FileS1 JAGS Model Specification

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knitr::opts_chunk$set(echo = FALSE)


# model {
#
#     #-------------------------------------------------------------------
#     # States and Observation of states (S; O):
#     # 1 - alive at BB; seen at BB
#     # 2 - alive at LINWR; seen at LINWR
#     # 3 - alive at BS; seen at BS
#     # 4 - alive at HI; seen at HI
#     # 5 - alive at M; seen at M
#     # 6 - alive at WL; seen at WL
#     # 7 - alive at CNWR; seen at CNWR
#     # 8 - alive at BLNWR; seen at BLNWR
#     # 9 - alive at LL; seen at LL
#     # 10 - alive at RLNWR_N; seen at RLNWR_N
#     # 11 - alive at HB; seen at HB
#     # 12 - alive at RLNWR_S; seen at RLNWR_S
#     # 13 - alive at P; seen at P
#     # 14 - dead or lost forever; not seen
#
#     #-------------------------------------------------------------------
#     # Parameters
#     # phi: survival probability for all sites. Because GPS transmitters can
#     #       fail, this is more accurately interpreted as transmitter survival
#     #       probability, which may or may not be related to actual the animals'
#     #       survival. We assume phi is constant across sites.
#     #
#     # p: recapture probability for all sites. Because we are using GPS transmitters
#     #     with potentially different fix rates and only using fixes on refuge,
#     #     this (p) is essentially the probability a fix occured on refuge between
#     #     10:00 and 19:00. We will also assume a constant probability
#     #
#     # psi.BB[1:14]:       probability of transition from BB to any other state
#     #                     that was observed in data
#     # psi.LINWR[1:14]:    probability of transition from LINWR to any other state
#     #                     that was observed in data
#     # psi.BS[1:14]:       probability of transition from BS to any other state
#     #                     that was observed in data
#     # psi.HI[1:14]:       probability of transition from HI to any other state
#     #                     that was observed in data
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#     # psi.M[1:14]:        probability of transition from M to any other state
