# Effects of Wetland Impoundment Management and Vegetation Community on Sora Density in Missouri During Fall Migration

## Set Up

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")

#load required libraries
library(unmarked)
library(AICcmodavg)
library(ggplot2)
library(reshape2)
library(lattice)
library(sjPlot)
library(grid)
```

## 2012 Round 2

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in the sora observations
sora12r2 <- read.csv('2012r2_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov12r2 <- read.csv('2012r2_cov.csv', header=T)
#subset just the covariates we need
cov12r2 <- cov12r2[,c("impound","region","length_2","averagewater_2","waterp","woodp")]

sora12r2 <- sora12r2[sora12r2$impound!="n mallard",]
sora12r2 <- sora12r2[sora12r2$impound!="sanctuary",]
sora12r2 <- sora12r2[sora12r2$impound!="ash",]
sora12r2 <- sora12r2[sora12r2$impound!="pool2",]

cov12r2 <- cov12r2[cov12r2$impound!="n mallard",]
cov12r2 <- cov12r2[cov12r2$impound!="sanctuary",]
cov12r2 <- cov12r2[cov12r2$impound!="ash",]
cov12r2 <- cov12r2[cov12r2$impound!="pool2",]

sora12r2 <- sora12r2[order(sora12r2$impound),]
cov12r2 <- cov12r2[order(cov12r2$impound),]
sora12r2 <- sora12r2[,3:41]

cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13)) #the fartherest distance is 12

#Unmarked Data Frame
umf12r2 = unmarkedFrameGDS(y=sora12r2,
                           numPrimary=3,
                           siteCovs = cov12r2,
                           survey="line",
```

```
                           dist.breaks=cutpt,
                           unitsIn="km",
                           tlength=cov12r2$length_2,
)

##candidate models
null12r2 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~1,
                     data = umf12r2, keyfun = "hazard",
                     mixture="NB",
                     se = T)


global12r2 = gdistsamp(lambdaformula = ~averagewater_2+region-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf12r2,
                       keyfun = "hazard",
                       mixture="NB",
                       output="density",
                       unitsOut="kmsq",
                       se = F)

a12r2 = gdistsamp(lambdaformula = ~waterp-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf12r2, keyfun = "hazard", mixture="NB",se = T)

b12r2 = gdistsamp(lambdaformula = ~averagewater_2-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf12r2, keyfun = "hazard", mixture="NB",se = T)

c12r2 = gdistsamp(lambdaformula = ~region-1,
                   phiformula = ~1,
                   pformula = ~  1,
                   data = umf12r2, keyfun = "hazard", mixture="NB",se = F)

list12r2 = fitList(null12r2, global12r2, a12r2, b12r2, c12r2)
model12r2 = modSel(list12r2)
```

```
## Hessian is singular.
## Hessian is singular.
```

## 2012 Round 3

```
# #read in the sora observations
# sora12r3 <- read.csv('2012r3_sora.csv', header=T)
# #read in the covariate data #organized by impoundment.
# cov12r3 <- read.csv('2012r3_cov.csv', header=T)
```

```
# #subset the covariates we need
# cov12r3 <- cov12r3[,c("region","length_3","averagewater_3","impound")]
#
# sora12r3 <- sora12r3[order(sora12r3$impound),]
# cov12r3 <- cov12r3[order(cov12r3$impound),]
# sora12r3 <- sora12r3[,2:40]
# #the distance bins
# cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13)) #the fartherest distance is 12
# #Unmarked Data Frame
# umf12r3 = unmarkedFrameGDS(y=sora12r3,
#                            numPrimary=3,
#                            siteCovs = cov12r3,
#                            survey="line",
#                            dist.breaks=cutpt,
#                            unitsIn="m",
#                            tlength=cov12r3$length_3,
# )
#
# null12r3 = gdistsamp(lambdaformula = ~1,
#                      phiformula = ~1,
#                      pformula = ~ 1,
#                      data = umf12r3, keyfun = "hazard", mixture="NB",se = T)
#
# global12r3 = gdistsamp(lambdaformula = ~averagewater_3+region-1,
#                        phiformula = ~1,
#                        pformula = ~ 1,
#                        data = umf12r3, keyfun = "hazard", mixture="NB",se = T)
#
# a12r3 = gdistsamp(lambdaformula = ~averagewater_3-1,
#                   phiformula = ~1,
#                   pformula = ~ 1,
#                   data = umf12r3, keyfun = "hazard", mixture="NB",se = T)
#
#
# b12r3 = gdistsamp(lambdaformula = ~region-1,
#                   phiformula = ~1,
#                   pformula = ~ 1,
#                   data = umf12r3, keyfun = "hazard", mixture="NB",se = T)
#
#
#
#
# list12r3 = fitList(null12r3, global12r3, a12r3, b12r3, d12r3,e12r3, f12r3,h12r3,m12r3)
# model12r3 = modSel(list12r3)
```

