Arapaho NWR vegetation monitoring analyses for 2005 to 2008 (final corrections 08/17/11)

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```
###Note that the data file read in had multiple errors in coordinate locations
###and variable values corrected.  NEWHABITAT variable is the revised
classification
###of habitat types made by Pam Johnson (Oct 2010) to assign Mixed types to either
###riparian, meadown, or upland. Sampling_Seq = 1 identifies those transects in
the first
###round of monitoring during 2005 to 2008 (n = 900).

arapaho<- read.csv("c:\\cadestuff\\data\\arapahonwr\\arapaho.csv",header=T)

###To create a categorical factor variable for year.
arapaho$year <- as.factor(arapaho$YEAR)
```

UPLANDS (modified 10/05/2010 to include Mix types assigned by Pam J.)
n = 511. Note that we have used alpha=0.10 in rq for both 2-tailed
(1 - 2*alpha)*100% CI associated with an alpha = 0.05 for two 1-sided
equivalance tests and for a 1-tailed (1 - alpha)*100% CI associated with an
alpha = 0.05 1-sided equivalence test (see Cade et al. 2011. Ecol.
Appl. 21(1):281-289) because the alpha in rq always puts 1/2*alpha in
2-tails of the CI. So an alpha=0.10 in rq yields 2-tailed 90% CI for
two 1-sided equivalence tests at alpha=0.05 and by using 1-tail of the
2-tailed 90% CI we get a 1-tailed 95% CI for a single 1-sided

equivalence test
at alpha=0.05.

```
library(quantreg)

###Note small random uniform numbers (magnitude less) were added (jittered) to
raw values to
###prevent convergence issues with quantile rank score confidence intervals.
###Values were checked by reestimating models with raw data in a restricted range
of quantiles
###near the benefit-of-doubt and fail-safe limits.
###Primary models estimated with "sum" contrasts so that intercept is average
across years.
###Plotting function provides the CI across the quantiles for the intercept
estimates.

prop.sage.Uavg <- rq((PROP_SAGE + runif(n=511,min=-0.001,max=0.001)) ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau= 5:95/100,contrasts=list(year="contr.sum"))
plot(summary(prop.sage.Uavg,se="rank",iid=F,alpha=0.10),ols=F,parm =1)
abline(h=0.70)
abline(v=0.41)
abline(v=0.48)

prop.sage.Uavg.3550 <- rq(PROP_SAGE ~ year,data=arapaho[arapaho$SAMPLING_SEQ==1
& arapaho$NEWHABITAT=="Upland",],tau=
35:50/100,contrasts=list(year="contr.sum"))
prop.sage.Uavg.3550.stats <-
summary(prop.sage.Uavg.3550,se="rank",iid=F,alpha=0.10)
plot(prop.sage.Uavg.3550.stats,ols=F,parm=1)
abline(h=0.70)
abline(v=0.41)
abline(v=0.48)



###Here models are estimated without an intercept (the -1 in the rhs of formula)
and "treatment" contrasts
###so that quantile estimates are provided by year.

prop.sage.U.41 <- rq(PROP_SAGE ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=0.41,contrasts=list(year="contr.treatment"
))
summary(prop.sage.U.41,se="ker")

prop.sage.U.48 <- rq(PROP_SAGE ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=0.48,contrasts=list(year="contr.treatment"
))
summary(prop.sage.U.48,se="ker")

prop.sage.U <- rq(PROP_SAGE ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=1:99/100,contrasts=list(year="contr.treatm
ent"))

forb.cover.Uavg <- rq((FORB_COVER + runif(n=511,min=-0.1,max=0.1)) ~
```

```
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau= 5:95/100,contrasts=list(year="contr.sum"))
plot(summary(forb.cover.Uavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=10)
abline(v=0.80)
abline(v=0.87)

forb.cover.Uavg.7595 <- rq(FORB_COVER ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=
75:95/100,contrasts=list(year="contr.sum"))
forb.cover.Uavg.7595.stats
<-summary(forb.cover.Uavg.7595,se="rank",iid=F,alpha=0.10)
plot(forb.cover.Uavg.7595.stats,parm=1,ols=F)
abline(h=10)
abline(v=0.80)
abline(v=0.87)

forb.cover.Uavg.5570 <- rq(FORB_COVER ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=
55:70/100,contrasts=list(year="contr.sum"))
forb.cover.Uavg.5570.stats
<-summary(forb.cover.Uavg.5570,se="rank",iid=F,alpha=0.10)
plot(forb.cover.Uavg.5570.stats,parm=1,ols=F)
abline(h=5)
abline(v=0.57)
abline(v=0.65)


###Here models are estimated without an intercept (the -1 in the rhs of formula)
and "treatment" contrasts
###so that quantile estimates are provided by year.


forb.cover.U.80 <- rq(FORB_COVER ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& arapaho$NEWHABITAT=="Upland",],tau=
0.80,contrasts=list(year="contr.treatment"))
summary(forb.cover.U.80,se="ker")

forb.cover.U.87 <- rq(FORB_COVER ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& arapaho$NEWHABITAT=="Upland",],tau=
0.87,contrasts=list(year="contr.treatment"))
summary(forb.cover.U.87,se="ker")


forb.cover.U.57 <- rq(FORB_COVER ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& arapaho$NEWHABITAT=="Upland",],tau=
0.57,contrasts=list(year="contr.treatment"))
summary(forb.cover.U.57,se="ker")

forb.cover.U.65 <- rq(FORB_COVER ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& arapaho$NEWHABITAT=="Upland",],tau=
0.65,contrasts=list(year="contr.treatment"))
summary(forb.cover.U.65,se="ker")

forb.cover.U <- rq(FORB_COVER ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
```

```
arapaho$NEWHABITAT=="Upland",],tau=
1:99/100,contrasts=list(year="contr.treatment"))


grass.cover.Uavg <- rq((GRASS_COVER + runif(n=511,min=-0.1,max=0.1)) ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau= 5:95/100,contrasts=list(year="contr.sum"))
plot(summary(grass.cover.Uavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=20)
abline(v=0.34)
abline(v=0.43)

grass.cover.Uavg.3050 <- rq(GRASS_COVER ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=
30:50/100,contrasts=list(year="contr.sum"))
grass.cover.Uavg.3050.stats<-
summary(grass.cover.Uavg.3050,se="rank",iid=F,alpha=0.10)
plot(grass.cover.Uavg.3050.stats,ols=F,parm=1)
abline(h=20)
abline(v=0.34)
abline(v=0.43)

grass.cover.Uavg.3050 <- rq(GRASS_COVER ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=
30:50/100,contrasts=list(year="contr.sum"))
grass.cover.Uavg.3050.stats<-
summary(grass.cover.Uavg.3050,se="rank",iid=F,alpha=0.10)
plot(grass.cover.Uavg.3050.stats,ols=F,parm=1)
abline(h=20)
abline(v=0.33)
abline(v=0.42)


###Here models are estimated without an intercept (the -1 in the rhs of formula)
and "treatment" contrasts
###so that quantile estimates are provided by year.

grass.cover.U.34 <- rq(GRASS_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.34,contrasts=list(year="contr.treatment"))
summary(grass.cover.U.34,se="ker")

grass.cover.U.43 <- rq(GRASS_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.43,contrasts=list(year="contr.treatment"))
summary(grass.cover.U.43,se="ker")

grass.cover.U.33 <- rq(GRASS_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.33,contrasts=list(year="contr.treatment"))
summary(grass.cover.U.33,se="ker")

grass.cover.U.42 <- rq(GRASS_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.42,contrasts=list(year="contr.treatment"))
```

```
summary(grass.cover.U.42,se="ker")


grass.cover.U <- rq(GRASS_COVER ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& arapaho$NEWHABITAT=="Upland",],tau=
1:99/100,contrasts=list(year="contr.treatment"))


highsage.cover.Uavg <- rq((HIGH_SAGEBRUSH_COVER +
runif(n=511,min=-0.1,max=0.1)) ~ year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau= 5:95/100,contrasts=list(year="contr.sum"))
plot(summary(highsage.cover.Uavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=c(20,30))
abline(v=0.82)
abline(v=0.88)
abline(v=0.94)

highsage.cover.Uavg.7595 <- rq(HIGH_SAGEBRUSH_COVER ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=
75:95/100,contrasts=list(year="contr.sum"))
highsage.cover.Uavg.7595.stats <-
summary(highsage.cover.Uavg.7595,se="rank",iid=F,alpha=0.10)
plot(highsage.cover.Uavg.7595.stats,ols=F,parm=1)
abline(h=c(20,30))
abline(v=0.82)
abline(v=0.88)
abline(v=0.94)

###Here models are estimated without an intercept (the -1 in the rhs of formula)
and "treatment" contrasts
###so that quantile estimates are provided by year.

highsage.cover.U.82 <- rq(HIGH_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.82,contrasts=list(year="contr.treatment"))
summary(highsage.cover.U.82,se="ker")

highsage.cover.U.88 <- rq(HIGH_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.88,contrasts=list(year="contr.treatment"))
summary(highsage.cover.U.88,se="ker")

highsage.cover.U.94 <- rq(HIGH_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.94,contrasts=list(year="contr.treatment"))
summary(highsage.cover.U.94,se="ker")

highsage.cover.U <- rq(HIGH_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
1:99/100,contrasts=list(year="contr.treatment"))


g40sage.cover.Uavg <- rq((G40_SAGEBRUSH_COVER + runif(n=511,min=-0.1,max=0.1))
~ year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau= 5:95/100,contrasts=list(year="contr.sum"))
```

```
plot(summary(g40sage.cover.Uavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)

g40sage.cover.Uavg.4098 <- rq((G40_SAGEBRUSH_COVER +
runif(n=511,min=-0.1,max=0.1)) ~ year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=
40:98/100,contrasts=list(year="contr.sum"))
plot(summary(g40sage.cover.Uavg.4098,se="rank",iid=F,alpha=0.10),ols=F,parm=1
,ylim=c(0,40))
abline(h=c(30))

g40sage.cover.Uavg.98 <- rq(G40_SAGEBRUSH_COVER ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
arapaho$NEWHABITAT=="Upland",],tau=0.98,contrasts=list(year="contr.sum"))
summary(g40sage.cover.Uavg.98,se="rank",iid=F,alpha=0.10)
```

###Here models are estimated without an intercept (the -1 in the rhs of formula) and "treatment" contrasts
###so that quantile estimates are provided by year.

