SUPPLEMENTARY ELECTRONIC MATERIAL

ESTIMATING THE ABUNDANCE AND HABITAT SELECTION OF CONSERVATION PRIORITY MARSH-DWELLING PASSERINES WITH A DOUBLE-OBSERVER APPROACH

ESTIMA DE LA ABUNDANCIA Y SELECCIÓN DE HÁBITAT DE PASERIFORMES PALUSTRES DE CONSERVACIÓN PRIORITARITARIA A TRAVÉS DE UNA APROXIMACIÓN DE DOBLE OBSERVADOR

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Simulating data and WinBUGS analysis.
[Simulación de datos y análisis con WinBUGS.]

```
library("R2WinBUGS")

setwd('..')


# We simulate data for double observer

nSites <- 750

psi <- runif(1, 0.05, 0.1)

p1 <- 0.4

p2 <- 0.7

cp <- c(p1*(1-p2), p2*(1-p1), p1*p2)

set.seed(9023)

N <- rpois(nSites, psi)

y <- matrix(NA, nSites, 3)

for(i in 1:nSites) {

  y[i,] <- rmultinom(1, N[i], c(cp, 1-sum(cp)))[1:3]

}


x<- apply(y,2,sum)

x01<-x[1]

x10<-x[2]

x11<-x[3]


# This code (Royle & Dorazio, 2008) creates the multinomial trial representation
```

```
# of the data
ncap2<-matrix(0,nrow=sum(x),ncol=4)
rid<-c(1:x[1], (x[1]+1):(x[1]+x[2]),(x[1]+x[2]+1):nrow(ncap2))
cid<-c( rep(1,x[1]),rep(2,x[2]),rep(3,x[3]) )
ncap2[cbind(rid,cid)]<-1

# We augment the encounter histories with histories of the last type
# which are those not seen by either observer (0,0,0,1).
nz<-nSites-dim(ncap2)[1]
ncap<-rbind(ncap2,matrix(rep(c(0,0,0,1),nz),ncol=4,byrow=TRUE))

nind<-dim(ncap2)[1]

# Real population size:
cat("Real population", sum(N), "individuals", "\n")

# Naive estimation:
cat("We detect", nind, "individuals", "\n")


sink("model.txt")
cat("
model {
  # Priors
  psi~dunif(0,1)
```

```
tau~dunif(0,10)
mu1.p~dunif(-5,5)
mu2.p~dunif(-5,5)

# First nind observations
for(i in 1:nind){
  z[i]~dbin(psi,1)
}
# Data augmentation
for(i in (nind+1):(nind+nz)){
  z[i]~dbin(psi,1)
}
for(i in 1:(nind+nz)){
  e[i]~dnorm(0,tau)I(-5,5)
  # Logit for probability covariates
  logit(p1[i])<- mu1.p + e[i]
  logit(p2[i])<- mu2.p + e[i]
  cp1[i]<- (1-p2[i])*p1[i]
  cp2[i]<- p2[i]*(1-p1[i])
  cp3[i]<- p1[i]*p2[i]
  cp4[i]<- (1-p1[i])*(1-p2[i])
  mu[i,1]<-z[i]*cp1[i]
  mu[i,2]<-z[i]*cp2[i]
  mu[i,3]<-z[i]*cp3[i]
  mu[i,4]<-z[i]*cp4[i] + (1-z[i])
```

```
    ncap[i,1:4]~dmulti(mu[i,1:4],1)
  }
  # We transform back to obtain observation probabilities
  logit(p1bar)<-mu1.p
  logit(p2bar)<-mu2.p
  Nind<-sum(z[1:(nind+nz)])
}
",fill=TRUE)
sink()

data<-list("ncap"=ncap, "nind"=nind, "nz"=nz)
zst<-c(rep(1, nind),rbinom(nz, 1, 0.5))
inits<-function(){
  list(mu1.p=0, mu2.p=0, z=zst)
}
parameters <- c('Nind', 'mu1.p', 'mu2.p', 'p1bar', 'p2bar', 'psi')

ni=5000
nb=2500
nthin=1
nc=3
library(R2WinBUGS)
out <- bugs(data, inits, parameters, "model.txt", n.thin=nthin,n.chains=nc,
  n.burnin=nb,n.iter=ni, debug=TRUE)
print(out, dig=3)
```

```
estima_moda <- function(x) {
  d <- density(x)
  d$x[which.max(d$y)]
}
moda<-estima_moda(out$sims.list$N); moda

hist(out$sims.list$Nind, col="lightgray", border="white", main="",
  xlab="Number of individuals", ylab="Frecuency", xlim=c(20,170), breaks=20)
abline(v=sum(N), lwd=2, col='red')
abline(v=moda, lwd=2, lty=2, col='blue')
abline(v=nind, lwd=2, lty=2, col='darkgreen')

legend('topright' ,c("Real population", "Estimation (Mode)", "Naïve") , lwd=2,
   lty=c(1,2,2), col=c('red', 'blue','darkgreen' ), bty='n', cex=0.9)
```