#     #                     that was observed in data
#     # psi.WL[1:14]:       probability of transition from WL to any other state
#     #                     that was observed in data
#     # psi.CNWR[1:14]:     probability of transition from CNWR to any other state
#     #                     that was observed in data
#     # psi.BLNWR[1:14]:    probability of transition from BLNWR to any other state
#     #                     that was observed in data
#     # psi.LL[1:14]:       probability of transition from LL to any other state
#     #                     that was observed in data
#     # psi.RLNWR_N[1:14]:  probability of transition from RLNWR_N to any other state
#     #                     that was observed in data
#     # psi.HB[1:14]:       probability of transition from HB to any other state
#     #                     that was observed in data
#     # psi.RLNWR_S[1:14]:  probability of transition from RLNWR_S to any other state
#     #                     that was observed in data
#     # psi.P[1:14]:        probability of transition from P to any other state
#     #                     that was observed in data
#     #-------------------------------------------------------------------------
#
#
#
#     ### Priors and constraints -----------
#
#     # Prior for recapture probability / fix probability and survival
#     # Uniform distribution from 0-1 assumes anywhere in parameter space
#     # Is there a way to come up with a more informative prior? Probably but good for now.
#
#     p ~ dunif(0, 1)
#     phi ~ dunif(0, 1)
#
#
#     # Priors for transition probabilities - multinomial logit. We will put normal
#     # priors on the logit scale for an intercept and any covariates for the probabilty
#     # of transitioning to any other refuge. Then we will constrain the transitions
#     # so they sum to < 1, and calculate the probability of staying on refuge.
#
#     # Priors for intercepts on logit scale for transitioning from refuge to any
#     # other refuge. It will be constant for each refuge and only vary based on
#     # covariates. If we were to add intercept for each refuge it would be too
#     # system-specific so we are assuming that refuge transitions depend solely
#     # on island biogeo. and individual characteristics.
#
#     b0 ~ dnorm(0, 0.04)
#
#     # Priors for effect sizes
#     b.dist ~ dnorm(0, 0.04)
#     b.size1 ~ dnorm(0, 0.04)
#     b.size2 ~ dnorm(0, 0.04)
#     b.sex ~ dnorm(0, 0.04)
#     b.age ~ dnorm(0, 0.04)
#
#
```

```
#     # Transition probabilities
#     for(i in 1:ninds){     # loop over no. of individuals (rows)
#       for(s in 2:13){      # And possible transitions 2-13 possibilities
#         # GLM on the logit scale for transition probabilities to any other refuge
#         lpsi.BB[i,s] <- b0 + b.dist * Distance[1,s-1] + b.size1 * Size1[1] +
#                         b.size2 * Size2[s-1,1] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.LINWR[i,s] <- b0 + b.dist * Distance[2,s-1] + b.size1 * Size1[2] +
#                         b.size2 * Size2[s-1,2] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.BS[i,s] <- b0 + b.dist * Distance[3,s-1] + b.size1 * Size1[3] +
#                         b.size2 * Size2[s-1,3] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.HI[i,s] <- b0 + b.dist * Distance[4,s-1] + b.size1 * Size1[4] +
#                         b.size2 * Size2[s-1,4] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.M[i,s] <- b0 + b.dist * Distance[5,s-1] + b.size1 * Size1[5] +
#                         b.size2 * Size2[s-1,5] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.WL[i,s] <- b0 + b.dist * Distance[6,s-1] + b.size1 * Size1[6] +
#                         b.size2 * Size2[s-1,6] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.CNWR[i,s] <- b0 + b.dist * Distance[7,s-1] + b.size1 * Size1[7] +
#                         b.size2 * Size2[s-1,7] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.BLNWR[i,s] <- b0 + b.dist * Distance[8,s-1] + b.size1 * Size1[8] +
#                         b.size2 * Size2[s-1,8] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.LL[i,s] <- b0 + b.dist * Distance[9,s-1] + b.size1 * Size1[9] +
#                         b.size2 * Size2[s-1,9] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.RLNWR_N[i,s] <- b0 + b.dist * Distance[10,s-1] + b.size1 * Size1[10] +
#                         b.size2 * Size2[s-1,10] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.HB[i,s] <- b0 + b.dist * Distance[11,s-1] + b.size1 * Size1[11] +
#                         b.size2 * Size2[s-1,11] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.RLNWR_S[i,s] <- b0 + b.dist * Distance[12,s-1] + b.size1 * Size1[12] +
#                         b.size2 * Size2[s-1,12] + b.sex * Sex[i] + b.age * Age[i]
#         lpsi.P[i,s] <- b0 + b.dist * Distance[13,s-1] + b.size1 * Size1[13] +
#                         b.size2 * Size2[s-1,13] + b.sex * Sex[i] + b.age * Age[i]
#
#
#         # Transform to probability scale and constrain probabilites < 1
#
#         psi.BB[i,s] <- exp(lpsi.BB[i,s]) / (1 + exp(lpsi.BB[i,2]) + exp(lpsi.BB[i,3]) +
#           exp(lpsi.BB[i,4]) + exp(lpsi.BB[i,5]) + exp(lpsi.BB[i,6]) + exp(lpsi.BB[i,7]) +
#           exp(lpsi.BB[i,8]) + exp(lpsi.BB[i,9]) + exp(lpsi.BB[i,10]) + exp(lpsi.BB[i,11]) +
#           exp(lpsi.BB[i,12]) + exp(lpsi.BB[i,13]))
#
#         psi.LINWR[i,s] <- exp(lpsi.LINWR[i,s]) / (1 + exp(lpsi.LINWR[i,2]) +
#           exp(lpsi.LINWR[i,3]) + exp(lpsi.LINWR[i,4]) + exp(lpsi.LINWR[i,5]) +
#           exp(lpsi.LINWR[i,6]) + exp(lpsi.LINWR[i,7]) + exp(lpsi.LINWR[i,8]) +
#           exp(lpsi.LINWR[i,9]) + exp(lpsi.LINWR[i,10]) + exp(lpsi.LINWR[i,11]) +
#           exp(lpsi.LINWR[i,12]) + exp(lpsi.LINWR[i,13]))
#
#         psi.BS[i,s] <- exp(lpsi.BS[i,s]) / (1 + exp(lpsi.BS[i,2]) + exp(lpsi.BS[i,3]) +
#           exp(lpsi.BS[i,4]) + exp(lpsi.BS[i,5]) + exp(lpsi.BS[i,6]) + exp(lpsi.BS[i,7]) +
#           exp(lpsi.BS[i,8]) + exp(lpsi.BS[i,9]) + exp(lpsi.BS[i,10]) + exp(lpsi.BS[i,11]) +
#           exp(lpsi.BS[i,12]) + exp(lpsi.BS[i,13]))
#
#         psi.HI[i,s] <- exp(lpsi.HI[i,s]) / (1 + exp(lpsi.HI[i,2]) + exp(lpsi.HI[i,3]) +
#           exp(lpsi.HI[i,4]) + exp(lpsi.HI[i,5]) + exp(lpsi.HI[i,6]) + exp(lpsi.HI[i,7]) +
#           exp(lpsi.HI[i,8]) + exp(lpsi.HI[i,9]) + exp(lpsi.HI[i,10]) + exp(lpsi.HI[i,11]) +
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```
#           exp(lpsi.HI[i,12]) + exp(lpsi.HI[i,13]))
#
#         psi.M[i,s] <- exp(lpsi.M[i,s]) / (1 + exp(lpsi.M[i,2]) + exp(lpsi.M[i,3]) +
#           exp(lpsi.M[i,4]) + exp(lpsi.M[i,5]) + exp(lpsi.M[i,6]) + exp(lpsi.M[i,7]) +
#           exp(lpsi.M[i,8]) + exp(lpsi.M[i,9]) + exp(lpsi.M[i,10]) + exp(lpsi.M[i,11]) +
#           exp(lpsi.M[i,12]) + exp(lpsi.M[i,13]))
#
#         psi.WL[i,s] <- exp(lpsi.WL[i,s]) / (1 + exp(lpsi.WL[i,2]) + exp(lpsi.WL[i,3]) +
#           exp(lpsi.WL[i,4]) + exp(lpsi.WL[i,5]) + exp(lpsi.WL[i,6]) + exp(lpsi.WL[i,7]) +
#           exp(lpsi.WL[i,8]) + exp(lpsi.WL[i,9]) + exp(lpsi.WL[i,10]) + exp(lpsi.WL[i,11]) +
#           exp(lpsi.WL[i,12]) + exp(lpsi.WL[i,13]))
#
#         psi.CNWR[i,s] <- exp(lpsi.CNWR[i,s]) / (1 + exp(lpsi.CNWR[i,2]) + exp(lpsi.CNWR[i,3]) +
#           exp(lpsi.CNWR[i,4]) + exp(lpsi.CNWR[i,5]) + exp(lpsi.CNWR[i,6]) + exp(lpsi.CNWR[i,7]) +
#           exp(lpsi.CNWR[i,8]) + exp(lpsi.CNWR[i,9]) + exp(lpsi.CNWR[i,10]) + exp(lpsi.CNWR[i,11]) +
#           exp(lpsi.CNWR[i,12]) + exp(lpsi.CNWR[i,13]))