```
g40sage.cover.U <- rq(G40_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
1:99/100,contrasts=list(year="contr.treatment"))
```

###Simple statistical summaries of variables by year for 2005 to 2008 data in uplands.

```
upland0508<-(arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",])
by(upland0508$PROP_SAGE,upland0508$year,summary)
by(upland0508$FORB_COVER,upland0508$year,summary)
by(upland0508$GRASS_COVER,upland0508$year,summary)
by(upland0508$HIGH_SAGEBRUSH_COVER,upland0508$year,summary)
by(upland0508$G40_SAGEBRUSH_COVER,upland0508$year,summary)
```

Graphs the quantile estimates (no CI) by year.

```
plot(prop.sage.U,ols=F,ylim=c(0,1))
plot(forb.cover.U,ols=F,ylim=c(0,50))
plot(grass.cover.U,ols=F,ylim=c(0,100))
plot(highsage.cover.U,ols=F,ylim=c(0,60))
plot(g40sage.cover.U,ols=F,ylim=c(0,50))
```

###Results

```
> summary(prop.sage.U.41,se="ker")

Call: rq(formula = PROP_SAGE ~ year - 1, tau = 0.41, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.41

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  0.59574  0.03734   15.95635  0.00000
year2006  0.70370  0.02769   25.41750  0.00000
year2007  0.60000  0.03440   17.43946  0.00000
```

```
year2008  0.79412  0.03422   23.20387  0.00000
>
> prop.sage.U.48 <- rq(PROP_SAGE ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
&
arapaho$NEWHABITAT=="Upland",],tau=0.48,contrasts=list(year="contr.treatment"
))
> summary(prop.sage.U.48,se="ker")

Call: rq(formula = PROP_SAGE ~ year - 1, tau = 0.48, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.48

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  0.64516  0.03670   17.57958  0.00000
year2006  0.76000  0.02669   28.47862  0.00000
year2007  0.65385  0.03203   20.41329  0.00000
year2008  0.85714  0.03257   26.31925  0.00000
>


> summary(forb.cover.U.80,se="ker")

Call: rq(formula = FORB_COVER ~ year - 1, tau = 0.8, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.8

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  4.00000  0.45365    8.81745  0.00000
year2006  2.00000  0.31918    6.26604  0.00000
year2007 13.00000  1.38775    9.36769  0.00000
year2008 15.00000  1.41632   10.59080  0.00000
>
>
> forb.cover.U.87 <- rq(FORB_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.87,contrasts=list(year="contr.treatment"))
> summary(forb.cover.U.87,se="ker")

Call: rq(formula = FORB_COVER ~ year - 1, tau = 0.87, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.87

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  6.00000  0.59396   10.10169  0.00000
year2006  5.00000  0.54300    9.20805  0.00000
```

```
year2007 20.00000  2.51732    7.94495  0.00000
year2008 21.00000  2.65605    7.90648  0.00000
>
> summary(forb.cover.U.57,se="ker")

Call: rq(formula = FORB_COVER ~ year - 1, tau = 0.57, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.57

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  3.00000  0.49472    6.06407  0.00000
year2006  0.00000  0.34010    0.00000  1.00000
year2007  6.00000  0.66314    9.04782  0.00000
year2008 10.00000  1.05940    9.43926  0.00000
>
> forb.cover.U.65 <- rq(FORB_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.65,contrasts=list(year="contr.treatment"))
> summary(forb.cover.U.65,se="ker")

Call: rq(formula = FORB_COVER ~ year - 1, tau = 0.65, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.65

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  3.00000  0.43074    6.96471  0.00000
year2006  0.00000  0.26774    0.00000  1.00000
year2007  8.00000  0.83707    9.55709  0.00000
year2008 11.00000  1.08532   10.13524  0.00000
>

> summary(grass.cover.U.34,se="ker")

Call: rq(formula = GRASS_COVER ~ year - 1, tau = 0.34, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.34

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 22.00000  2.45578    8.95845  0.00000
year2006  4.00000  1.27175    3.14527  0.00176
year2007 22.00000  1.97852   11.11941  0.00000
year2008 28.00000  2.10342   13.31166  0.00000
>
> grass.cover.U.43 <- rq(GRASS_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
```

```
0.43,contrasts=list(year="contr.treatment"))
> summary(grass.cover.U.43,se="ker")

Call: rq(formula = GRASS_COVER ~ year - 1, tau = 0.43, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.43

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 26.00000  2.40003   10.83318  0.00000
year2006  6.00000  1.30175    4.60919  0.00001
year2007 27.00000  2.11917   12.74084  0.00000
year2008 29.00000  2.20426   13.15634  0.00000
>
>
> summary(grass.cover.U.33,se="ker")

Call: rq(formula = GRASS_COVER ~ year - 1, tau = 0.33, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.33

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 22.00000  2.43389    9.03902  0.00000
year2006  4.00000  1.25635    3.18382  0.00154
year2007 21.00000  1.96479   10.68814  0.00000
year2008 27.00000  2.08986   12.91954  0.00000
>
> summary(grass.cover.U.42,se="ker")

Call: rq(formula = GRASS_COVER ~ year - 1, tau = 0.42, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.42

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 25.00000  2.41971   10.33181  0.00000
year2006  5.00000  1.30369    3.83526  0.00014
year2007 26.00000  2.09313   12.42157  0.00000
year2008 29.00000  2.19337   13.22169  0.00000
>

> summary(highsage.cover.U.82,se="ker")

Call: rq(formula = HIGH_SAGEBRUSH_COVER ~ year - 1, tau = 0.82, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))
```

```
tau: [1] 0.82

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 17.00000  1.81959    9.34278  0.00000
year2006 19.00000  1.70239   11.16077  0.00000
year2007 15.00000  1.44277   10.39668  0.00000
year2008 24.00000  2.75615    8.70779  0.00000
>
> highsage.cover.U.88 <- rq(HIGH_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.88,contrasts=list(year="contr.treatment"))
> summary(highsage.cover.U.88,se="ker")

Call: rq(formula = HIGH_SAGEBRUSH_COVER ~ year - 1, tau = 0.88, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.88

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 18.00000  1.65969   10.84538  0.00000
year2006 24.00000  2.04593   11.73059  0.00000
year2007 16.00000  1.33440   11.99044  0.00000
year2008 28.00000  2.79891   10.00390  0.00000
>
> highsage.cover.U.94 <- rq(HIGH_SAGEBRUSH_COVER ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & arapaho$NEWHABITAT=="Upland",],tau=
0.94,contrasts=list(year="contr.treatment"))
> summary(highsage.cover.U.94,se="ker")

Call: rq(formula = HIGH_SAGEBRUSH_COVER ~ year - 1, tau = 0.94, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year =
"contr.treatment"))

tau: [1] 0.94

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005 22.00000  1.77047   12.42607  0.00000
year2006 28.00000  2.14636   13.04533  0.00000
year2007 25.00000  2.83393    8.82166  0.00000
year2008 38.00000  4.88782    7.77443  0.00000
>

> summary(g40sage.cover.Uavg.98,se="rank",iid=F,alpha=0.10)

Call: rq(formula = G40_SAGEBRUSH_COVER ~ year, tau = 0.98, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & arapaho$NEWHABITAT == "Upland", ], contrasts = list(year = "contr.sum"))

tau: [1] 0.98
```

```
Coefficients:
            coefficients   lower bd       upper bd
(Intercept)   2.575000e+01   1.871365e+01   2.915127e+01
year1        -1.275000e+01  -1.805486e+01  1.797693e+308
year2         5.250000e+00   7.512400e-01   1.139619e+01
year3        -6.750000e+00  -1.203198e+01   3.890610e+00
Warning message:
In rq.fit.br(x, y, tau = tau, ci = TRUE, ...) : Solution may be nonunique
>
```

###Create identifying variables for each condition with 1 assigned if meeting the quantile conditions by each year.
###These are for liberal interpretation.

```
arapaho$UP_FORB_LIB <- 0
arapaho$UP_GRASS_LIB <- 0
arapaho$UP_PROPSAGE_LIB <- 0
arapaho$UP_SAGE25_LIB <- 0
arapaho$UP_ALL_LIB <- 0
arapaho$UP_GRASSL20_LIB <- 0
arapaho$UP_FORBG5_LIB <- 0


arapaho$UP_FORB_LIB[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$FORB_COVER >=
coef(forb.cover.U.80)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$FORB_COVER >=
coef(forb.cover.U.80)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$FORB_COVER >=
coef(forb.cover.U.80)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$FORB_COVER >=
coef(forb.cover.U.80)[[4]])] <- 1
arapaho$UP_GRASS_LIB[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$GRASS_COVER >=
coef(grass.cover.U.34)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$GRASS_COVER >=
coef(grass.cover.U.34)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$GRASS_COVER >=
coef(grass.cover.U.34)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$GRASS_COVER >=
coef(grass.cover.U.34)[[4]])] <- 1
arapaho$UP_PROPSAGE_LIB[(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2005 & arapaho$PROP_SAGE >=
coef(prop.sage.U.41)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$PROP_SAGE >=
coef(prop.sage.U.41)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$PROP_SAGE >=
coef(prop.sage.U.41)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$PROP_SAGE >=
coef(prop.sage.U.41)[[4]])] <- 1
arapaho$UP_SAGE25_LIB[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.82)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.82)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.82)[[3]])|(arapaho$NEWHABITAT=="Upland" &
```

```
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.82)[[4]])] <- 1
arapaho$UP_ALL_LIB[arapaho$UP_FORB_LIB==1 & arapaho$UP_GRASS_LIB ==1 &
arapaho$UP_PROPSAGE_LIB==1 & arapaho$UP_SAGE25_LIB==1] <- 1
arapaho$UP_FORBG5_LIB[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$FORB_COVER >=
coef(forb.cover.U.57)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$FORB_COVER >=
coef(forb.cover.U.57)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$FORB_COVER >=
coef(forb.cover.U.57)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$FORB_COVER >=
coef(forb.cover.U.57)[[4]])] <- 1
arapaho$UP_GRASSL20_LIB[(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2005 & arapaho$GRASS_COVER <=
coef(grass.cover.U.42)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$GRASS_COVER <=
coef(grass.cover.U.42)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$GRASS_COVER <=
coef(grass.cover.U.42)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$GRASS_COVER <=
coef(grass.cover.U.42)[[4]])] <- 1
```

###Create identifying variables for each condition with 1 assigned if meeting the quantile conditions by each year.
###These are for conservative interpretation.

