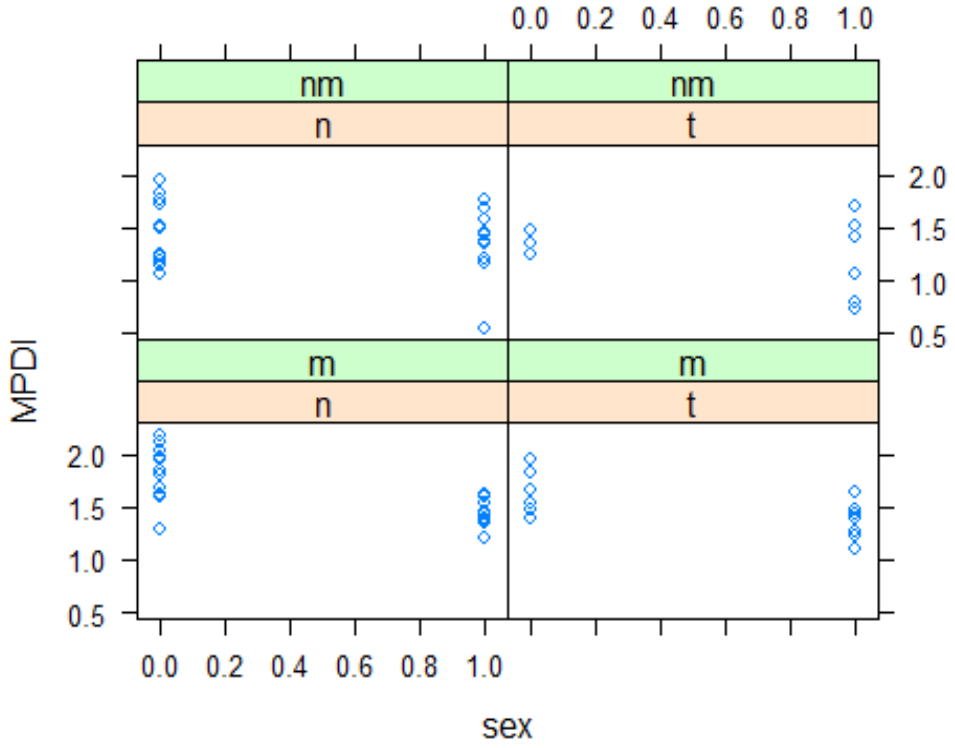
#Generalized Linear Mixed Effects Models (GLMMs) for movement and space Use metrics with Least Squared (LS) means contrasts for pairwise comparisons

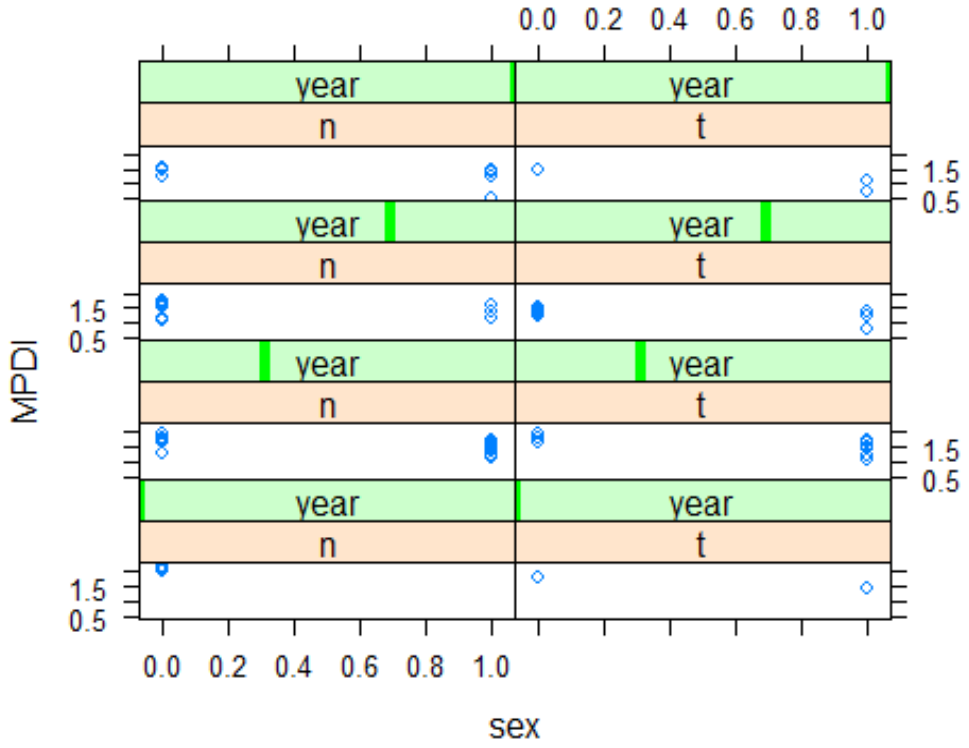
#plot showing differences in spread and location of MPD across sex and within habitat and season