#
#         psi.BLNWR[i,s] <- exp(lpsi.BLNWR[i,s]) / (1 + exp(lpsi.BLNWR[i,2]) +
#           exp(lpsi.BLNWR[i,3]) + exp(lpsi.BLNWR[i,4]) + exp(lpsi.BLNWR[i,5]) +
#           exp(lpsi.BLNWR[i,6]) + exp(lpsi.BLNWR[i,7]) + exp(lpsi.BLNWR[i,8]) +
#           exp(lpsi.BLNWR[i,9]) + exp(lpsi.BLNWR[i,10]) + exp(lpsi.BLNWR[i,11]) +
#           exp(lpsi.BLNWR[i,12]) + exp(lpsi.BLNWR[i,13]))
#
#         psi.LL[i,s] <- exp(lpsi.LL[i,s]) / (1 + exp(lpsi.LL[i,2]) + exp(lpsi.LL[i,3]) +
#           exp(lpsi.LL[i,4]) + exp(lpsi.LL[i,5]) + exp(lpsi.LL[i,6]) + exp(lpsi.LL[i,7]) +
#           exp(lpsi.LL[i,8]) + exp(lpsi.LL[i,9]) + exp(lpsi.LL[i,10]) + exp(lpsi.LL[i,11]) +
#           exp(lpsi.LL[i,12]) + exp(lpsi.LL[i,13]))
#
#         psi.RLNWR_N[i,s] <- exp(lpsi.RLNWR_N[i,s]) / (1 + exp(lpsi.RLNWR_N[i,2]) + exp(lpsi.RLNWR_N[i
#           exp(lpsi.RLNWR_N[i,4]) + exp(lpsi.RLNWR_N[i,5]) + exp(lpsi.RLNWR_N[i,6]) + exp(lpsi.RLNWR_N
#           exp(lpsi.RLNWR_N[i,8]) + exp(lpsi.RLNWR_N[i,9]) + exp(lpsi.RLNWR_N[i,10]) + exp(lpsi.RLNWR_
#           exp(lpsi.RLNWR_N[i,12]) + exp(lpsi.RLNWR_N[i,13]))
#
#         psi.HB[i,s] <- exp(lpsi.HB[i,s]) / (1 + exp(lpsi.HB[i,2]) + exp(lpsi.HB[i,3]) +
#           exp(lpsi.HB[i,4]) + exp(lpsi.HB[i,5]) + exp(lpsi.HB[i,6]) + exp(lpsi.HB[i,7]) +
#           exp(lpsi.HB[i,8]) + exp(lpsi.HB[i,9]) + exp(lpsi.HB[i,10]) + exp(lpsi.HB[i,11]) +
#           exp(lpsi.HB[i,12]) + exp(lpsi.HB[i,13]))
#
#         psi.RLNWR_S[i,s] <- exp(lpsi.RLNWR_S[i,s]) / (1 + exp(lpsi.RLNWR_S[i,2]) + exp(lpsi.RLNWR_S[i
#           exp(lpsi.RLNWR_S[i,4]) + exp(lpsi.RLNWR_S[i,5]) + exp(lpsi.RLNWR_S[i,6]) + exp(lpsi.RLNWR_S
#           exp(lpsi.RLNWR_S[i,8]) + exp(lpsi.RLNWR_S[i,9]) + exp(lpsi.RLNWR_S[i,10]) + exp(lpsi.RLNWR_
#           exp(lpsi.RLNWR_S[i,12]) + exp(lpsi.RLNWR_S[i,13]))
#
#         psi.P[i,s] <- exp(lpsi.P[i,s]) / (1 + exp(lpsi.P[i,2]) + exp(lpsi.P[i,3]) +
#           exp(lpsi.P[i,4]) + exp(lpsi.P[i,5]) + exp(lpsi.P[i,6]) + exp(lpsi.P[i,7]) +
#           exp(lpsi.P[i,8]) + exp(lpsi.P[i,9]) + exp(lpsi.P[i,10]) + exp(lpsi.P[i,11]) +
#           exp(lpsi.P[i,12]) + exp(lpsi.P[i,13]))
#
#       } # end s
#
#       # Calculate probability of staying
#       # Simply 1 - sum of transition probs
#
```

```
#       psi.BB[i,1] <- 1 - sum(psi.BB[i,2:13])
#       psi.LINWR[i,1] <- 1 - sum(psi.LINWR[i,2:13])
#       psi.BS[i,1] <- 1 - sum(psi.BS[i,2:13])
#       psi.HI[i,1] <- 1 - sum(psi.HI[i,2:13])
#       psi.M[i,1] <- 1 - sum(psi.M[i,2:13])
#       psi.WL[i,1] <- 1 - sum(psi.WL[i,2:13])
#       psi.CNWR[i,1] <- 1 - sum(psi.CNWR[i,2:13])
#       psi.BLNWR[i,1] <- 1 - sum(psi.BLNWR[i,2:13])
#       psi.LL[i,1] <- 1 - sum(psi.LL[i,2:13])
#       psi.RLNWR_N[i,1] <- 1 - sum(psi.RLNWR_N[i,2:13])
#       psi.HB[i,1] <- 1 - sum(psi.HB[i,2:13])
#       psi.RLNWR_S[i,1] <- 1 - sum(psi.RLNWR_S[i,2:13])
#       psi.P[i,1] <- 1 - sum(psi.P[i,2:13])
#
#     } # end i
#
#
#     ### Define state-transition and observer matrices --------
#     for(i in 1:ninds){
#       for(t in f[i]:(noccs - 1)){
#
#         # Movement (ps) from BB (1) to any other refuge and observation (po)
#         ps[1,i,t,1] <- psi.BB[i,1] * phi
#         ps[1,i,t,2] <- psi.BB[i,2] * phi
#         ps[1,i,t,3] <- psi.BB[i,3] * phi
#         ps[1,i,t,4] <- psi.BB[i,4] * phi
#         ps[1,i,t,5] <- psi.BB[i,5] * phi
#         ps[1,i,t,6] <- psi.BB[i,6] * phi
#         ps[1,i,t,7] <- psi.BB[i,7] * phi
#         ps[1,i,t,8] <- psi.BB[i,8] * phi
#         ps[1,i,t,9] <- psi.BB[i,9] * phi
#         ps[1,i,t,10] <- psi.BB[i,10] * phi
#         ps[1,i,t,11] <- psi.BB[i,11] * phi
#         ps[1,i,t,12] <- psi.BB[i,12] * phi
#         ps[1,i,t,13] <- psi.BB[i,13] * phi
#         ps[1,i,t,14] <- 1 - phi
#
#         po[1,i,t,1] <- p
#         po[1,i,t,2] <- 0
#         po[1,i,t,3] <- 0
#         po[1,i,t,4] <- 0
#         po[1,i,t,5] <- 0
#         po[1,i,t,6] <- 0
#         po[1,i,t,7] <- 0
#         po[1,i,t,8] <- 0
#         po[1,i,t,9] <- 0
#         po[1,i,t,10] <- 0
#         po[1,i,t,11] <- 0
#         po[1,i,t,12] <- 0
#         po[1,i,t,13] <- 0
#         po[1,i,t,14] <- 1 - p
#
#         # Movement from LINWR (2) to any other refuge and observation (po)
```