```
arapaho$UP_FORB_CON <- 0
arapaho$UP_GRASS_CON <- 0
arapaho$UP_PROPSAGE_CON <- 0
arapaho$UP_SAGE25_CON <- 0
arapaho$UP_ALL_CON <- 0
arapaho$UP_GRASSL20_CON <- 0
arapaho$UP_FORBG5_CON <- 0

arapaho$UP_FORB_CON[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$FORB_COVER >=
coef(forb.cover.U.87)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$FORB_COVER >=
coef(forb.cover.U.87)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$FORB_COVER >=
coef(forb.cover.U.87)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$FORB_COVER >=
coef(forb.cover.U.87)[[4]])] <- 1
arapaho$UP_GRASS_CON[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$GRASS_COVER >=
coef(grass.cover.U.43)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$GRASS_COVER >=
coef(grass.cover.U.43)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$GRASS_COVER >=
coef(grass.cover.U.43)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$GRASS_COVER >=
coef(grass.cover.U.43)[[4]])] <- 1
arapaho$UP_PROPSAGE_CON[(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2005 & arapaho$PROP_SAGE >=
coef(prop.sage.U.48)[[1]])|(arapaho$NEWHABITAT=="Upland" &
```

```
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$PROP_SAGE >=
coef(prop.sage.U.48)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$PROP_SAGE >=
coef(prop.sage.U.48)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$PROP_SAGE >=
coef(prop.sage.U.48)[[4]])] <- 1
arapaho$UP_SAGE25_CON[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.88)[[1]] & arapaho$HIGH_SAGEBRUSH_COVER <=
coef(highsage.cover.U.94)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.88)[[2]] & arapaho$HIGH_SAGEBRUSH_COVER <=
coef(highsage.cover.U.94)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.88)[[3]] & arapaho$HIGH_SAGEBRUSH_COVER <=
coef(highsage.cover.U.94)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$HIGH_SAGEBRUSH_COVER >=
coef(highsage.cover.U.88)[[4]] & arapaho$HIGH_SAGEBRUSH_COVER <=
coef(highsage.cover.U.94)[[4]])] <- 1
arapaho$UP_ALL_CON[arapaho$UP_FORB_CON==1 & arapaho$UP_GRASS_CON==1 &
arapaho$UP_PROPSAGE_CON==1 & arapaho$UP_SAGE25_CON==1] <- 1
arapaho$UP_FORBG5_CON[(arapaho$NEWHABITAT=="Upland" & arapaho$SAMPLING_SEQ==1 &
arapaho$year==2005 & arapaho$FORB_COVER >=
coef(forb.cover.U.65)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$FORB_COVER >=
coef(forb.cover.U.65)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$FORB_COVER >=
coef(forb.cover.U.65)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$FORB_COVER >=
coef(forb.cover.U.65)[[4]])] <- 1
arapaho$UP_GRASSL20_CON[(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2005 & arapaho$GRASS_COVER <=
coef(grass.cover.U.33)[[1]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2006 & arapaho$GRASS_COVER <=
coef(grass.cover.U.33)[[2]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2007 & arapaho$GRASS_COVER <=
coef(grass.cover.U.33)[[3]])|(arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$year==2008 & arapaho$GRASS_COVER <=
coef(grass.cover.U.33)[[4]])] <- 1
```

###Combining conditions

```
###Note this is a liberal (benefit-of-doubt)interpretation that allows average
values outside the management
###objectives to be included if the sampling variability (end of 95% CI) suggests
population value could
###be within objectives.  First transects meeting sagebrush proportion and canopy
cover are compared to transects
###meeting grass cover.  Then the sagebrush transects that don't meet the distance
criterion are subtracted from
###sagebrush subset and remainder compared with transects meeting forb cover.
Note 0.0 distances are for those
###transects that simultaneously met conditions on same transect.


arapaho.upland.forb<- subset(arapaho,(UP_FORB_LIB==1))
arapaho.upland.grass<- subset(arapaho,(UP_GRASS_LIB==1))
```

```
arapaho.upland.sage<- subset(arapaho,(UP_PROPSAGE_LIB==1 & UP_SAGE25_LIB==1))

###arapaho.upland.forb<- subset(arapaho,(NEWHABITAT=="Upland" & SAMPLING_SEQ==1
& year==2005 & FORB_COVER >=4.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2006 & FORB_COVER >=2.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2007 & FORB_COVER >=13.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2008 & FORB_COVER >=15.0))
###arapaho.upland.grass<- subset(arapaho,(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2005 & GRASS_COVER >=22.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2006 & GRASS_COVER >=4.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2007 & GRASS_COVER >=22.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2008 & GRASS_COVER >=28.0))
###arapaho.upland.sage<- subset(arapaho,(NEWHABITAT=="Upland" & SAMPLING_SEQ==1
& year==2005 & PROP_SAGE>=0.59574 & HIGH_SAGEBRUSH_COVER >=
15.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 & year==2006 & PROP_SAGE>=0.70370
& HIGH_SAGEBRUSH_COVER >= 18.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2007 & PROP_SAGE>=0.600 & HIGH_SAGEBRUSH_COVER >=
14.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 & year==2008 & PROP_SAGE>=0.79412
& HIGH_SAGEBRUSH_COVER >= 23.0))

###To calculate distances between samples meeting sagebrush and grass cover with
those meeting forb cover.

library(fields)
upland.sg.dist200 <-
fields.rdist.near(arapaho.upland.sage[,c(6,7)],arapaho.upland.grass[,c(6,7)],
delta=200)

upland.sgf.dist200 <-
fields.rdist.near(arapaho.upland.sage[c(unique(upland.sg.dist200$ind[,1])),c(
6,7)],arapaho.upland.forb[,c(6,7)],delta=200)
> upland.sg.dist200
$ind
       [,1] [,2]
  [1,]    1    1
  [2,]    1    2
  [3,]    1    3
  [4,]    2    1
  [5,]    2    2
  [6,]    2    3
  [7,]    3    1
  [8,]    3    2
  [9,]    3    3
 [10,]    4   11
 [11,]    4   12
 [12,]    5   20
 [13,]    6   25
 [14,]    6   26
 [15,]    6   28
 [16,]    7   31
 [17,]    7   32
 [18,]   10   40
 [19,]   11   44
 [20,]   12   47
 [21,]   12   48
 [22,]   12   49
 [23,]   13   66
```

```
[24,]   14   70
[25,]   14   71
[26,]   18   85
[27,]   19   90
[28,]   19   91
[29,]   19   92
[30,]   20   93
[31,]   22  103
[32,]   22  104
[33,]   23  113
[34,]   24  114
[35,]   24  115
[36,]   25  116
[37,]   25  118
[38,]   26  119
[39,]   27  123
[40,]   27  124
[41,]   28  130
[42,]   29  136
[43,]   29  163
[44,]   30  139
[45,]   31  141
[46,]   32  170
[47,]   33  174
[48,]   35  144
[49,]   36  177
[50,]   36  178
[51,]   37  177
[52,]   37  178
[53,]   38  179
[54,]   39  182
[55,]   40  184
[56,]   40  185
[57,]   41  195
[58,]   42  187
[59,]   42  188
[60,]   43  187
[61,]   43  188
[62,]   44  190
[63,]   44  199
[64,]   45  203
[65,]   45  234
[66,]   46  204
[67,]   46  205
[68,]   47  204
[69,]   47  205
[70,]   48  206
[71,]   49  215
[72,]   50  217
[73,]   50  218
[74,]   51  229
[75,]   51  230
[76,]   51  231
[77,]   52  230
[78,]   52  231
[79,]   53  236
[80,]   54  246
```

```
 [81,]   55  255
 [82,]   55  287
 [83,]   57  263
 [84,]   58  269
 [85,]   58  271
 [86,]   59  269
 [87,]   59  271
 [88,]   60  274
 [89,]   60  275
 [90,]   61  274
 [91,]   61  275
 [92,]   62  277
 [93,]   63  281
 [94,]   63  282
 [95,]   64  284
 [96,]   65  265
 [97,]   65  292
 [98,]   65  293
 [99,]   66  295
[100,]   66  296
[101,]   67  295
[102,]   67  296
[103,]   68  299
[104,]   69  304
[105,]   71  310
[106,]   71  311
[107,]   72  311
[108,]   73  315
[109,]   74  317
[110,]   75  321
[111,]   76  322
[112,]   78  324
[113,]   79  303
[114,]   79  325
[115,]   80  334
[116,]   81  335
[117,]   81  336
[118,]   82  335
[119,]   82  336
[120,]   83  335
[121,]   83  336
[122,]   84  337
[123,]   84  339
[124,]   85  337
[125,]   85  338
[126,]   85  339
[127,]   86  342

$ra
  [1]   0.00000  75.02666 132.43867  75.02666   0.00000  64.66065 132.43867
  [8]  64.66065   0.00000  71.47027   0.00000   0.00000  87.23531   0.00000
 [15] 175.32826   0.00000 144.00694   0.00000   0.00000 169.00296   0.00000
 [22]  76.00658   0.00000 144.02778   0.00000   0.00000 182.23611  66.03787
 [29]   0.00000   0.00000   0.00000 110.63905   0.00000  91.23596   0.00000
 [36]   0.00000 163.49006   0.00000   0.00000 111.94642   0.00000   0.00000
 [43] 128.87591 177.28226 198.28263   0.00000   0.00000   0.00000   0.00000
 [50] 138.91724 138.91724   0.00000   0.00000   0.00000 123.47064   0.00000
```