> dat$MPDl=log10(dat$MPD)

> xyplot(MPDl~sex|habitat*season,data=dat)

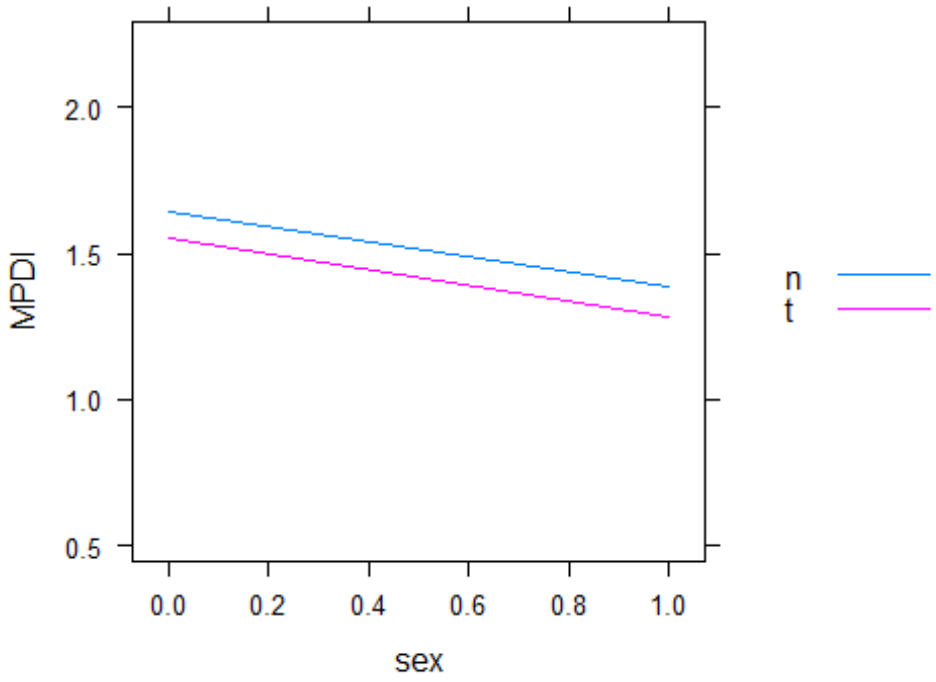


> xyplot(MPDl~sex|habitat*year,data=dat)