```
#         ps[2,i,t,1] <- psi.LINWR[i,2] * phi
#         ps[2,i,t,2] <- psi.LINWR[i,1] * phi
#         ps[2,i,t,3] <- psi.LINWR[i,3] * phi
#         ps[2,i,t,4] <- psi.LINWR[i,4] * phi
#         ps[2,i,t,5] <- psi.LINWR[i,5] * phi
#         ps[2,i,t,6] <- psi.LINWR[i,6] * phi
#         ps[2,i,t,7] <- psi.LINWR[i,7] * phi
#         ps[2,i,t,8] <- psi.LINWR[i,8] * phi
#         ps[2,i,t,9] <- psi.LINWR[i,9] * phi
#         ps[2,i,t,10] <- psi.LINWR[i,10] * phi
#         ps[2,i,t,11] <- psi.LINWR[i,11] * phi
#         ps[2,i,t,12] <- psi.LINWR[i,12] * phi
#         ps[2,i,t,13] <- psi.LINWR[i,13] * phi
#         ps[2,i,t,14] <- 1 - phi
#
#         po[2,i,t,1] <- 0
#         po[2,i,t,2] <- p
#         po[2,i,t,3] <- 0
#         po[2,i,t,4] <- 0
#         po[2,i,t,5] <- 0
#         po[2,i,t,6] <- 0
#         po[2,i,t,7] <- 0
#         po[2,i,t,8] <- 0
#         po[2,i,t,9] <- 0
#         po[2,i,t,10] <- 0
#         po[2,i,t,11] <- 0
#         po[2,i,t,12] <- 0
#         po[2,i,t,13] <- 0
#         po[2,i,t,14] <- 1 - p
#
#         # Movement from BS (3) to any other refuge and observation (po)
#         ps[3,i,t,1] <- psi.BS[i,2] * phi
#         ps[3,i,t,2] <- psi.BS[i,3] * phi
#         ps[3,i,t,3] <- psi.BS[i,1] * phi
#         ps[3,i,t,4] <- psi.BS[i,4] * phi
#         ps[3,i,t,5] <- psi.BS[i,5] * phi
#         ps[3,i,t,6] <- psi.BS[i,6] * phi
#         ps[3,i,t,7] <- psi.BS[i,7] * phi
#         ps[3,i,t,8] <- psi.BS[i,8] * phi
#         ps[3,i,t,9] <- psi.BS[i,9] * phi
#         ps[3,i,t,10] <- psi.BS[i,10] * phi
#         ps[3,i,t,11] <- psi.BS[i,11] * phi
#         ps[3,i,t,12] <- psi.BS[i,12] * phi
#         ps[3,i,t,13] <- psi.BS[i,13] * phi
#         ps[3,i,t,14] <- 1 - phi
#
#         po[3,i,t,1] <- 0
#         po[3,i,t,2] <- 0
#         po[3,i,t,3] <- p
#         po[3,i,t,4] <- 0
#         po[3,i,t,5] <- 0
#         po[3,i,t,6] <- 0
#         po[3,i,t,7] <- 0
```

```
#         po[3,i,t,8] <- 0
#         po[3,i,t,9] <- 0
#         po[3,i,t,10] <- 0
#         po[3,i,t,11] <- 0
#         po[3,i,t,12] <- 0
#         po[3,i,t,13] <- 0
#         po[3,i,t,14] <- 1 - p
#
#         # Movement from HI (4) to any other refuge and observation (po)
#         ps[4,i,t,1] <- psi.HI[i,2] * phi
#         ps[4,i,t,2] <- psi.HI[i,3] * phi
#         ps[4,i,t,3] <- psi.HI[i,4] * phi
#         ps[4,i,t,4] <- psi.HI[i,1] * phi
#         ps[4,i,t,5] <- psi.HI[i,5] * phi
#         ps[4,i,t,6] <- psi.HI[i,6] * phi
#         ps[4,i,t,7] <- psi.HI[i,7] * phi
#         ps[4,i,t,8] <- psi.HI[i,8] * phi
#         ps[4,i,t,9] <- psi.HI[i,9] * phi
#         ps[4,i,t,10] <- psi.HI[i,10] * phi
#         ps[4,i,t,11] <- psi.HI[i,11] * phi
#         ps[4,i,t,12] <- psi.HI[i,12] * phi
#         ps[4,i,t,13] <- psi.HI[i,13] * phi
#         ps[4,i,t,14] <- 1 - phi
#
#         po[4,i,t,1] <- 0
#         po[4,i,t,2] <- 0
#         po[4,i,t,3] <- 0
#         po[4,i,t,4] <- p
#         po[4,i,t,5] <- 0
#         po[4,i,t,6] <- 0
#         po[4,i,t,7] <- 0
#         po[4,i,t,8] <- 0
#         po[4,i,t,9] <- 0
#         po[4,i,t,10] <- 0
#         po[4,i,t,11] <- 0
#         po[4,i,t,12] <- 0
#         po[4,i,t,13] <- 0
#         po[4,i,t,14] <- 1 - p
#
#         # Movement from M (5) to any other refuge and observation (po)
#         ps[5,i,t,1] <- psi.M[i,2] * phi
#         ps[5,i,t,2] <- psi.M[i,3] * phi
#         ps[5,i,t,3] <- psi.M[i,4] * phi
#         ps[5,i,t,4] <- psi.M[i,5] * phi
#         ps[5,i,t,5] <- psi.M[i,1] * phi
#         ps[5,i,t,6] <- psi.M[i,6] * phi
#         ps[5,i,t,7] <- psi.M[i,7] * phi
#         ps[5,i,t,8] <- psi.M[i,8] * phi
#         ps[5,i,t,9] <- psi.M[i,9] * phi
#         ps[5,i,t,10] <- psi.M[i,10] * phi
#         ps[5,i,t,11] <- psi.M[i,11] * phi
#         ps[5,i,t,12] <- psi.M[i,12] * phi
#         ps[5,i,t,13] <- psi.M[i,13] * phi
```