## 2013 Round 1

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in sora data
sora13r1 <- read.csv('2013r1_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov13r1 <- read.csv('2013r1_cov.csv', header=T)
```

```r
#subset the covariates we need
cov13r1 <- cov13r1[,c("region","length_1","averagewater_1","impound")]

sora13r1 <- sora13r1[sora13r1$impound!="pool2w",]
sora13r1 <- sora13r1[sora13r1$impound!="ditch",]
sora13r1 <- sora13r1[sora13r1$impound!="dc14",]

cov13r1 <- cov13r1[cov13r1$impound!="pool2w",]
cov13r1 <- cov13r1[cov13r1$impound!="ditch",]
cov13r1 <- cov13r1[cov13r1$impound!="dc14",]

sora13r1 <- sora13r1[order(sora13r1$impound),]
cov13r1 <- cov13r1[order(cov13r1$impound),]

sora13r1 <- sora13r1[,2:79] #we're cutting out night 4.1 and 4.2 because it only happened once

#the distance bins
cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13)) #the fartherest distance is 12
#Unmarked Data Frame
umf13r1 = unmarkedFrameGDS(y=sora13r1,
                           numPrimary=6,
                           siteCovs = cov13r1,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov13r1$length_1,
)

null13r1 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~ 1,
                     data = umf13r1, keyfun = "hazard", mixture="NB",se = T
)

global13r1 = gdistsamp(lambdaformula = ~averagewater_1+region-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf13r1, keyfun = "hazard", mixture="NB",se = T)

a13r1 = gdistsamp(lambdaformula = ~averagewater_1-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf13r1, keyfun = "hazard", mixture="NB",se = T)

b13r1 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf13r1, keyfun = "hazard", mixture="NB",se = T)

list13r1 = fitList(null13r1, global13r1, a13r1, b13r1)
model13r1 =modSel(list13r1)
```

## 2013 Round 2

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in the sora observations
sora13r2 <- read.csv('2013r2_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov13r2 <- read.csv('2013r2_cov.csv', header=T)
#subset covaraites we need
cov13r2 <- cov13r2[,c("region","length_2","averagewater_2","impound")]
# #the distance bins

sora13r2 <- sora13r2[sora13r2$impound!="kt2",]
sora13r2 <- sora13r2[sora13r2$impound!="pool2w",]
cov13r2 <- cov13r2[cov13r2$impound!="kt2",]
cov13r2 <- cov13r2[cov13r2$impound!="pool2w",]


sora13r2 <- sora13r2[order(sora13r2$impound),]
cov13r2 <- cov13r2[order(cov13r2$impound),]

sora13r2 <- sora13r2[,2:79] #we're cutting out night 4.1 and 4.2 because it only happened once
cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13))
#Unmarked Data Frame
umf13r2 = unmarkedFrameGDS(y=sora13r2,
                           numPrimary=6,
                           siteCovs = cov13r2,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov13r2$length_2,
)

null13r2 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~  1,
                     data = umf13r2, keyfun = "hazard", mixture="NB",se = T
)

global13r2 = gdistsamp(lambdaformula = ~averagewater_2+region-1,
                       phiformula = ~1,
                       pformula = ~ 1,
                       data = umf13r2, keyfun = "hazard", mixture="NB",se = T)

a13r2 = gdistsamp(lambdaformula = ~averagewater_2-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf13r2, keyfun = "hazard", mixture="NB",se = T)


b13r2 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf13r2, keyfun = "hazard", mixture="NB",se = T)
```

```
list13r2 = fitList(null13r2, global13r2, a13r2, b13r2)
model13r2 = modSel(list13r2)
```