```
 [57] 107.64757   0.00000  88.14193  88.14193   0.00000   0.00000 185.85209
 [64]   0.00000  98.50888   0.00000  77.46612  77.46612   0.00000   0.00000
 [71]   0.00000   0.00000 175.61606  70.06426   0.00000 159.52429 159.52429
 [78]   0.00000   0.00000   0.00000   0.00000 176.91806   0.00000   0.00000
 [85] 172.58621 172.58621   0.00000   0.00000  82.34683  82.34683   0.00000
 [92]   0.00000   0.00000 134.48048   0.00000 138.39798   0.00000 116.38728
 [99]   0.00000 141.82383 141.82383   0.00000   0.00000   0.00000 122.71104
[106]   0.00000 165.00000   0.00000   0.00000   0.00000   0.00000   0.00000
[113] 130.81667   0.00000   0.00000   0.00000  87.69265  87.69265   0.00000
[120] 165.10905  87.36704 147.07821   0.00000 192.01042 154.50890 134.71451
[127]   0.00000

$da
[1]  86 344

> upland.sgf.dist200
$ind
      [,1] [,2]
 [1,]    1    1
 [2,]    2    1
 [3,]    3    1
 [4,]    4    3
 [5,]    5    9
 [6,]   12   23
 [7,]   14   37
 [8,]   14   38
 [9,]   21   48
[10,]   31   63
[11,]   32   64
[12,]   35   66
[13,]   35   67
[14,]   36   66
[15,]   36   67
[16,]   37   73
[17,]   38   77
[18,]   38   87
[19,]   39   78
[20,]   40   78
[21,]   42   81
[22,]   46   89
[23,]   47   93
[24,]   47   94
[25,]   49  102
[26,]   50  103
[27,]   51  103
[28,]   52  105
[29,]   52  106
[30,]   53  105
[31,]   53  106
[32,]   55  108
[33,]   70  124
[34,]   74  127
[35,]   75  127

$ra
 [1]  75.02666   0.00000  64.66065  71.47027   0.00000   0.00000 182.23611
 [8]  66.03787 111.94642   0.00000   0.00000 101.95097   0.00000 176.38878
```

```
[15]  88.14193 185.85209   0.00000  98.50888  77.46612   0.00000   0.00000
[22]   0.00000 122.78844 130.08074   0.00000 172.58621   0.00000   0.00000
[29]  82.34683  82.34683   0.00000   0.00000 120.81391   0.00000 134.71451

$da
[1]  76 127
```

###Determine the length of the vector of distances meeting all criteria simultaneously on a transect.

```
length(upland.sgf.dist200$ra[upland.sgf.dist200$ra==0.0])
[1] 16
```

###Determine the length of the vector of distances meeting all criteria simultaneously within specified
###distance (200 m) on a transect.

```
arapaho.upland.sg <-
arapaho.upland.sage[c(unique(upland.sg.dist200$ind[,1])),1]
arapaho.upland.sg <- as.data.frame(arapaho.upland.sg)
colnames(arapaho.upland.sg)<-c("SITE_ID")

arapaho.upland.sg.dist <-
arapaho.upland.sg[c(unique(upland.sgf.dist200$ind[,1])),1]
arapaho.upland.sg.dist <- as.data.frame(arapaho.upland.sg.dist)
colnames(arapaho.upland.sg.dist)<-c("SITE_ID")

arapaho.upland.forb.dist <-
arapaho.upland.forb[c(unique(upland.sgf.dist200$ind[,2])),1]
arapaho.upland.forb.dist <- as.data.frame(arapaho.upland.forb.dist)
colnames(arapaho.upland.forb.dist)<-c("SITE_ID")

arapaho.upland.sgf.unique <-
unique(rbind(arapaho.upland.sg.dist,arapaho.upland.forb.dist))

length(arapaho.upland.sgf.unique$SITE_ID)
[1] 38
```

###So 16 of 511 Upland transects met all conditions simultaneously on transects and 38 of 511
###met all conditions on transects within 200 m of each other.

###To get proportion estimates averaged across 4 years recognizing sample sizes in years
###may not be equal we have to calculate weighted averages of individual obs.

```
up.lib.2005 <- (length(arapaho$up_ALL_LIB[arapaho$UP_ALL_LIB==1 &
arapaho$YEAR==2005]))/(length(arapaho$UP_ALL_LIB[(arapaho$NEWHABITAT=="Upland
") & arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2005]))
up.lib.2006 <- (length(arapaho$UP_ALL_LIB[arapaho$UP_ALL_LIB==1 &
arapaho$YEAR==2006]))/(length(arapaho$UP_ALL_LIB[(arapaho$NEWHABITAT=="Upland
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2006]))
up.lib.2007 <- (length(arapaho$UP_ALL_LIB[arapaho$UP_ALL_LIB==1 &
arapaho$YEAR==2007]))/(length(arapaho$UP_ALL_LIB[(arapaho$NEWHABITAT=="Upland
```

```
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2007]))
up.lib.2008 <- (length(arapaho$UP_ALL_LIB[arapaho$UP_ALL_LIB==1 &
arapaho$YEAR==2008]))/(length(arapaho$UP_ALL_LIB[(arapaho$NEWHABITAT=="Upland
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2008]))

mean(c(up.lib.2005,up.lib.2006,up.lib.2007,up.lib.2008))*14285
[1] 444.2366 acres
```

###To perform distance analyses across a range of distances.
###m determines number of distance values that are calculated
###by multiples of 100 m.
###Modified 08/16/2011 to use weighted proportions to get average proportions across the 4 years

```
m<-12
sage.forb.dist<- matrix(0,nrow=m,ncol=2)
colnames(sage.forb.dist) <- c("distance","proportion")
for(i in 1:m){
dist<-100*i
upland.sg.dist <-
fields.rdist.near(arapaho.upland.sage[,c(6,7)],arapaho.upland.grass[,c(6,7)],
delta=dist)

upland.sgf.dist <-
fields.rdist.near(arapaho.upland.sage[c(unique(upland.sg.dist$ind[,1])),c(6,7
)],arapaho.upland.forb[,c(6,7)],delta=dist)

arapaho.upland.sg <-
arapaho.upland.sage[c(unique(upland.sg.dist$ind[,1])),c(1,9)]
arapaho.upland.sg <- as.data.frame(arapaho.upland.sg)
colnames(arapaho.upland.sg)<-c("SITE_ID","YEAR")

arapaho.upland.sg.dist <-
arapaho.upland.sg[c(unique(upland.sgf.dist$ind[,1])),]
arapaho.upland.sg.dist <- as.data.frame(arapaho.upland.sg.dist)
colnames(arapaho.upland.sg.dist)<-c("SITE_ID","YEAR")

arapaho.upland.forb.dist <-
arapaho.upland.forb[c(unique(upland.sgf.dist$ind[,2])),c(1,9)]
arapaho.upland.forb.dist <- as.data.frame(arapaho.upland.forb.dist)
colnames(arapaho.upland.forb.dist)<-c("SITE_ID","YEAR")

sg.all<- rbind(arapaho.upland.sg.dist,arapaho.upland.forb.dist)
arapaho.upland.sgf.unique <- unique(sg.all)
arapaho.upland.sgf.unique <- as.data.frame(arapaho.upland.sgf.unique)
colnames(arapaho.upland.sgf.unique) <- c("SITE_ID","YEAR")

###note that the 4 in the wts calculation comes from averaging across 4 years
arapaho.upland.sgf.unique$WT[arapaho.upland.sgf.unique$YEAR==2005]<-
1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2005])))
arapaho.upland.sgf.unique$WT[arapaho.upland.sgf.unique$YEAR==2006]<-
1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2006])))
arapaho.upland.sgf.unique$WT[arapaho.upland.sgf.unique$YEAR==2007]<-
1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
```

```
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2007])))
arapaho.upland.sgf.unique$WT[arapaho.upland.sgf.unique$YEAR==2008]<-
1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2008])))


sage.forb.dist[i,1] <- dist

sage.forb.dist[i,2] <- sum(arapaho.upland.sgf.unique$WT)
}
sage.forb.dist<-as.data.frame(sage.forb.dist)



###Note this is a conservative (fail-safe)interpretation that ensures values
averaged across years met or exceeded the management
###objectives based on sampling variability (end of 95% CI) indicating population
value was
###within objectives.

arapaho.upland.forb.cons<- subset(arapaho,(UP_FORB_CON==1))
arapaho.upland.grass.cons<- subset(arapaho,(UP_GRASS_CON==1))
arapaho.upland.sage.cons<- subset(arapaho,(UP_PROPSAGE_CON==1 &
UP_SAGE25_CON==1))


###arapaho.upland.forb.cons<- subset(arapaho,(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2005 & FORB_COVER >=6.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2006 & FORB_COVER >=5.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2007 & FORB_COVER >=20.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2008 & FORB_COVER >=21.0))
###arapaho.upland.grass.cons<- subset(arapaho,(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2005 & GRASS_COVER >=26.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2006 & GRASS_COVER >=6.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2007 & GRASS_COVER >=27.0)|(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2008 & GRASS_COVER >=29.0))
###arapaho.upland.sage.cons<- subset(arapaho,(NEWHABITAT=="Upland" &
SAMPLING_SEQ==1 & year==2005 & PROP_SAGE>=0.64516 & HIGH_SAGEBRUSH_COVER >= 18.0
& HIGH_SAGEBRUSH_COVER <= 20.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2006 & PROP_SAGE>=0.760 & HIGH_SAGEBRUSH_COVER >= 24.0 &
HIGH_SAGEBRUSH_COVER <= 26.0) |(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2007 & PROP_SAGE>=0.65385 & HIGH_SAGEBRUSH_COVER >= 17.0 &
HIGH_SAGEBRUSH_COVER <= 23.0)|(NEWHABITAT=="Upland" & SAMPLING_SEQ==1 &
year==2008 & PROP_SAGE>=0.85714 & HIGH_SAGEBRUSH_COVER >= 29.0 &
HIGH_SAGEBRUSH_COVER <= 34.0))