```
#         ps[5,i,t,14] <- 1 - phi
#
#         po[5,i,t,1] <- 0
#         po[5,i,t,2] <- 0
#         po[5,i,t,3] <- 0
#         po[5,i,t,4] <- 0
#         po[5,i,t,5] <- p
#         po[5,i,t,6] <- 0
#         po[5,i,t,7] <- 0
#         po[5,i,t,8] <- 0
#         po[5,i,t,9] <- 0
#         po[5,i,t,10] <- 0
#         po[5,i,t,11] <- 0
#         po[5,i,t,12] <- 0
#         po[5,i,t,13] <- 0
#         po[5,i,t,14] <- 1 - p
#
#         # Movement from WL (6) to any other refuge and observation (po)
#         ps[6,i,t,1] <- psi.WL[i,2] * phi
#         ps[6,i,t,2] <- psi.WL[i,3] * phi
#         ps[6,i,t,3] <- psi.WL[i,4] * phi
#         ps[6,i,t,4] <- psi.WL[i,5] * phi
#         ps[6,i,t,5] <- psi.WL[i,6] * phi
#         ps[6,i,t,6] <- psi.WL[i,1] * phi
#         ps[6,i,t,7] <- psi.WL[i,7] * phi
#         ps[6,i,t,8] <- psi.WL[i,8] * phi
#         ps[6,i,t,9] <- psi.WL[i,9] * phi
#         ps[6,i,t,10] <- psi.WL[i,10] * phi
#         ps[6,i,t,11] <- psi.WL[i,11] * phi
#         ps[6,i,t,12] <- psi.WL[i,12] * phi
#         ps[6,i,t,13] <- psi.WL[i,13] * phi
#         ps[6,i,t,14] <- 1 - phi
#
#         po[6,i,t,1] <- 0
#         po[6,i,t,2] <- 0
#         po[6,i,t,3] <- 0
#         po[6,i,t,4] <- 0
#         po[6,i,t,5] <- 0
#         po[6,i,t,6] <- p
#         po[6,i,t,7] <- 0
#         po[6,i,t,8] <- 0
#         po[6,i,t,9] <- 0
#         po[6,i,t,10] <- 0
#         po[6,i,t,11] <- 0
#         po[6,i,t,12] <- 0
#         po[6,i,t,13] <- 0
#         po[6,i,t,14] <- 1 - p
#
#         # Movement from CNWR (7) to any other refuge and observation (po)
#         ps[7,i,t,1] <- psi.CNWR[i,2] * phi
#         ps[7,i,t,2] <- psi.CNWR[i,3] * phi
#         ps[7,i,t,3] <- psi.CNWR[i,4] * phi
#         ps[7,i,t,4] <- psi.CNWR[i,5] * phi
```

```
#         ps[7,i,t,5] <- psi.CNWR[i,6] * phi
#         ps[7,i,t,6] <- psi.CNWR[i,7] * phi
#         ps[7,i,t,7] <- psi.CNWR[i,1] * phi
#         ps[7,i,t,8] <- psi.CNWR[i,8] * phi
#         ps[7,i,t,9] <- psi.CNWR[i,9] * phi
#         ps[7,i,t,10] <- psi.CNWR[i,10] * phi
#         ps[7,i,t,11] <- psi.CNWR[i,11] * phi
#         ps[7,i,t,12] <- psi.CNWR[i,12] * phi
#         ps[7,i,t,13] <- psi.CNWR[i,13] * phi
#         ps[7,i,t,14] <- 1 - phi
#
#         po[7,i,t,1] <- 0
#         po[7,i,t,2] <- 0
#         po[7,i,t,3] <- 0
#         po[7,i,t,4] <- 0
#         po[7,i,t,5] <- 0
#         po[7,i,t,6] <- 0
#         po[7,i,t,7] <- p
#         po[7,i,t,8] <- 0
#         po[7,i,t,9] <- 0
#         po[7,i,t,10] <- 0
#         po[7,i,t,11] <- 0
#         po[7,i,t,12] <- 0
#         po[7,i,t,13] <- 0
#         po[7,i,t,14] <- 1 - p
#
#         # Movement from BLNWR (8) to any other refuge and observation (po)
#         ps[8,i,t,1] <- psi.BLNWR[i,2] * phi
#         ps[8,i,t,2] <- psi.BLNWR[i,3] * phi
#         ps[8,i,t,3] <- psi.BLNWR[i,4] * phi
#         ps[8,i,t,4] <- psi.BLNWR[i,5] * phi
#         ps[8,i,t,5] <- psi.BLNWR[i,6] * phi
#         ps[8,i,t,6] <- psi.BLNWR[i,7] * phi
#         ps[8,i,t,7] <- psi.BLNWR[i,8] * phi
#         ps[8,i,t,8] <- psi.BLNWR[i,1] * phi
#         ps[8,i,t,9] <- psi.BLNWR[i,9] * phi
#         ps[8,i,t,10] <- psi.BLNWR[i,10] * phi
#         ps[8,i,t,11] <- psi.BLNWR[i,11] * phi
#         ps[8,i,t,12] <- psi.BLNWR[i,12] * phi
#         ps[8,i,t,13] <- psi.BLNWR[i,13] * phi
#         ps[8,i,t,14] <- 1 - phi
#
#         po[8,i,t,1] <- 0
#         po[8,i,t,2] <- 0
#         po[8,i,t,3] <- 0
#         po[8,i,t,4] <- 0
#         po[8,i,t,5] <- 0
#         po[8,i,t,6] <- 0
#         po[8,i,t,7] <- 0
#         po[8,i,t,8] <- p
#         po[8,i,t,9] <- 0
#         po[8,i,t,10] <- 0
#         po[8,i,t,11] <- 0
```