## 2013 Round 3

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in the sora observations
sora13r3 <- read.csv("2013r3_sora.csv", header=T)
#read in the covariate data #organized by impoundment.
cov13r3 <- read.csv('2013r3_cov.csv', header=T)
#subset the covariates
cov13r3 <- cov13r3[,c("region","length_3","averagewater_3","impound")]
# #the distance bins

sora13r3 <- sora13r3[sora13r3$impound!="dc11",]
sora13r3 <- sora13r3[sora13r3$impound!="dc13",]
sora13r3 <- sora13r3[sora13r3$impound!="dc15",]
sora13r3 <- sora13r3[sora13r3$impound!="dc16",]
sora13r3 <- sora13r3[sora13r3$impound!="r7",]
cov13r3 <- cov13r3[cov13r3$impound!="dc11",]
cov13r3 <- cov13r3[cov13r3$impound!="dc13",]
cov13r3 <- cov13r3[cov13r3$impound!="dc15",]
cov13r3 <- cov13r3[cov13r3$impound!="dc16",]
cov13r3 <- cov13r3[cov13r3$impound!="r7",]
sora13r3 <- sora13r3[order(sora13r3$impound),]
cov13r3 <- cov13r3[order(cov13r3$impound),]
sora13r3 <- sora13r3[,2:79] #we're cutting out night 4.1 and 4.2 because it only happened once

cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13))
#Unmarked Data Frame
umf13r3 = unmarkedFrameGDS(y=sora13r3,
                           numPrimary=6,
                           siteCovs = cov13r3,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov13r3$length_3,
)

null13r3 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~  1,
                     data = umf13r3, keyfun = "hazard", mixture="NB",se = T)

global13r3 = gdistsamp(lambdaformula = ~averagewater_3+region-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf13r3, keyfun = "hazard", mixture="NB",se = T)
```

```
a13r3 = gdistsamp(lambdaformula = ~averagewater_3-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf13r3, keyfun = "hazard", mixture="NB",se = T)


b13r3 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf13r3, keyfun = "hazard", mixture="NB",se = T)


list13r3 = fitList(null13r3, global13r3, a13r3, b13r3)
model13r3 = modSel(list13r3)
```

## 2013 Round 4

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#sora
sora13r4 <- read.csv('2013r4_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov13r4 <- read.csv('2013r4_cov.csv', header=T)
#subset the covariates
cov13r4 <- cov13r4[,c("region","length_4","averagewater_4","impound")]
# the distance bins


sora13r4 <- sora13r4[order(sora13r4$impound),]
cov13r4 <- cov13r4[order(cov13r4$impound),]
sora13r4 <- sora13r4[,2:79] #we're cutting out night 4.1 and 4.2 because it only happened once

cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13))
#Unmarked Data Frame
umf13r4 = unmarkedFrameGDS(y=sora13r4,
                           numPrimary=6,
                           siteCovs = cov13r4,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov13r4$length_4,
)

null13r4 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~  1,
                     data = umf13r4, keyfun = "hazard", mixture="NB",se = T)

global13r4 = gdistsamp(lambdaformula = ~averagewater_4+region-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf13r4, keyfun = "hazard", mixture="NB",se = T)
```

```
a13r4 = gdistsamp(lambdaformula = ~averagewater_4-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf13r4, keyfun = "hazard", mixture="NB",se = T)

b13r4 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~  1,
                  data = umf13r4, keyfun = "hazard", mixture="NB",se = T)



list13r4 = fitList(null13r4, global13r4, a13r4, b13r4)
model13r4 = modSel(list13r4)
```