###To calculate distances between samples meeting sagebrush and grass cover with
those meeting forb cover
###for conservative approach.

library(fields)
upland.sg.dist200.cons <-
fields.rdist.near(arapaho.upland.sage.cons[,c(6,7)],arapaho.upland.grass.cons
[,c(6,7)],delta=200)

upland.sgf.dist200.cons <-
```

```
fields.rdist.near(arapaho.upland.sage.cons[,c(6,7)],arapaho.upland.forb.cons[
,c(6,7)],delta=200)


upland.sgf.dist200.cons <-
fields.rdist.near(arapaho.upland.sage.cons[c(unique(upland.sg.dist200.cons$in
d[,1])),c(6,7)],arapaho.upland.forb.cons[,c(6,7)],delta=200)

> upland.sg.dist200.cons
$ind
      [,1] [,2]
 [1,]    1    1
 [2,]    1    2
 [3,]    1    3
 [4,]    2    1
 [5,]    2    2
 [6,]    2    3
 [7,]    3    8
 [8,]    3    9
 [9,]    4   17
[10,]    5   27
[11,]    5   28
[12,]    7   36
[13,]    8   40
[14,]    9   43
[15,]    9   44
[16,]    9   45
[17,]   10   63
[18,]   10   64
[19,]   12   74
[20,]   13   79
[21,]   13   80
[22,]   14   97
[23,]   15  112
[24,]   16  121
[25,]   17  150
[26,]   19  153
[27,]   19  154
[28,]   20  158
[29,]   21  160
[30,]   21  161
[31,]   22  166
[32,]   23  170
[33,]   24  174
[34,]   24  203
[35,]   25  187
[36,]   26  213
[37,]   27  221
[38,]   27  247
[39,]   28  227
[40,]   29  232
[41,]   30  235
[42,]   30  236
[43,]   31  235
[44,]   31  236
[45,]   32  241
[46,]   32  242
```

```
[47,]   33  255
[48,]   33  256
[49,]   35  269
[50,]   35  270
[51,]   36  275
[52,]   37  263
[53,]   37  280
[54,]   38  287
[55,]   39  290
[56,]   39  291
[57,]   40  293

$ra
 [1]  75.02666   0.00000  64.66065 132.43867  64.66065   0.00000  71.47027
0.00000   0.00000   0.00000
[11] 144.00694   0.00000   0.00000 169.00296   0.00000  76.00658 144.02778
0.00000   0.00000 182.23611
[21]  66.03787   0.00000   0.00000 177.28226   0.00000   0.00000 138.91724
0.00000 123.47064   0.00000
[31] 107.64757 185.85209   0.00000  98.50888   0.00000   0.00000   0.00000
176.91806   0.00000 172.58621
[41]   0.00000  82.34683  82.34683   0.00000   0.00000 134.48048   0.00000
141.82383 122.71104   0.00000
[51]   0.00000 130.81667   0.00000   0.00000 147.07821   0.00000   0.00000

$da
[1]  40 295

> upland.sgf.dist200.cons
$ind
      [,1] [,2]
 [1,]    1    1
 [2,]    2    1
 [3,]    3    3
 [4,]    4    5
 [5,]   12   19
 [6,]   12   20
 [7,]   18   33
 [8,]   21   38
 [9,]   22   40
[10,]   24   50
[11,]   26   54
[12,]   28   56
[13,]   28   57
[14,]   29   56
[15,]   29   57
[16,]   37   69

$ra
 [1]   0.00000  64.66065  71.47027   0.00000 182.23611  66.03787   0.00000
185.85209   0.00000 122.78844
[11]   0.00000   0.00000  82.34683  82.34683   0.00000   0.00000

$da
[1] 38 69
```

```
length(upland.sgf.dist200.cons$ra[upland.sgf.dist200.cons$ra==0.0])
[1] 8
>
arapaho.upland.sg.cons <-
arapaho.upland.sage.cons[c(unique(upland.sg.dist200.cons$ind[,1])),1]
arapaho.upland.sg.cons <- as.data.frame(arapaho.upland.sg.cons)
colnames(arapaho.upland.sg.cons)<-c("SITE_ID")

arapaho.upland.sg.dist.cons <-
arapaho.upland.sg.cons[c(unique(upland.sgf.dist200.cons$ind[,1])),1]
arapaho.upland.sg.dist.cons <- as.data.frame(arapaho.upland.sg.dist.cons)
colnames(arapaho.upland.sg.dist.cons)<-c("SITE_ID")

arapaho.upland.forb.dist.cons <-
arapaho.upland.forb.cons[c(unique(upland.sgf.dist200.cons$ind[,2])),1]
arapaho.upland.forb.dist.cons <- as.data.frame(arapaho.upland.forb.dist.cons)
colnames(arapaho.upland.forb.dist.cons)<-c("SITE_ID")

arapaho.upland.sgf.unique.cons <-
unique(rbind(arapaho.upland.sg.dist.cons,arapaho.upland.forb.dist.cons))

length(arapaho.upland.sgf.unique.cons$SITE_ID)
[1] 18
>
```

###So 8 of 511 Upland transects met all conditions simultaneously on transects and 18 of 511
###met all conditions on transects within 200 m of each other.

###To get proportion estimates averaged across 4 years recognizing sample sizes in years
###may not be equal we have to calculate weighted averages of individual obs.

```
up.con.2005 <- (length(arapaho$up_ALL_CON[arapaho$UP_ALL_CON==1 &
arapaho$YEAR==2005]))/(length(arapaho$UP_ALL_CON[(arapaho$NEWHABITAT=="Upland
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2005]))
up.con.2006 <- (length(arapaho$UP_ALL_CON[arapaho$UP_ALL_CON==1 &
arapaho$YEAR==2006]))/(length(arapaho$UP_ALL_CON[(arapaho$NEWHABITAT=="Upland
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2006]))
up.con.2007 <- (length(arapaho$UP_ALL_CON[arapaho$UP_ALL_CON==1 &
arapaho$YEAR==2007]))/(length(arapaho$UP_ALL_CON[(arapaho$NEWHABITAT=="Upland
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2007]))
up.con.2008 <- (length(arapaho$UP_ALL_CON[arapaho$UP_ALL_CON==1 &
arapaho$YEAR==2008]))/(length(arapaho$UP_ALL_CON[(arapaho$NEWHABITAT=="Upland
")& arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2008]))

mean(c(up.con.2005,up.con.2006,up.con.2007,up.con.2008))*14285
[1] 224.5670 acres
```

###Note no evidence under even benefit-of-doubt approach that >=30% canopy cover of sagebrush >40 cm ht
###has been met.

###To perform distance analyses across a range of distances.
###m determines number of distance values that are calculated

```
###by multiples of 100 m.
###Modified 08/16/2011 to use weighted proportions to get average proportions
across the 4 years

m<-12
sage.forb.dist.cons<- matrix(0,nrow=m,ncol=2)
colnames(sage.forb.dist.cons) <- c("distance","proportion")
for(i in 1:m){
dist<-100*i
upland.sg.dist.cons <-
fields.rdist.near(arapaho.upland.sage.cons[,c(6,7)],arapaho.upland.grass.cons
[,c(6,7)],delta=dist)

upland.sgf.dist.cons <-
fields.rdist.near(arapaho.upland.sage.cons[c(unique(upland.sg.dist.cons$ind[,
1])),c(6,7)],arapaho.upland.forb.cons[,c(6,7)],delta=dist)

arapaho.upland.sg.cons <-
arapaho.upland.sage.cons[c(unique(upland.sg.dist.cons$ind[,1])),c(1,9)]
arapaho.upland.sg.cons <- as.data.frame(arapaho.upland.sg.cons)
colnames(arapaho.upland.sg.cons)<-c("SITE_ID","YEAR")

arapaho.upland.sg.dist.cons <-
arapaho.upland.sg.cons[c(unique(upland.sgf.dist.cons$ind[,1])),]
arapaho.upland.sg.dist.cons <- as.data.frame(arapaho.upland.sg.dist.cons)
colnames(arapaho.upland.sg.dist.cons)<-c("SITE_ID","YEAR")

arapaho.upland.forb.dist.cons <-
arapaho.upland.forb.cons[c(unique(upland.sgf.dist.cons$ind[,2])),c(1,9)]
arapaho.upland.forb.dist.cons <- as.data.frame(arapaho.upland.forb.dist.cons)
colnames(arapaho.upland.forb.dist.cons)<-c("SITE_ID","YEAR")

sg.all<- rbind(arapaho.upland.sg.dist.cons,arapaho.upland.forb.dist.cons)
arapaho.upland.sgf.unique.cons <- unique(sg.all)
arapaho.upland.sgf.unique.cons <-
as.data.frame(arapaho.upland.sgf.unique.cons)
colnames(arapaho.upland.sgf.unique.cons) <- c("SITE_ID","YEAR")

###note that the 4 in the wts calculation comes from averaging across 4 years
arapaho.upland.sgf.unique.cons$WT[arapaho.upland.sgf.unique.cons$YEAR==2005]<
- 1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2005])))
arapaho.upland.sgf.unique.cons$WT[arapaho.upland.sgf.unique.cons$YEAR==2006]<
- 1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2006])))
arapaho.upland.sgf.unique.cons$WT[arapaho.upland.sgf.unique.cons$YEAR==2007]<
- 1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2007])))
arapaho.upland.sgf.unique.cons$WT[arapaho.upland.sgf.unique.cons$YEAR==2008]<
- 1/(4*(length(arapaho$NEWHABITAT[arapaho$NEWHABITAT=="Upland" &
arapaho$SAMPLING_SEQ==1 & arapaho$YEAR==2008])))


sage.forb.dist.cons[i,1] <- dist

sage.forb.dist.cons[i,2] <- sum(arapaho.upland.sgf.unique.cons$WT)
}
```

```
sage.forb.dist.cons<-as.data.frame(sage.forb.dist.cons)
```

###To graph the distance results simultaneously for the liberal and conservative approaches.