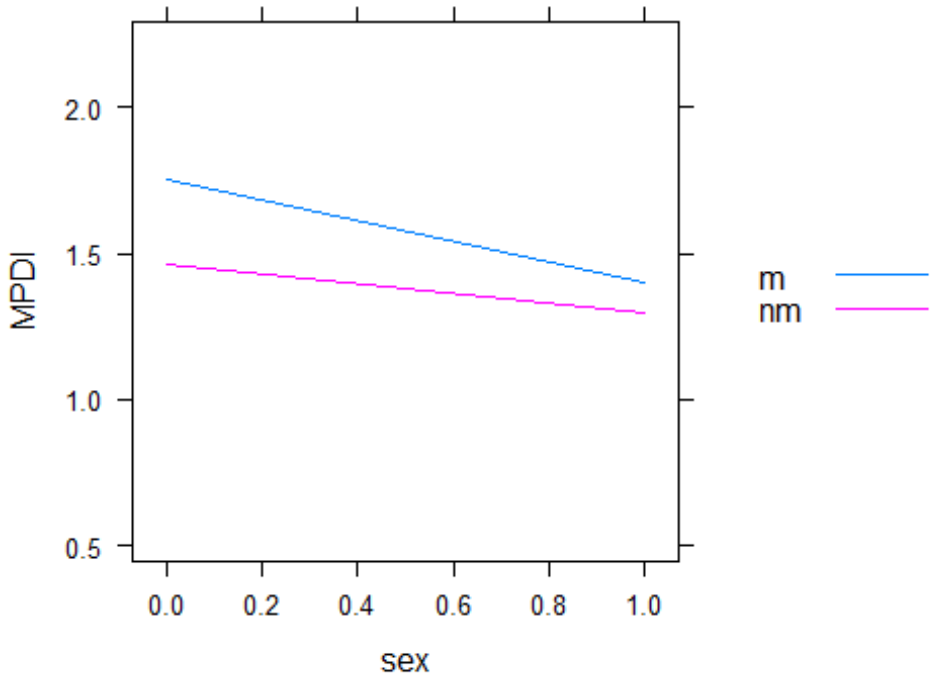


#plot showing differences in MPDl across sex with habitat and season interaction (separately)

> xyplot(MPDl ~ sex, dat, groups = habitat, type = "a", auto.key = list(space = "right", points = FALSE, lines = TRUE))

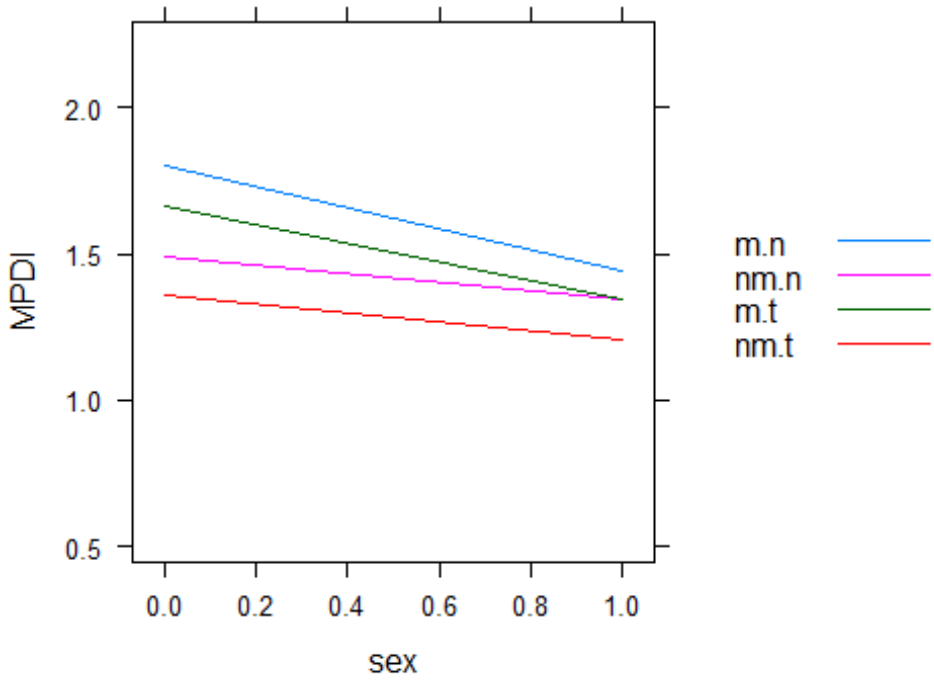


> xyplot(MPDl ~ sex, dat, groups = season, type = "a", auto.key = list(space = "right", points = FALSE, lines = TRUE))



> dat$SeaHab=interaction(dat$season,dat$habitat)

> xyplot(MPDl ~ sex, dat, groups = SeaHab, type = "a", auto.key = list(space = "right", points = FALSE, lines = TRUE))



#ggplot(dat,aes(sex,MPDl,season,habitat,ID)+geom_point(dat,aes(sex,MPDl,season,habitat,ID)))

> mpdmodel <- lmer(MPDl ~ as.factor(sex)*season*habitat+(1|ID)+(1|ID:year),data=dat)

> summary(mpdmodel)

> lsmeans(mpdmodel,pairwise~"sex")