## 2014 Round 1

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in sora data
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
sora14r1 <- read.csv('2014r1_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov14r1 <- read.csv('2014r1_cov.csv', header=T)
#subset the covariates we need
cov14r1 <- cov14r1[,c("region","length_1","averagewater_1","impound","treat")]

sora14r1 <- sora14r1[sora14r1$impound!="dc18",]
cov14r1 <- cov14r1[cov14r1$impound!="dc18",]

sora14r1 <- sora14r1[order(sora14r1$impound),]
cov14r1 <- cov14r1[order(cov14r1$impound),]


sora14r1 <- sora14r1[,2:79]


#the distance bins
cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13)) #the fartherest distance is 12
#Unmarked Data Frame
umf14r1 = unmarkedFrameGDS(y=sora14r1,
                           numPrimary=6,
                           siteCovs = cov14r1,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov14r1$length_1,
)

null14r1 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
```

```
                    pformula = ~ 1,
                    data = umf14r1, keyfun = "hazard", mixture="NB",se = T
)

global14r1 = gdistsamp(lambdaformula = ~averagewater_1+region+treat-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf14r1, keyfun = "hazard", mixture="NB",se = T)

water14r1 = gdistsamp(lambdaformula = ~averagewater_1-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r1, keyfun = "hazard", mixture="NB",se = T)

reg14r1 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r1, keyfun = "hazard", mixture="NB",se = T)

treat14r1 = gdistsamp(lambdaformula = ~treat-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r1, keyfun = "hazard", mixture="NB",se = T)

treat_reg14r1 = gdistsamp(lambdaformula = ~treat+region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r1, keyfun = "hazard", mixture="NB",se = T)

water_reg14r1 = gdistsamp(lambdaformula = ~region+averagewater_1-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r1, keyfun = "hazard", mixture="NB",se = T)

list14r1 = fitList(null14r1, global14r1, water_reg14r1, treat_reg14r1,treat14r1,reg14r1,water14r1)
model14r1 =modSel(list14r1)
```

## 2014 Round 2

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in the sora observations
sora14r2 <- read.csv('2014r2_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov14r2 <- read.csv('2014r2_cov.csv', header=T)
#subset covaraites we need
cov14r2 <- cov14r2[,c("region","length_2","averagewater_2","impound","treat")]
# #the distance bins

sora14r2 <- sora14r2[order(sora14r2$impound),]
cov14r2 <- cov14r2[order(cov14r2$impound),]
```

```
sora14r2 <- sora14r2[,2:79]
cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13))
#Unmarked Data Frame
umf14r2 = unmarkedFrameGDS(y=sora14r2,
                           numPrimary=6,
                           siteCovs = cov14r2,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov14r2$length_2,
)

null14r2 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~ 1,
                     data = umf14r2, keyfun = "hazard", mixture="NB",se = T
)

global14r2 = gdistsamp(lambdaformula = ~averagewater_2+region+treat-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf14r2, keyfun = "hazard", mixture="NB",se = T)

water14r2 = gdistsamp(lambdaformula = ~averagewater_2-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r2, keyfun = "hazard", mixture="NB",se = T)

reg14r2 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r2, keyfun = "hazard", mixture="NB",se = T)

treat14r2 = gdistsamp(lambdaformula = ~treat-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r2, keyfun = "hazard", mixture="NB",se = T)

treat_reg14r2 = gdistsamp(lambdaformula = ~treat+region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r2, keyfun = "hazard", mixture="NB",se = T)

water_reg14r2 = gdistsamp(lambdaformula = ~region+averagewater_2-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r2, keyfun = "hazard", mixture="NB",se = T)

list14r2 = fitList(null14r2, global14r2, water_reg14r2, treat_reg14r2,treat14r2,reg14r2,water14r2)
model14r2 =modSel(list14r2)
```