```
matplot(sage.forb.dist.cons$distance,cbind(sage.forb.dist$proportion,sage.for
b.dist.cons$proportion),type="b",lty=c(1,1),pch=c(19,24))
```

MEADOW AND RIPARIAN(modified 10/05/2010 to include Mix types assigned by Pam J.)
n = 389 except for VOR where n = 378. Note that we have used alpha=0.10 in rq for both 2-tailed
(1 - 2*alpha)*100% CI associated with an alpha = 0.05 for two 1-sided
equivalance tests and for a 1-tailed (1 - alpha)*100% CI associated with a single
alpha = 0.05 1-sided test of equivalence (see Cade et al. 2011. Ecol.
Appl. 21(1):281-289) because the alpha in rq always puts 1/2*alpha in
2-tails of the CI. So an alpha=0.10 in rq yields 2-tailed 90% CI for
two 1-sided equivalence tests at alpha=0.05 and by using 1-tail of the
2-tailed 90% CI we get a 1-tailed 95% CI for a 1-sided equivalence test
at alpha=0.05.

###Note small random uniform numbers (magnitude less) were added (jittered) to raw values to
###prevent convergence issues with quantile rank score confidence intervals.
###Values were checked by reestimating models with raw data in a restricted range of quantiles
###near the benefit-of-doubt and fail-safe limits.
###Primary models estimated with "sum" contrasts so that intercept is average across years.
###Plotting function provides the CI across the quantiles for the intercept estimates.

```
prop.grass.MRavg <- rq((PROP_GRASS + runif(n=389,min=-0.001,max=0.001)) ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
5:95/100,contrasts=list(year="contr.sum"))
plot(summary(prop.grass.MRavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=0.75)
abline(v=0.49)
abline(v=0.57)
```

```
prop.grass.MRavg.4560 <- rq(PROP_GRASS ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
45:60/100,contrasts=list(year="contr.sum"))
prop.grass.MRavg.4560.stats <-
summary(prop.grass.MRavg.4560,se="rank",iid=F,alpha=0.10)
plot(prop.grass.MRavg.4560.stats,ols=F,parm=1)
abline(h=0.75)
abline(v=0.49)
abline(v=0.57)
```

###Here models are estimated without an intercept (the -1 in the rhs of formula) and "treatment" contrasts
###so that quantile estimates are provided by year.

```
prop.grass.MR.49 <- rq(PROP_GRASS ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& (arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.49,contrasts=list(year="contr.treatment"))
summary(prop.grass.MR.49,se="rank",iid=F,alpha=0.10)

prop.grass.MR.57 <- rq(PROP_GRASS ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& (arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.57,contrasts=list(year="contr.treatment"))
summary(prop.grass.MR.57,se="rank",iid=F,alpha=0.10)

prop.grass.MR <- rq(PROP_GRASS ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
1:99/100,contrasts=list(year="contr.treatment"))


bareground.MRavg.6095 <- rq((BAREGROUND + runif(n=389,min=-0.1,max=0.1)) ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
60:95/100,contrasts=list(year="contr.sum"))
plot(summary(bareground.MRavg.6095,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=5)
abline(v=0.88)
abline(v=0.93)

bareground.MRavg.8595 <- rq(BAREGROUND ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
85:95/100,contrasts=list(year="contr.sum"))
bareground.MRavg.8595.stats <-
summary(bareground.MRavg.8595,se="rank",iid=F,alpha=0.10)
plot(bareground.MRavg.8595.stats,ols=F,parm=1)
abline(h=5)
abline(v=0.88)
abline(v=0.93)
```

###Here models are estimated without an intercept (the -1 in the rhs of formula) and "treatment" contrasts
###so that quantile estimates are provided by year.

```
bareground.MR.88 <- rq(BAREGROUND ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& (arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
```

```
0.88,contrasts=list(year="contr.treatment"))
summary(bareground.MR.88,se="rank",iid=F,alpha=0.10)

bareground.MR.93 <- rq(BAREGROUND ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1
& (arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.93,contrasts=list(year="contr.treatment"))
summary(bareground.MR.93,se="rank",iid=F,alpha=0.10)

bareground.MR <- rq(BAREGROUND ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
1:99/100,contrasts=list(year="contr.treatment"))


###Note n = 378 for VOR

vor.MRavg <- rq((VOR + runif(n=378,min=-0.01,max=0.01)) ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=5:95/100,contrasts=list(year="contr.sum
"))
plot(summary(vor.MRavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=c(1,3))
abline(v=c(0.10,0.15,0.48,0.56))

vor.MRavg.0560 <- rq(VOR ~ year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
5:60/100,contrasts=list(year="contr.sum"))
vor.MRavg.0560.stats <- summary(vor.MRavg.0560,se="rank",iid=F,alpha=0.10)

plot(vor.MRavg.0560.stats,ols=F,parm=1)
abline(h=c(1,3))
abline(v=c(0.10,0.15,0.48,0.56))

###Here models are estimated without an intercept (the -1 in the rhs of formula)
and "treatment" contrasts
###so that quantile estimates are provided by year.

vor.MR.10 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.10,contrasts=list(year="contr.treatment"))
summary(vor.MR.10,se="ker")

vor.MR.15 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.15,contrasts=list(year="contr.treatment"))
summary(vor.MR.15,se="ker")

vor.MR.48 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.48,contrasts=list(year="contr.treatment"))
summary(vor.MR.48,se="ker")

vor.MR.56 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.56,contrasts=list(year="contr.treatment"))
summary(vor.MR.56,se="ker")

vor.MR <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
```

```
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
1:99/100,contrasts=list(year="contr.treatment"))


duff.depth.MRavg <- rq((DUFF_DEPTH_LINECM + runif(n=389,min=-0.1,max=0.1)) ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
5:98/100,contrasts=list(year="contr.sum"))
plot(summary(duff.depth.MRavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=c(10))
abline(v=0.95)

duff.depth.MRavg.9098 <- rq(DUFF_DEPTH_LINECM ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
90:98/100,contrasts=list(year="contr.sum"))
duff.depth.MRavg.9098.stats <-
summary(duff.depth.MRavg.9098,se="rank",iid=F,alpha=0.10)
plot(duff.depth.MRavg.9098.stats,ols=F,parm=1)
abline(h=c(10))
abline(v=0.95)

###Here models are estimated without an intercept (the -1 in the rhs of formula)
and "treatment" contrasts
###so that quantile estimates are provided by year.

duff.depth.MR.95 <- rq(DUFF_DEPTH_LINECM ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.95,contrasts=list(year="contr.treatment"))
summary(duff.depth.MR.95,se="ker")

duff.depth.MR.96 <- rq(DUFF_DEPTH_LINECM ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.96,contrasts=list(year="contr.treatment"))
summary(duff.depth.MR.96,se="ker")


duff.depth.MR.98 <- rq(DUFF_DEPTH_LINECM ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.98,contrasts=list(year="contr.treatment"))
summary(duff.depth.MR.98,se="ker")

duff.depth.MR <- rq(DUFF_DEPTH_LINECM ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
1:99/100,contrasts=list(year="contr.treatment"))


duff.depth.MRavg.9096 <- rq(DUFF_DEPTH_LINECM ~
year,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
90:96/100,contrasts=list(year="contr.sum"))
duff.depth.MRavg.9096.stats2 <-
summary(duff.depth.MRavg.9096,se="rank",iid=F,alpha=0.10)
```

```
plot(duff.depth.MRavg.9096.stats2,ols=F,parm=1)
abline(h=c(10))
abline(v=0.95)

duff.depth.MR.96 <- rq(DUFF_DEPTH_LINECM ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.96,contrasts=list(year="contr.treatment"))
summary(duff.depth.MR.96,se="ker")

vor.MRavg.0560 <- rq(VOR ~ year,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
5:60/100,contrasts=list(year="contr.sum"))
vor.MRavg.0560.stats90 <- summary(vor.MRavg.0560,se="rank",iid=F,alpha=0.10)

plot(vor.MRavg.0560.stats90,ols=F,parm=1)
abline(h=c(3))
abline(v=c(0.49,0.57))

plot(summary(vor.MRavg,se="rank",iid=F,alpha=0.10),ols=F,parm=1)
abline(h=c(3))
abline(v=c(0.49,0.57))
```

###Here models are estimated without an intercept (the -1 in the rhs of formula) and "treatment" contrasts
###so that quantile estimates are provided by year.

```
vor.MR.49 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.49,contrasts=list(year="contr.treatment"))
summary(vor.MR.49,se="ker")
```

###Simple statistical summaries of variables by year for 2005 to 2008 data in meadow/riparian.