```
#         po[8,i,t,12] <- 0
#         po[8,i,t,13] <- 0
#         po[8,i,t,14] <- 1 - p
#
#         # Movement from LL (9) to any other refuge and observation (po)
#         ps[9,i,t,1] <- psi.LL[i,2] * phi
#         ps[9,i,t,2] <- psi.LL[i,3] * phi
#         ps[9,i,t,3] <- psi.LL[i,4] * phi
#         ps[9,i,t,4] <- psi.LL[i,5] * phi
#         ps[9,i,t,5] <- psi.LL[i,6] * phi
#         ps[9,i,t,6] <- psi.LL[i,7] * phi
#         ps[9,i,t,7] <- psi.LL[i,8] * phi
#         ps[9,i,t,8] <- psi.LL[i,9] * phi
#         ps[9,i,t,9] <- psi.LL[i,1] * phi
#         ps[9,i,t,10] <- psi.LL[i,10] * phi
#         ps[9,i,t,11] <- psi.LL[i,11] * phi
#         ps[9,i,t,12] <- psi.LL[i,12] * phi
#         ps[9,i,t,13] <- psi.LL[i,13] * phi
#         ps[9,i,t,14] <- 1 - phi
#
#         po[9,i,t,1] <- 0
#         po[9,i,t,2] <- 0
#         po[9,i,t,3] <- 0
#         po[9,i,t,4] <- 0
#         po[9,i,t,5] <- 0
#         po[9,i,t,6] <- 0
#         po[9,i,t,7] <- 0
#         po[9,i,t,8] <- 0
#         po[9,i,t,9] <- p
#         po[9,i,t,10] <- 0
#         po[9,i,t,11] <- 0
#         po[9,i,t,12] <- 0
#         po[9,i,t,13] <- 0
#         po[9,i,t,14] <- 1 - p
#
#         # Movement from RLNWR_N (10) to any other refuge and observation (po)
#         ps[10,i,t,1] <- psi.RLNWR_N[i,2] * phi
#         ps[10,i,t,2] <- psi.RLNWR_N[i,3] * phi
#         ps[10,i,t,3] <- psi.RLNWR_N[i,4] * phi
#         ps[10,i,t,4] <- psi.RLNWR_N[i,5] * phi
#         ps[10,i,t,5] <- psi.RLNWR_N[i,6] * phi
#         ps[10,i,t,6] <- psi.RLNWR_N[i,7] * phi
#         ps[10,i,t,7] <- psi.RLNWR_N[i,8] * phi
#         ps[10,i,t,8] <- psi.RLNWR_N[i,9] * phi
#         ps[10,i,t,9] <- psi.RLNWR_N[i,10] * phi
#         ps[10,i,t,10] <- psi.RLNWR_N[i,1] * phi
#         ps[10,i,t,11] <- psi.RLNWR_N[i,11] * phi
#         ps[10,i,t,12] <- psi.RLNWR_N[i,12] * phi
#         ps[10,i,t,13] <- psi.RLNWR_N[i,13] * phi
#         ps[10,i,t,14] <- 1 - phi
#
#         po[10,i,t,1] <- 0
#         po[10,i,t,2] <- 0
```

```
#         po[10,i,t,3] <- 0
#         po[10,i,t,4] <- 0
#         po[10,i,t,5] <- 0
#         po[10,i,t,6] <- 0
#         po[10,i,t,7] <- 0
#         po[10,i,t,8] <- 0
#         po[10,i,t,9] <- 0
#         po[10,i,t,10] <- p
#         po[10,i,t,11] <- 0
#         po[10,i,t,12] <- 0
#         po[10,i,t,13] <- 0
#         po[10,i,t,14] <- 1 - p
#
#         # Movement from HB (11) to any other refuge and observation (po)
#         ps[11,i,t,1] <- psi.HB[i,2] * phi
#         ps[11,i,t,2] <- psi.HB[i,3] * phi
#         ps[11,i,t,3] <- psi.HB[i,4] * phi
#         ps[11,i,t,4] <- psi.HB[i,5] * phi
#         ps[11,i,t,5] <- psi.HB[i,6] * phi
#         ps[11,i,t,6] <- psi.HB[i,7] * phi
#         ps[11,i,t,7] <- psi.HB[i,8] * phi
#         ps[11,i,t,8] <- psi.HB[i,9] * phi
#         ps[11,i,t,9] <- psi.HB[i,10] * phi
#         ps[11,i,t,10] <- psi.HB[i,11] * phi
#         ps[11,i,t,11] <- psi.HB[i,1] * phi
#         ps[11,i,t,12] <- psi.HB[i,12] * phi
#         ps[11,i,t,13] <- psi.HB[i,13] * phi
#         ps[11,i,t,14] <- 1 - phi
#
#         po[11,i,t,1] <- 0
#         po[11,i,t,2] <- 0
#         po[11,i,t,3] <- 0
#         po[11,i,t,4] <- 0
#         po[11,i,t,5] <- 0
#         po[11,i,t,6] <- 0
#         po[11,i,t,7] <- 0
#         po[11,i,t,8] <- 0
#         po[11,i,t,9] <- 0
#         po[11,i,t,10] <- 0
#         