1	40	NA

<u>FCMR Inputs (2008 estimate):</u>



FCMR Inputs (2010 estimate):



<u>FCMR Inputs (2011 through 2015 estimate):</u>