Wildlife Biology **WLB-00427**

Folliot, B., Guillemain, M., Champagnon, J. and Caizergues, A. 2018. Patterns of spatial distribution and migration phenology of common pochards *Aythya ferina* in the Western Palearctic: a ring-recoveries analysis. – Wildlife Biology 2018: wlb.00427

Appendix 1

R code for the Bayesian multinomial regression analysis

```
# read in common pochard ring recovery data from Table 2
data <- matrix(c(0, 0, 1, 0, 349, 34, 6, 389,
                 0, 0, 0, 1, 50, 6, 8, 64,
                 0, 0, 0, 0, 4, 1, 0, 5,
                 0, 1, 1, 0, 1726, 76, 2, 1804,
                 0, 1, 0, 1, 138, 4, 0, 142,
                 0, 1, 0, 0, 3, 0, 0, 3,
                 1, 0, 1, 0, 924, 171, 112, 1207,
                 1, 0, 0, 1, 393, 99, 190, 682,
                 1, 0, 0, 0, 230, 58, 49, 337,
                 1, 1, 1, 0, 311, 47, 0, 358,
                 1, 1, 0, 1, 160, 27, 2, 189,
                 1, 1, 0, 0, 246, 26, 1, 273),
               nrow = 12, ncol = 8, byrow = TRUE)
colnames(data) <- c("winter","direct","season1","season2","nwe","ce","swa","banded")

library(jagsUI)
sink("pochard.bug")
cat("
   model {
  # Priors and contraints
    # intercepts (mean probability of recovery in flyway x on logit scale)
    # note, probability for flyway SWA found by subtraction
    b0.nwe ~ dnorm(0,0.33)
    b0.ce ~ dnorm(0,0.33)
    SD.p ~ dunif(0,1)
    tau.p <- pow(SD.p,-2)

  # regression coefficients, does probability vary by time of banding?
    b.nwe.winter ~ dnorm(0,0.33)
    b.ce.winter ~ dnorm(0,0.33)

  # does it vary by direct vs. indirect recoveries
    b.nwe.direct ~ dnorm(0,0.33)
    b.ce.direct ~ dnorm(0,0.33)
```

```
 # is there an interaction between season and direct/indirect recoveries?
  b.nwe.winter.direct ~ dnorm(0,0.33)
  b.ce.winter.direct ~ dnorm(0,0.33)

 # is it different in first banding period (early years)
  b.nwe.season1 ~ dnorm(0,0.33)
  b.ce.season1 ~ dnorm(0,0.33)

 # is it different in second banding period
  b.nwe.season2 ~ dnorm(0,0.33)
  b.ce.season2 ~ dnorm(0,0.33)

 # most importantly, have these distributions changed by period
  b.nwe.winter.season1 ~ dnorm(0,0.33)
  b.ce.winter.season1 ~ dnorm(0,0.33)
  b.nwe.winter.season2 ~ dnorm(0,0.33)
  b.ce.winter.season2 ~ dnorm(0,0.33)

 # most importantly, have these distributions changed by period
  b.nwe.direct.season1 ~ dnorm(0,0.33)
  b.ce.direct.season1 ~ dnorm(0,0.33)
  b.nwe.direct.season2 ~ dnorm(0,0.33)
  b.ce.direct.season2 ~ dnorm(0,0.33)

 # Probability of being recovered in each flyway
  for (i in 1:n.row){
    eta[i,1] ~ dnorm(0,tau.p)
    logit(p[i,1]) <- b0.nwe + b.nwe.winter*winter[i] + b.nwe.direct*direct[i] +
      b.nwe.season1*season1[i] + b.nwe.season2*season2[i] +
      b.nwe.winter.direct*winter[i]*direct[i] +
      b.nwe.winter.season1*winter[i]*season1[i] + b.nwe.winter.season2*winter[i]*season2[i] +
      b.nwe.direct.season1*direct[i]*season1[i] + b.nwe.direct.season2*direct[i]*season2[i] + eta[i,1]
    eta[i,2] ~ dnorm(0,tau.p)

    logit(p[i,2]) <- b0.ce + b.ce.winter*winter[i] + b.ce.direct*direct[i] +
      b.ce.season1*season1[i] + b.ce.season2*season2[i] +
      b.ce.winter.direct*winter[i]*direct[i] +
      b.ce.winter.season1*winter[i]*season1[i] + b.ce.winter.season2*winter[i]*season2[i] +
      b.ce.direct.season1*direct[i]*season1[i] + b.ce.direct.season2*direct[i]*season2[i] + eta[i,2]

    p[i,3] <- 1 - (p[i,1] + p[i,2])

  # observation data
    y[i,1:3] ~ dmulti(p[i,1:3],recov[i])
  }
}
  ",fill=TRUE)
sink()

# Bundle data
bugs.data <- list(winter = data[,1], direct = data[,2],
```

```
            season1 = data[,3], season2 = data[,4],
            y = data[,5:7], recov = data[,8],
            n.row = dim(data)[1])

# Parameters monitored
parameters <- c("p","b0.nwe","b0.ce",
          "b.nwe.winter","b.ce.winter",
          "b.nwe.direct","b.ce.direct",
          "b.nwe.winter.direct","b.ce.winter.direct",
          "b.nwe.season1","b.ce.season1",
          "b.nwe.season2","b.ce.season2",
          "b.nwe.winter.season1","b.nwe.winter.season2",
          "b.nwe.direct.season1","b.nwe.direct.season2",
          "b.ce.winter.season1","b.ce.winter.season2",
          "b.ce.direct.season1","b.ce.direct.season2")

# set initial values to keep p(nwe) large and p(ce) small
inits <- function(){list(b0.nwe = runif(1,1.5,2.5), b0.ce = runif(1,-2.5,-1.5),
                b.nwe.winter = runif(1,-1.2,-0.5), b.ce.winter = runif(1, 0, 1),
                b.nwe.direct = runif (1, 0.5, 1.5), b.ce.direct = runif(1,-2,-1))}

# MCMC settings
na <- 1000; ni <- 1100000; nt <- 10 ; nb <- 100000; nc <- 3

# Call JAGS from R
pochard <- jagsUI(bugs.data, inits=inits, parameters, "pochard.bug", n.chains=nc,
          n.adapt=na, n.thin=nt, n.iter=ni, n.burnin=nb, parallel=TRUE)

print(pochard)
```

Appendix 2

Summary table of the general linear mixed model analysis assessing changes in the proportion of individuals recovered > 200 km eastwards of their ringing site in western Europe over months, year of recovery (between 1960-2017) and their interaction as fixed effects, with a random effect on the ringing site. Conditional and marginal coefficients of determination (R^2 marginal and R^2 conditional) were equal to 0.36 and 0.46 respectively.

Fixed effect	Estimate	Std. error	Z	P (> |z|)
Intercept	-50.93	6.62	-7.70	$1.40e\text{-}^{14}$
Month	2019	31.61	63.85	$< 2e^{-16}$
Month ²	-170	27.46	-6.19	$5.90e^{-10}$
Month ³	-1640	34.53	-47.51	$< 2e^{-16}$
Year	0.0256	0.003326	7.70	$1.38e^{-14}$
Year × Month	-1.012	0.0159	-63.63	$< 2e^{-16}$
Year × Month ²	0.04678	0.01387	3.37	0.000743
Year × Month ³	0.8298	0.01739	47.73	$< 2e^{-16}$