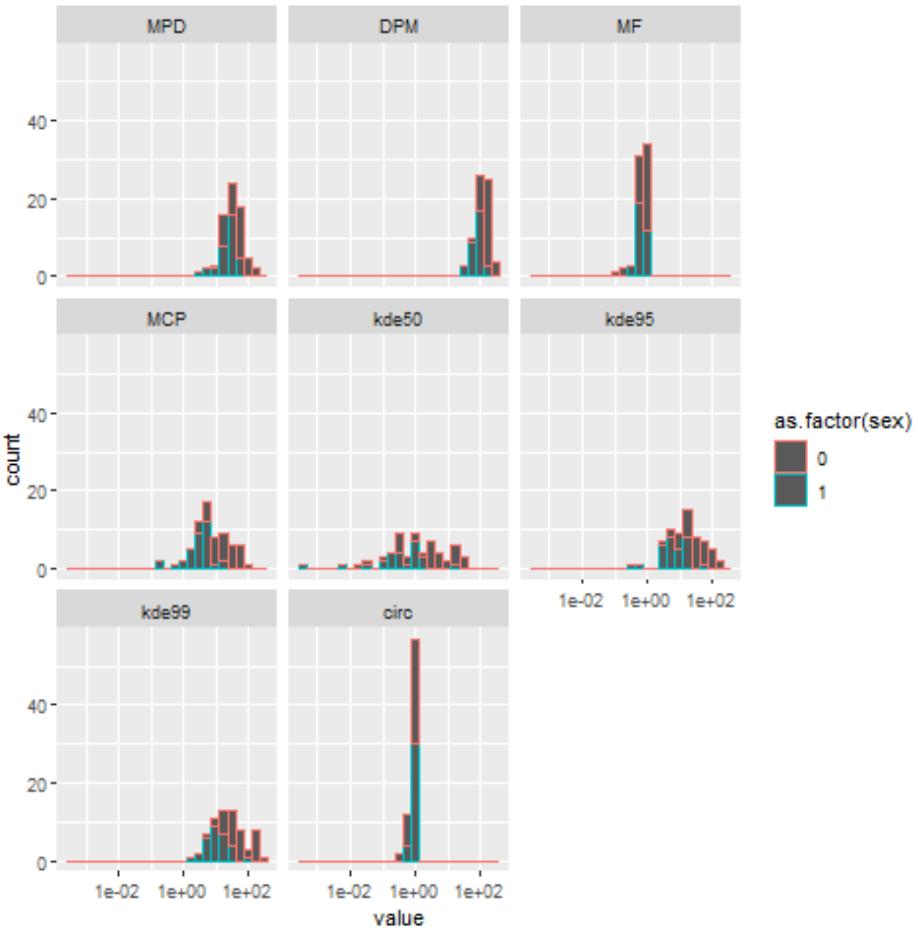
> lsmeans(mpdmodel,pairwise~season|sex)

> lsmeans(mpdmodel,pairwise~season|sex*habitat)

> lsmeans(mpdmodel,pairwise~habitat|sex*season)

> r.squaredGLMM(mpdmodel)

#Combined histogram (sex as factor) for movement and space use metrics



#additional movement and space use models (not displayed here) used same source code

#**GLMMs for Reproductive Behavior**

> dat$SVLl=log10(dat$SVL)

> dat$MPDl=log10(dat$MPD)

> dat$DPMl=log10(dat$DPM)

> dat$MCPl=log10(dat$MCP)

> dat$KDE50l=log10(dat$KDE50)

> dat$KDE95l=log10(dat$KDE95)

> dat$MMFl=logit(dat$MMF,adjust=TRUE)

> dat$dirl=logit(dat$Directionality,adjust=TRUE)

> dat$Sexf=factor(dat$Sex)

> dat$Habf=factor(dat$Habitat)

> dats=data.frame(scale(dat[,c(2,5:11)]),dat[,-c(2,5:11)])

#hist(dats$partners)

> dat$partl=log10(dat$partners+1)

#summary(dats$partl)

>pmod0=glmer(partners~(Habf)+(SVLl)+Sexf+(MPDl)+(DPMl)+(MMFl)+(MCPl)+(KDE50l)+(KDE95l)+(dirl)+(1|ID),data=(dat),family=poisson(link="log"))