```
meadrip0508<-(arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow"
|arapaho$NEWHABITAT=="Riparian"),])
by(meadrip0508$PROP_GRASS,meadrip0508$year,summary)
by(meadrip0508$BAREGROUND,meadrip0508$year,summary)
by(meadrip0508$DUFF_DEPTH_LINECM,meadrip0508$year,summary)
by(meadrip0508$VOR,meadrip0508$year,summary)
```

###Graph the quantile estimates (no CI) by year

```
plot(prop.grass.MR,ols=F,ylim=c(0,1))
plot(bareground.MR,ols=F,ylim=c(0,30))
plot(duff.depth.MR,ols=F,ylim=c(0,20))
plot(vor.MR,ols=F,ylim=c(0,15))
```

###Results

```
> summary(prop.grass.MR.49,se="rank",iid=F,alpha=0.10)

Call: rq(formula = PROP_GRASS ~ year - 1, tau = 0.49, data =
arapaho[arapaho$SAMPLING_SEQ ==
```

```
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.49

Coefficients:
         coefficients lower bd upper bd
year2005 0.76106      0.73520  0.81782
year2006 0.67241      0.63306  0.70415
year2007 0.76562      0.72249  0.85695
year2008 0.67857      0.63400  0.70927
>
> prop.grass.MR.57 <- rq(PROP_GRASS ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.57,contrasts=list(year="contr.treatment"))
> summary(prop.grass.MR.57,se="rank",iid=F,alpha=0.10)

Call: rq(formula = PROP_GRASS ~ year - 1, tau = 0.57, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.57

Coefficients:
         coefficients lower bd upper bd
year2005 0.82143      0.76287  0.84246
year2006 0.71134      0.67408  0.76115
year2007 0.85185      0.76537  0.90578
year2008 0.70930      0.67718  0.75985
>
>
> summary(bareground.MR.88,se="rank",iid=F,alpha=0.10)

Call: rq(formula = BAREGROUND ~ year - 1, tau = 0.88, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.88

Coefficients:
         coefficients   lower bd       upper bd
year2005   5.000000e+00 -1.797693e+308   8.850780e+00
year2006   1.000000e+00 -1.797693e+308   2.984140e+00
year2007   4.000000e+00   5.834000e-02   1.284662e+01
year2008   4.000000e+00 -1.797693e+308   1.009925e+01
>
> bareground.MR.93 <- rq(BAREGROUND ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.93,contrasts=list(year="contr.treatment"))
> summary(bareground.MR.93,se="rank",iid=F,alpha=0.10)

Call: rq(formula = BAREGROUND ~ year - 1, tau = 0.93, data =
arapaho[arapaho$SAMPLING_SEQ ==
```

```
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.93

Coefficients:
         coefficients   lower bd       upper bd
year2005   7.000000e+00   3.349010e+00   1.346593e+01
year2006   2.000000e+00 -1.797693e+308   3.010230e+00
year2007   9.000000e+00   3.918440e+00   1.911089e+01
year2008   6.000000e+00   5.524870e+00   1.059513e+01
>
>
> summary(vor.MR.10,se="ker")

Call: rq(formula = VOR ~ year - 1, tau = 0.1, data = arapaho[arapaho$SAMPLING_SEQ
==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.1

Coefficients:
         Value   Std. Error t value Pr(>|t|)
year2005 1.10000 0.31100    3.53696 0.00046
year2006 1.40000 0.23704    5.90630 0.00000
year2007 0.40000 0.22272    1.79598 0.07330
year2008 0.50000 0.20174    2.47842 0.01364
>
> vor.MR.15 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.15,contrasts=list(year="contr.treatment"))
> summary(vor.MR.15,se="ker")

Call: rq(formula = VOR ~ year - 1, tau = 0.15, data = arapaho[arapaho$SAMPLING_SEQ
==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.15

Coefficients:
         Value   Std. Error t value Pr(>|t|)
year2005 1.90000 0.26564    7.15248 0.00000
year2006 1.60000 0.25964    6.16236 0.00000
year2007 0.50000 0.25246    1.98049 0.04838
year2008 0.90000 0.19961    4.50884 0.00001
>
> vor.MR.48 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.48,contrasts=list(year="contr.treatment"))
> summary(vor.MR.48,se="ker")

Call: rq(formula = VOR ~ year - 1, tau = 0.48, data = arapaho[arapaho$SAMPLING_SEQ
==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))
```

```
tau: [1] 0.48

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  3.60000  0.30088   11.96501  0.00000
year2006  3.40000  0.31437   10.81526  0.00000
year2007  2.10000  0.31733    6.61774  0.00000
year2008  1.90000  0.25687    7.39671  0.00000
>
> vor.MR.56 <- rq(VOR ~ year -1,data=arapaho[arapaho$SAMPLING_SEQ==1 &
(arapaho$NEWHABITAT=="Meadow" | arapaho$NEWHABITAT=="Riparian"),],tau=
0.56,contrasts=list(year="contr.treatment"))
> summary(vor.MR.56,se="ker")

Call: rq(formula = VOR ~ year - 1, tau = 0.56, data = arapaho[arapaho$SAMPLING_SEQ
==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.56

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  4.00000  0.30331   13.18804  0.00000
year2006  4.00000  0.32613   12.26522  0.00000
year2007  2.40000  0.32510    7.38229  0.00000
year2008  2.30000  0.25871    8.89028  0.00000
>
>


> summary(vor.MR.49,se="ker")

Call: rq(formula = VOR ~ year - 1, tau = 0.49, data = arapaho[arapaho$SAMPLING_SEQ
==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.49

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  3.60000  0.30113   11.95497  0.00000
year2006  3.50000  0.31616   11.07034  0.00000
year2007  2.10000  0.31761    6.61187  0.00000
year2008  2.00000  0.25745    7.76849  0.00000
>

> summary(duff.depth.MR.95,se="ker")

Call: rq(formula = DUFF_DEPTH_LINECM ~ year - 1, tau = 0.95, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.95
```

```
Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  5.67000  0.29741   19.06468  0.00000
year2006 13.20000  0.90574   14.57370  0.00000
year2007  9.26000  0.73858   12.53758  0.00000
year2008  8.49000  0.70948   11.96657  0.00000
>
> duff.depth.MR.98 <- rq(DUFF_DEPTH_LINECM ~ year
-1,data=arapaho[arapaho$SAMPLING_SEQ==1 & (arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian"),],tau=
0.98,contrasts=list(year="contr.treatment"))
> summary(duff.depth.MR.98,se="ker")

Call: rq(formula = DUFF_DEPTH_LINECM ~ year - 1, tau = 0.98, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.98

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  6.71000  0.26693   25.13758  0.00000
year2006 14.70000  0.86516   16.99114  0.00000
year2007 10.34000  0.65246   15.84776  0.00000
year2008  8.87000  0.47565   18.64807  0.00000
>

> summary(duff.depth.MR.96,se="ker")

Call: rq(formula = DUFF_DEPTH_LINECM ~ year - 1, tau = 0.96, data =
arapaho[arapaho$SAMPLING_SEQ ==
    1 & (arapaho$NEWHABITAT == "Meadow" | arapaho$NEWHABITAT ==
    "Riparian"), ], contrasts = list(year = "contr.treatment"))

tau: [1] 0.96

Coefficients:
         Value    Std. Error t value  Pr(>|t|)
year2005  5.97000  0.30291   19.70901  0.00000
year2006 13.58000  0.91525   14.83754  0.00000
year2007  9.26000  0.66464   13.93239  0.00000
year2008  8.57000  0.65003   13.18394  0.00000
>
>
```

###Create identifying variables for each condition with 1 assigned if meeting the quantile conditions by each year.
###These are for liberal interpretation.

```
arapaho$MR_DUFFDEPTH_LIB <-0
arapaho$MR_BAREGROUND_LIB <-0
arapaho$MR_PROPGRASS_LIB <-0
arapaho$MR_VOR_LIB <-0
arapaho$MR_ALL_LIB <-0
arapaho$MR_VORG3_LIB <-0
arapaho$MR_DUFFDEPTH1020_LIB <-0
```

```
arapaho$MR_B_ALL_LIB <-0

arapaho$MR_DUFFDEPTH_LIB[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$DUFF_DEPTH_LINECM <=
coef(duff.depth.MR.98)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$DUFF_DEPTH_LINECM  <=
coef(duff.depth.MR.98)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$DUFF_DEPTH_LINECM  <=
coef(duff.depth.MR.98)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$DUFF_DEPTH_LINECM  <= coef(duff.depth.MR.98)[[4]])] <- 1
arapaho$MR_BAREGROUND_LIB[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$BAREGROUND <=
coef(bareground.MR.93)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$BAREGROUND <=
coef(bareground.MR.93)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$BAREGROUND <=
coef(bareground.MR.93)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$BAREGROUND <= coef(bareground.MR.93)[[4]])] <- 1
arapaho$MR_PROPGRASS_LIB[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$PROP_GRASS <=
coef(prop.grass.MR.57)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$PROP_GRASS <=
coef(prop.grass.MR.57)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$PROP_GRASS <=
coef(prop.grass.MR.57)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$PROP_GRASS <= coef(prop.grass.MR.57)[[4]])] <- 1
arapaho$MR_VOR_LIB[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$VOR >= coef(vor.MR.10)[[1]] & arapaho$VOR <=
coef(vor.MR.56)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$VOR >= coef(vor.MR.10)[[2]] & arapaho$VOR <=
coef(vor.MR.56)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$VOR >= coef(vor.MR.10)[[3]] & arapaho$VOR <=
coef(vor.MR.56)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$VOR >= coef(vor.MR.10)[[4]] & arapaho$VOR <= coef(vor.MR.56)[[4]])] <-
1
arapaho$MR_ALL_LIB[arapaho$MR_DUFFDEPTH_LIB==1 & arapaho$MR_BAREGROUND_LIB ==1
& arapaho$MR_PROPGRASS_LIB==1 & arapaho$MR_VOR_LIB==1] <- 1

arapaho$MR_VORG3_LIB[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$VOR >= coef(vor.MR.49)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
```

```
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$VOR >= coef(vor.MR.49)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$VOR >= coef(vor.MR.49)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$VOR >= coef(vor.MR.49)[[4]])] <- 1
arapaho$MR_DUFFDEPTH1020_LIB[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$DUFF_DEPTH_LINECM >=
coef(duff.depth.MR.96)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$DUFF_DEPTH_LINECM  >=
coef(duff.depth.MR.96)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$DUFF_DEPTH_LINECM  >=
coef(duff.depth.MR.96)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$DUFF_DEPTH_LINECM  >= coef(duff.depth.MR.96)[[4]])] <- 1
arapaho$MR_B_ALL_LIB[arapaho$MR_DUFFDEPTH1020_LIB==1 &
arapaho$MR_BAREGROUND_LIB ==1 & arapaho$MR_PROPGRASS_LIB==1 &
arapaho$MR_VORG3_LIB==1] <- 1
```

###Create identifying variables for each condition with 1 assigned if meeting the quantile conditions by each year.
###These are for conservative interpretation.