po[11,i,t,11] <- p
#         po[11,i,t,12] <- 0
#         po[11,i,t,13] <- 0
#         po[11,i,t,14] <- 1 - p
#
#         # Movement from RLNWR_S (12) to any other refuge and observation (po)
#         ps[12,i,t,1] <- psi.RLNWR_S[i,2] * phi
#         ps[12,i,t,2] <- psi.RLNWR_S[i,3] * phi
#         ps[12,i,t,3] <- psi.RLNWR_S[i,4] * phi
#         ps[12,i,t,4] <- psi.RLNWR_S[i,5] * phi
#         ps[12,i,t,5] <- psi.RLNWR_S[i,6] * phi
#         ps[12,i,t,6] <- psi.RLNWR_S[i,7] * phi
#         ps[12,i,t,7] <- psi.RLNWR_S[i,8] * phi
#         ps[12,i,t,8] <- psi.RLNWR_S[i,9] * phi
```

```
#         ps[12,i,t,9] <- psi.RLNWR_S[i,10] * phi
#         ps[12,i,t,10] <- psi.RLNWR_S[i,11] * phi
#         ps[12,i,t,11] <- psi.RLNWR_S[i,12] * phi
#         ps[12,i,t,12] <- psi.RLNWR_S[i,1] * phi
#         ps[12,i,t,13] <- psi.RLNWR_S[i,13] * phi
#         ps[12,i,t,14] <- 1 - phi
#
#         po[12,i,t,1] <- 0
#         po[12,i,t,2] <- 0
#         po[12,i,t,3] <- 0
#         po[12,i,t,4] <- 0
#         po[12,i,t,5] <- 0
#         po[12,i,t,6] <- 0
#         po[12,i,t,7] <- 0
#         po[12,i,t,8] <- 0
#         po[12,i,t,9] <- 0
#         po[12,i,t,10] <- 0
#         po[12,i,t,11] <- 0
#         po[12,i,t,12] <- p
#         po[12,i,t,13] <- 0
#         po[12,i,t,14] <- 1 - p
#
#         # Movement from P (13) to any other refuge and observation (po)
#         ps[13,i,t,1] <- psi.P[i,2] * phi
#         ps[13,i,t,2] <- psi.P[i,3] * phi
#         ps[13,i,t,3] <- psi.P[i,4] * phi
#         ps[13,i,t,4] <- psi.P[i,5] * phi
#         ps[13,i,t,5] <- psi.P[i,6] * phi
#         ps[13,i,t,6] <- psi.P[i,7] * phi
#         ps[13,i,t,7] <- psi.P[i,8] * phi
#         ps[13,i,t,8] <- psi.P[i,9] * phi
#         ps[13,i,t,9] <- psi.P[i,10] * phi
#         ps[13,i,t,10] <- psi.P[i,11] * phi
#         ps[13,i,t,11] <- psi.P[i,12] * phi
#         ps[13,i,t,12] <- psi.P[i,13] * phi
#         ps[13,i,t,13] <- psi.P[i,1] * phi
#         ps[13,i,t,14] <- 1 - phi
#
#         po[13,i,t,1] <- 0
#         po[13,i,t,2] <- 0
#         po[13,i,t,3] <- 0
#         po[13,i,t,4] <- 0
#         po[13,i,t,5] <- 0
#         po[13,i,t,6] <- 0
#         po[13,i,t,7] <- 0
#         po[13,i,t,8] <- 0
#         po[13,i,t,9] <- 0
#         po[13,i,t,10] <- 0
#         po[13,i,t,11] <- 0
#         po[13,i,t,12] <- 0
#         po[13,i,t,13] <- p
#         po[13,i,t,14] <- 1 - p
#
```

```
#
#         # Movement from dead/lost (14) to any other refuge and observation (po)
#         ps[14,i,t,1] <- 0
#         ps[14,i,t,2] <- 0
#         ps[14,i,t,3] <- 0
#         ps[14,i,t,4] <- 0
#         ps[14,i,t,5] <- 0
#         ps[14,i,t,6] <- 0
#         ps[14,i,t,7] <- 0
#         ps[14,i,t,8] <- 0
#         ps[14,i,t,9] <- 0
#         ps[14,i,t,10] <- 0
#         ps[14,i,t,11] <- 0
#         ps[14,i,t,12] <- 0
#         ps[14,i,t,13] <- 0
#         ps[14,i,t,14] <- 1
#
#         po[14,i,t,1] <- 0
#         po[14,i,t,2] <- 0
#         po[14,i,t,3] <- 0
#         po[14,i,t,4] <- 0
#         po[14,i,t,5] <- 0
#         po[14,i,t,6] <- 0
#         po[14,i,t,7] <- 0
#         po[14,i,t,8] <- 0
#         po[14,i,t,9] <- 0
#         po[14,i,t,10] <- 0
#         po[14,i,t,11] <- 0
#         po[14,i,t,12] <- 0
#         po[14,i,t,13] <- 0
#         po[14,i,t,14] <- 1
#
#       } # end t
#     } # end i
#
#
#
#     ### Likelihood -----------
#     for(i in 1:ninds){
#       # Define latent state at first capture
#       z[i,f[i]] <- init_state[i]
#
#       for(t in (f[i]+1):noccs){
#
#         # Ecological / state process: draw S(t) given S(t-1)
#         z[i,t] ~ dcat(ps[z[i,t-1], i, t-1,])
#
#         # Observation process: draw O(t) given S(t)
#         y[i,t] ~ dcat(po[z[i,t], i, t-1,])
#       } # end t
#     } # end i
#
#
```

```
#     }
```