> summary(pmod0)

#lsmeans(pmod0,pairwise~"Sexf")

> plot(pmod0, which=c("Picture", "TVset"), pairwise = TRUE)

>pmod1=glmer(partners~(Habf)+(SVLl)+Sexf+(MPDl)+(DPMl)+(MMFl)+(MCPl)+(KDE50l)+(KDE95l)+(dirl)+(1|ID)+(1|Year),data=dat,family=poisson(link="log"))

#,family=poisson(link="log"))

```
> summary(pmod1)

> AIC(pmod0,pmod1)

> BIC(pmod0,pmod1)

> mod1=lmerTest::lmer(pmod0,data=dat)

> summary(mod1)

> ci.res=confint.merMod(pmod0,method="Wald")[-c(1:2),]

>eff=cbind(summary(mod1)$coefficients[,4],summary(mod1)$coefficients[,3],summary(mod1)$

> coefficients[,5])

> colnames(eff)<-c("t","df","pval")

> eff<-as.data.frame(eff[-1,])

> eff$d=(2*eff$t)/sqrt(eff$df) (temp=data.frame(eff$t,eff$d,eff$df,eff$pval,ci.res))

#compare means

> confint(lsmeans(mod1.1,pairwise~HS))

>
modt=lmer(partners~0+(Habf+Sexf)*MPDl+SVLl+DPMl+MMFl+MCPl+KDE50l+KDE95l+dir
l+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|MPDl))

> confint(lsmeans(modt,pairwise~Sexf|MPDl))

>modt=lmer(partners~0+(Habf+Sexf)*SVLl+MPDl+DPMl+MMFl+MCPl+KDE50l+KDE95l+d
irl+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|SVLl))

> confint(lsmeans(modt,pairwise~Sexf|SVLl))

>modt=lmer(partners~0+(Habf+Sexf)*DPMl+SVLl+MPDl+MMFl+MCPl+KDE50l+KDE95l+d
irl+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|DPMl))
```

```
> confint(lsmeans(modt,pairwise~Sexf|DPMl))

>modt=lmer(partners~0+(Habf+Sexf)*MMFl+SVLl+MPDl+DPMl+MCPl+KDE50l+KDE95l+dirl+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|MMFl))

> confint(lsmeans(modt,pairwise~Sexf|MMFl))

>modt=lmer(partners~0+(Habf+Sexf)*MCPl+SVLl+MPDl+DPMl+MMFl+MCPl+KDE50l+KDE95l+dirl+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|MCPl))

> confint(lsmeans(modt,pairwise~Sexf|MCPl))

>modt=lmer(partners~0+(Habf+Sexf)*KDE50l+SVLl+MPDl+DPMl+MMFl+MCPl+KDE95l+dirl+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|KDE50l))

> confint(lsmeans(modt,pairwise~Sexf|KDE50l))

>modt=lmer(partners~0+(Habf+Sexf)*KDE95l+SVLl+MPDl+DPMl+MMFl+MCPl+KDE50l+dirl+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|KDE95l))

> confint(lsmeans(modt,pairwise~Sexf|KDE95l))

>modt=lmer(partners~0+(Habf+Sexf)*dirl+SVLl+MPDl+DPMl+MMFl+MCPl+KDE50l+KDE95l+(1|ID),data=dat)

> confint(lsmeans(modt,pairwise~Habf|dirl))

> confint(lsmeans(modt,pairwise~Sexf|dirl))

#attendance-days-per-partner model (not displayed here) used same source code
```

#Index of Dispersion: *k*-nearest neighbor calculations at weekly intervals

```
> dat$xn=scale(dat$x)

> dat$yn=scale(dat$y)

> names(dat)=c("id","week","x","y","xn","yn")
```

```
> summary(dat)

> table((dat$week))

#using Euclidean distance

> for (j in levels(dat$week)){E.dist=dist(dat[dat$week==j,5:6], method = "euclidean", diag =

FALSE, upper = FALSE, p = 2) res=na.omit(E.dist[lower.tri(E.dist)])

print(paste(j,"=",mean(res)/var(res)))
```