```
arapaho$MR_DUFFDEPTH_CON <-0
arapaho$MR_BAREGROUND_CON <-0
arapaho$MR_PROPGRASS_CON <-0
arapaho$MR_VOR_CON <-0
arapaho$MR_ALL_CON <-0
arapaho$MR_VORG3_CON <-0


arapaho$MR_DUFFDEPTH_CON[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$DUFF_DEPTH_LINECM  <=
coef(duff.depth.MR.95)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$DUFF_DEPTH_LINECM  <=
coef(duff.depth.MR.95)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$DUFF_DEPTH_LINECM  <=
coef(duff.depth.MR.95)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$DUFF_DEPTH_LINECM  <= coef(duff.depth.MR.95)[[4]])] <- 1
arapaho$MR_BAREGROUND_CON[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$BAREGROUND <=
coef(bareground.MR.88)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$BAREGROUND <=
coef(bareground.MR.88)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$BAREGROUND <=
coef(bareground.MR.88)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
```

```
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$BAREGROUND <= coef(bareground.MR.88)[[4]])] <- 1
arapaho$MR_PROPGRASS_CON[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$PROP_GRASS <=
coef(prop.grass.MR.49)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$PROP_GRASS <=
coef(prop.grass.MR.49)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$PROP_GRASS <=
coef(prop.grass.MR.49)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$PROP_GRASS <= coef(prop.grass.MR.49)[[4]])] <- 1
arapaho$MR_VOR_CON[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$VOR >= coef(vor.MR.15)[[1]] & arapaho$VOR <=
coef(vor.MR.48)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$VOR >= coef(vor.MR.15)[[2]] & arapaho$VOR <=
coef(vor.MR.48)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$VOR >= coef(vor.MR.15)[[3]] & arapaho$VOR <=
coef(vor.MR.48)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$VOR >= coef(vor.MR.15)[[4]] & arapaho$VOR <= coef(vor.MR.48)[[4]])] <-
1
arapaho$MR_ALL_CON[arapaho$MR_DUFFDEPTH_CON==1 & arapaho$MR_BAREGROUND_CON==1 &
arapaho$MR_PROPGRASS_CON==1 & arapaho$MR_VOR_CON==1] <- 1

arapaho$MR_VORG3_CON[((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2005
& arapaho$VOR >= coef(vor.MR.57)[[1]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2006
& arapaho$VOR >= coef(vor.MR.57)[[2]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2007
& arapaho$VOR >= coef(vor.MR.57)[[3]])|((arapaho$NEWHABITAT=="Meadow" |
arapaho$NEWHABITAT=="Riparian") & arapaho$SAMPLING_SEQ==1 & arapaho$year==2008
& arapaho$VOR >= coef(vor.MR.57)[[4]])] <- 1


###Combining conditions
###Note this is a liberal (benefit of doubt)interpretation that allows average
values outside the management
###objectives to be included if the sampling variability (end of 95% CI) suggests
population value could
###be within objectives.  We consider combinations of conditions that meet
management objectives on the same transect
###as reasonable for the meadow/riparian herbaceous vegetation as the combination
of 0-10 cm duff depth, <=5% bareground,
### <= 0.75 proportion grass (grass:forb ratios <= 75:25, and 1-3 dm VOR are
condtions of the herbaceous vegetation that
###can commonly occur in close spatial proximity represented by a 100 m transect.
A distance criteria could be used if meaninful
###distances between components could be specified.
```

```
###To calculate distances between samples meeting duff/bareground, proportion
grass, and VOR.
###Here we used only distances = 0 (selected 1 in function since any distance <60
will be on
###the same transect.

arapaho.mr.duffbare <- subset(arapaho,(MR_DUFFDEPTH_LIB==1 &
MR_BAREGROUND_LIB==1))
arapaho.mr.propgrass <- subset(arapaho,(MR_PROPGRASS_LIB==1))
arapaho.mr.vor <- subset(arapaho,(MR_VOR_LIB==1))
arapaho.mr.vorg3 <- subset(arapaho,(MR_VORG3_LIB==1))
arapaho.mr.duffg10bare <- subset(arapaho,(MR_DUFFDEPTH1020_LIB==1 &
MR_BAREGROUND_LIB==1))


library(fields)
mr.dbg.dist0 <-
fields.rdist.near(arapaho.mr.duffbare[,c(6,7)],arapaho.mr.propgrass[,c(6,7)],
delta=1)

mr.dbgv.dist0 <-
fields.rdist.near(arapaho.mr.duffbare[c(unique(mr.dbg.dist0$ind[,1])),c(6,7)]
,arapaho.mr.vor[,c(6,7)],delta=1)

length(mr.dbgv.dist0[mr.dbgv.dist0$ra==0.0])
[1] 99
>

###So 99/389 met combination of conditions on same transect for objective 1A
###To get proportion estimates averaged across 4 years recognizing sample sizes
in years
###may not be equal we have to calculate weighted averages of individual obs.


mr.lib.2005 <- (length(arapaho$MR_ALL_LIB[arapaho$MR_ALL_LIB==1 &
arapaho$YEAR==2005]))/(length(arapaho$MR_ALL_LIB[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2005]))
mr.lib.2006 <- (length(arapaho$MR_ALL_LIB[arapaho$MR_ALL_LIB==1 &
arapaho$YEAR==2006]))/(length(arapaho$MR_ALL_LIB[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2006]))
mr.lib.2007 <- (length(arapaho$MR_ALL_LIB[arapaho$MR_ALL_LIB==1 &
arapaho$YEAR==2007]))/(length(arapaho$MR_ALL_LIB[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2007]))
mr.lib.2008 <- (length(arapaho$MR_ALL_LIB[arapaho$MR_ALL_LIB==1 &
arapaho$YEAR==2008]))/(length(arapaho$MR_ALL_LIB[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2008]))

mean(c(mr.lib.2005,mr.lib.2006,mr.lib.2007,mr.lib.2008))*7057
[1] 1770.637 acres

mr.b.lib.2005 <- (length(arapaho$MR_B_ALL_LIB[arapaho$MR_B_ALL_LIB==1 &
arapaho$YEAR==2005]))/(length(arapaho$MR_B_ALL_LIB[(arapaho$NEWHABITAT=="Mead
ow" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
```

```
arapaho$YEAR==2005]))
mr.b.lib.2006 <- (length(arapaho$MR_B_ALL_LIB[arapaho$MR_B_ALL_LIB==1 &
arapaho$YEAR==2006]))/(length(arapaho$MR_B_ALL_LIB[(arapaho$NEWHABITAT=="Mead
ow" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2006]))
mr.b.lib.2007 <- (length(arapaho$MR_B_ALL_LIB[arapaho$MR_B_ALL_LIB==1 &
arapaho$YEAR==2007]))/(length(arapaho$MR_B_ALL_LIB[(arapaho$NEWHABITAT=="Mead
ow" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2007]))
mr.b.lib.2008 <- (length(arapaho$MR_B_ALL_LIB[arapaho$MR_B_ALL_LIB==1 &
arapaho$YEAR==2008]))/(length(arapaho$MR_B_ALL_LIB[(arapaho$NEWHABITAT=="Mead
ow" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2008]))

mean(c(mr.b.lib.2005,mr.b.lib.2006,mr.b.lib.2007,mr.b.lib.2008))*7057

[1] 133.5408 acres
```

###Note this is a conservative (fail-safe)interpretation that requires average values and their sampling variability to
###be within the desired management objectives (end of 95% CI) indicating population value is almost surely
###within the management objectives. We consider combinations of conditions that meet management objectives on the same transect
###as reasonable for the meadow/riparian herbaceous vegetation as the combination of 0-10 cm duff depth, <=5% bareground,
<= 0.75 proportion grass (grass:forb ratios <= 75:25, and 1-3 dm VOR are condtions of the herbaceous vegetation that
###can commonly occur in close spatial proximity represented by a 100 m transect. A distance criteria could be used if meaninful
###distances between components could be specified.

```
arapaho.mr.duffbare.cons <- subset(arapaho,(MR_DUFFDEPTH_CON==1 &
MR_BAREGROUND_CON==1))
arapaho.mr.propgrass.cons <- subset(arapaho,(MR_PROPGRASS_CON==1))
arapaho.mr.vor.cons <- subset(arapaho,(MR_VOR_CON==1))
```

###To calculate distances between samples meeting duff/bareground, proportion grass, and VOR.

```
library(fields)
mr.dbg.dist0.cons <-
fields.rdist.near(arapaho.mr.duffbare.cons[,c(6,7)],arapaho.mr.propgrass.cons
[,c(6,7)],delta=1)

mr.dbgv.dist0.cons <-
fields.rdist.near(arapaho.mr.duffbare.cons[c(unique(mr.dbg.dist0.cons$ind[,1]
)),c(6,7)],arapaho.mr.vor.cons[,c(6,7)],delta=1)

> length(mr.dbgv.dist0.cons[mr.dbgv.dist0.cons$ra==0.0])
[1] 56
>
>
```

###So 56/389 transects almost surely met the combination of conditions

simultaneously on the transect
###To get proportion estimates averaged across 4 years recognizing sample sizes in years
###may not be equal we have to calculate weighted averages of individual obs.

```
mr.con.2005 <- (length(arapaho$MR_ALL_CON[arapaho$MR_ALL_CON==1 &
arapaho$YEAR==2005]))/(length(arapaho$MR_ALL_CON[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2005]))
mr.con.2006 <- (length(arapaho$MR_ALL_CON[arapaho$MR_ALL_CON==1 &
arapaho$YEAR==2006]))/(length(arapaho$MR_ALL_CON[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2006]))
mr.con.2007 <- (length(arapaho$MR_ALL_CON[arapaho$MR_ALL_CON==1 &
arapaho$YEAR==2007]))/(length(arapaho$MR_ALL_CON[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2007]))
mr.con.2008 <- (length(arapaho$MR_ALL_CON[arapaho$MR_ALL_CON==1 &
arapaho$YEAR==2008]))/(length(arapaho$MR_ALL_CON[(arapaho$NEWHABITAT=="Meadow
" |arapaho$NEWHABITAT=="Riparian")& arapaho$SAMPLING_SEQ==1 &
arapaho$YEAR==2008]))

mean(c(mr.con.2005,mr.con.2006,mr.con.2007,mr.con.2008))*7057
[1] 1000.010 acres
```