## 2014 Round 3

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#read in the sora observations
sora14r3 <- read.csv("2014r3_sora.csv", header=T)
#read in the covariate data #organized by impoundment.
cov14r3 <- read.csv('2014r3_cov.csv', header=T)
#subset the covariates
cov14r3 <- cov14r3[,c("region","length_3","averagewater_3","impound","treat")]
# #the distance bins

sora14r3 <- sora14r3[order(sora14r3$impound),]
cov14r3 <- cov14r3[order(cov14r3$impound),]
sora14r3 <- sora14r3[,2:79]

cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13))
#Unmarked Data Frame
umf14r3 = unmarkedFrameGDS(y=sora14r3,
                           numPrimary=6,
                           siteCovs = cov14r3,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov14r3$length_3,
)

null14r3 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~ 1,
                     data = umf14r3, keyfun = "hazard", mixture="NB",se = T
)

global14r3 = gdistsamp(lambdaformula = ~averagewater_3+region+treat-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf14r3, keyfun = "hazard", mixture="NB",se = T)

water14r3 = gdistsamp(lambdaformula = ~averagewater_3-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r3, keyfun = "hazard", mixture="NB",se = T)

reg14r3 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r3, keyfun = "hazard", mixture="NB",se = T)

treat14r3 = gdistsamp(lambdaformula = ~treat-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r3, keyfun = "hazard", mixture="NB",se = T)

treat_reg14r3 = gdistsamp(lambdaformula = ~treat+region-1,
```

```
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r3, keyfun = "hazard", mixture="NB",se = T)

water_reg14r3 = gdistsamp(lambdaformula = ~region+averagewater_3-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r3, keyfun = "hazard", mixture="NB",se = T)

list14r3 = fitList(null14r3, global14r3, water_reg14r3, treat_reg14r3,treat14r3,reg14r3,water14r3)
model14r3 =modSel(list14r3)
```

## 2014 Round 4

```
setwd("C:/Users/avanderlaar/Dropbox/R/Distance")
#sora
sora14r4 <- read.csv('2014r4_sora.csv', header=T)
#read in the covariate data #organized by impoundment.
cov14r4 <- read.csv('2014r4_cov.csv', header=T)
#subset the covariates
cov14r4 <- cov14r4[,c("region","length_4","averagewater_4","impound","treat")]
# the distance bins

sora14r4 <- sora14r4[order(sora14r4$impound),]
cov14r4 <- cov14r4[order(cov14r4$impound),]
sora14r4 <- sora14r4[,2:79]

cutpt = as.numeric(c(0,1,2,3,4,5,6,7,8,9,10,11,12,13))
#Unmarked Data Frame
umf14r4 = unmarkedFrameGDS(y=sora14r4,
                           numPrimary=6,
                           siteCovs = cov14r4,
                           survey="line",
                           dist.breaks=cutpt,
                           unitsIn="m",
                           tlength=cov14r4$length_4,
)

null14r4 = gdistsamp(lambdaformula = ~1,
                     phiformula = ~1,
                     pformula = ~ 1,
                     data = umf14r4, keyfun = "hazard", mixture="NB",se = T
)

global14r4 = gdistsamp(lambdaformula = ~averagewater_4+region+treat-1,
                       phiformula = ~1,
                       pformula = ~  1,
                       data = umf14r4, keyfun = "hazard", mixture="NB",se = T)

water14r4 = gdistsamp(lambdaformula = ~averagewater_4-1,
                  phiformula = ~1,
```

```
                  pformula = ~ 1,
                  data = umf14r4, keyfun = "hazard", mixture="NB",se = T)

reg14r4 = gdistsamp(lambdaformula = ~region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r4, keyfun = "hazard", mixture="NB",se = T)

treat14r4 = gdistsamp(lambdaformula = ~treat-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r4, keyfun = "hazard", mixture="NB",se = T)

treat_reg14r4 = gdistsamp(lambdaformula = ~treat+region-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r4, keyfun = "hazard", mixture="NB",se = T)

water_reg14r4 = gdistsamp(lambdaformula = ~region+averagewater_4-1,
                  phiformula = ~1,
                  pformula = ~ 1,
                  data = umf14r4, keyfun = "hazard", mixture="NB",se = T)

list14r4 = fitList(null14r4, global14r4, water_reg14r4, treat_reg14r4,treat14r4,reg14r4,water14r4)
model14r4 =modSel(list14r4)
```

## Output Tables from models

```
model12r2
```

```
##            nPars    AIC delta   AICwt cumltvWt
## null12r2       5 451.33  0.00 6.5e-01     0.65
## c12r2          8 453.01  1.68 2.8e-01     0.93
## global12r2     9 455.83  4.50 6.9e-02     1.00
## a12r2          5 521.15 69.82 4.5e-16     1.00
## b12r2          5 526.01 74.68 4.0e-17     1.00
```

```
#model12r3

model13r1
```

```
##            nPars    AIC delta  AICwt cumltvWt
## b13r1          8 222.47  0.00 0.5588     0.56
## global13r1     9 223.32  0.84 0.3666     0.93
## null13r1       5 226.54  4.07 0.0732     1.00
## a13r1          5 234.33 11.85 0.0015     1.00
```

```
model13r2
```

```
##            nPars    AIC delta   AICwt cumltvWt
```

```
## null13r2       5 344.85  0.00 6.9e-01     0.69
## b13r2          8 347.05  2.20 2.3e-01     0.91
## global13r2     9 348.99  4.13 8.7e-02     1.00
## a13r2          5 397.86 53.01 2.1e-12     1.00
```

```
model13r3
```

```
##            nPars    AIC delta   AICwt cumltvWt
## null13r3       5 276.24  0.00 7.8e-01     0.78
## b13r3          8 279.42  3.18 1.6e-01     0.94
## global13r3     9 281.38  5.14 6.0e-02     1.00
## a13r3          5 364.19 87.96 6.2e-20     1.00
```

```
model13r4
```

```
##            nPars    AIC delta   AICwt cumltvWt
## global13r4     7 147.78  0.00 0.53244     0.53
## b13r4          6 148.76  0.99 0.32534     0.86
## null13r4       5 150.43  2.65 0.14158     1.00
## a13r4          5 161.22 13.44 0.00064     1.00
```

```
model14r1
```

```
##               nPars    AIC delta   AICwt cumltvWt
## reg14r1           8 385.36  0.00 4.6e-01     0.46
## water_reg14r1     9 386.39  1.04 2.7e-01     0.73
## global14r1       10 387.50  2.14 1.6e-01     0.88
## treat_reg14r1     9 388.09  2.74 1.2e-01     1.00
## null14r1          5 396.77 11.41 1.5e-03     1.00
## treat14r1         6 398.69 13.33 5.8e-04     1.00
## water14r1         5 420.46 35.11 1.1e-08     1.00
```

```
model14r2
```

```
##               nPars    AIC  delta   AICwt cumltvWt
## reg14r2           8 325.11  0.000 3.7e-01     0.37
## water_reg14r2     9 325.20  0.094 3.5e-01     0.72
## global14r2       10 327.03  1.928 1.4e-01     0.86
## treat_reg14r2     9 327.10  1.993 1.4e-01     0.99
## null14r2          5 333.71  8.599 5.0e-03     1.00
## treat14r2         6 334.86  9.757 2.8e-03     1.00
## water14r2         5 366.53 41.419 3.7e-10     1.00
```

```
model14r3
```

```
##               nPars    AIC delta   AICwt cumltvWt
## treat14r3         6 101.51  0.00 4.1e-01     0.41
## null14r3          5 102.47  0.97 2.6e-01     0.67
## water_reg14r3     9 103.62  2.11 1.4e-01     0.81
## treat_reg14r3     9 105.11  3.61 6.8e-02     0.88
## reg14r3           8 105.33  3.83 6.1e-02     0.94
## global14r3       10 105.48  3.98 5.7e-02     1.00
## water14r3         5 135.34 33.83 1.9e-08     1.00
```

```
model14r4
```

```
##                nPars    AIC delta   AICwt cumltvWt
## null14r4           5 506.72  0.00 4.9e-01     0.49
## treat14r4          6 507.90  1.17 2.7e-01     0.77
## reg14r4            8 510.26  3.53 8.4e-02     0.85
## water_reg14r4      9 510.34  3.62 8.1e-02     0.93
## treat_reg14r4      9 511.78  5.06 3.9e-02     0.97
## global14r4        10 512.26  5.54 3.1e-02     1.00
## water14r4          5 530.58 23.86 3.2e-06     1.00
```