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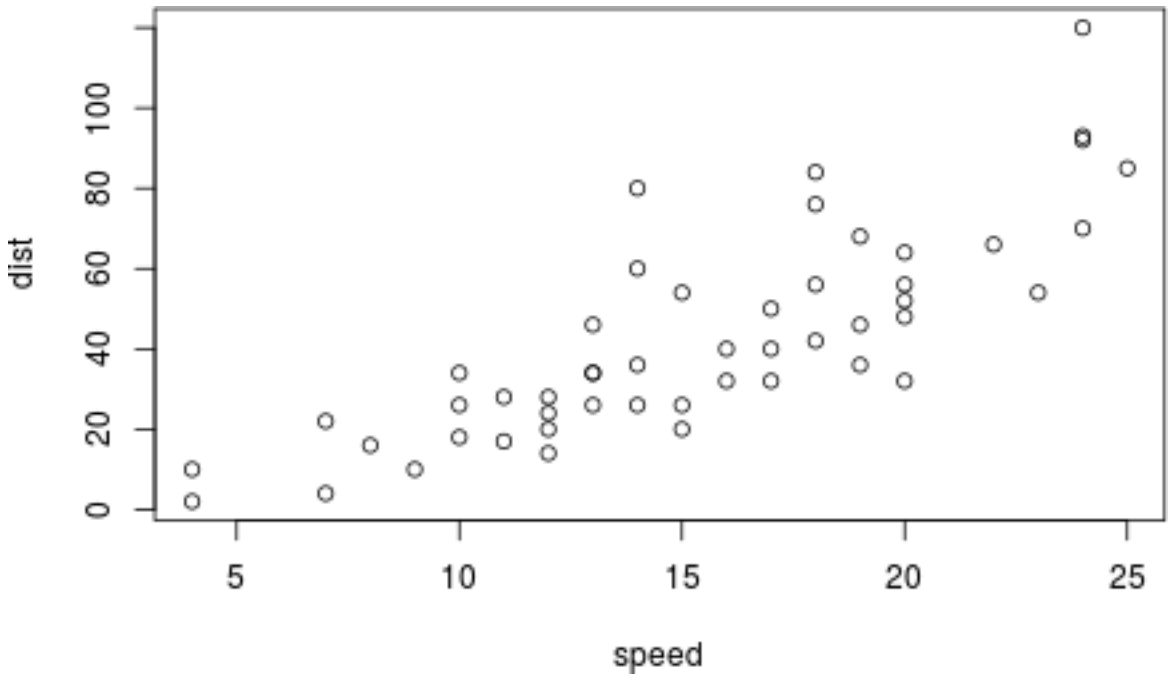
R Markdown

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```
## Lamar Tower Gauge
#png("Plots/lamarTower.png", width=1000, height=300)
#par(mar=c(4.1,5.5,4.1,2.1), mfrow=c(1,1))
#plot(as.yearmon(rownames(flowCpp$qOut)), flowCpp$qOut[, "21647"], type="l", lwd=2, cex=1, cex.lab=1, c
#lines(as.yearmon(rownames(gaugeDataFrame$qOut)), gaugeDataFrame$qOut[, "21647"], lwd=2)
#title("Simulated Streamflow at Lamar Tower Gauge", cex.main=1.5)
#legend("topleft", col=c("red", "black"), legend=c("Modelled LPJ-GUESS Streamflow", "Observed Streamflo
#dev.off()
plot(cars)
```




```
###############
### PLOTS FOR PAPER
###############


#### Snake river temp
png("Plots/snakeRiverTemp.png", width=1000, height=300)
par(mar=c(4.1,5.5,4.1,2.1), mfrow=c(1,1))
plot(as.yearmon(rownames(tempSimGyeCpp$Tw)), tempSimGyeCpp$Tw[, "29277"], type="l", lwd=2, cex=1, cex.la
lines(as.yearmon(rownames(tempDataFrame$Tw)), tempDataFrame$Tw[, "29277"], lwd=2)
title("Simulated Temperature on Snake River", cex.main=1.5)
legend("topleft", col=c("red", "black"), legend=c("Modelled LPJ-GUESS Stream Temperature", "Observed St
```

```
dev.off()

### Flow trend maps for daymet
png("Plots/daymetFlowTrend.png", width=1000, height=300)
par(mfrow=c(1,4), mar=c(0,0,2,5), oma=c(0,0,4,0))#, cex=1, cex.main=1, cex.lab=1, cex.axis=1)
plotSeasonalMaps(daymetFlowSeasSlopes, varName=" Streamflow", savePlots=F, plotSignifOnly=F, plotCatchs=
title("Daymet", outer=T, cex.main=2)
dev.off()

### Flow trend maps for topowx
png("Plots/topoFlowTrend.png", width=1000, height=300)
par(mfrow=c(1,4), mar=c(0,0,2,5), oma=c(0,0,4,0))#, cex=1, cex.main=1, cex.lab=1, cex.axis=1)
plotSeasonalMaps(topoFlowSeasSlopes, varName=" Streamflow", savePlots=F, plotSignifOnly=F, plotCatchs=F
title("TopoWx", outer=T, cex.main=2)
dev.off()

### seasonal density plots of trends
png("Plots/trendElevSeas.png", width=1500, height=450)
elevLevels <- cut(catchElev[edgesInBounds$RiverOrder > 10], breaks=c(0, 1750, 2500, 4000), dig.lab=5)
par(mar=c(4.1,4.2,4.1,1), mfrow=c(1,4), cex=1, cex.main=1.5, cex.lab=1.3, cex.axis=1.3)
for(seas in c("mam", "jja", "son", "djf")){
    sm::sm.density.compare(daymetFlowSeasSlopes[[seas]][[1]][edgesInBounds$RiverOrder > 10], elevLevels
    colfill<-c(2:(2+length(levels(elevLevels))))
    legend("topright", levels(elevLevels), lwd=2, lty=1:3, col=2:4, title="Elevation (m)", bty="n")
    title(paste(toupper(seas), "Flow Trends"))
    abline(v=0)
}
dev.off()

### Temp trend maps for daymet
png("Plots/daymetTempTrend.png", width=1000, height=300)
#par( mfrow = c( 1, 4 ), oma = c( 0, 0, 2, 0 ) )
#m <- matrix(c(1,1,1,1,2,3,4,5,6,6,6,6,7,8,9,10),nrow = 4,ncol = 4,byrow = TRUE)
#layout(mat = m,heights = c(.1,1,.1,1))
#title("Daymet")
par(mfrow=c(1,4), mar=c(0,0,2,5), oma=c(0,0,4,0))#, cex=1, cex.main=1, cex.lab=1, cex.axis=1)
plotSeasonalMaps(daymetTempSeasSlopes, varName=" Stream Temp", savePlots=F, plotSignifOnly=F, plotCatchs
title("Daymet", outer=T, cex.main=2)
dev.off()


### Temp trend maps for topowx
png("Plots/topoTempTrend.png", width=1000, height=300)
par(mfrow=c(1,4), mar=c(0,0,2,5), oma=c(0,0,4,0))#, cex=1, cex.main=1, cex.lab=1, cex.axis=1)
plotSeasonalMaps(topoTempSeasSlopes, varName=" Stream Temp", savePlots=F, plotSignifOnly=F, plotCatchs=
title("TopoWx", outer=T, cex.main=2)
dev.off()

### seasonal density plots of trends
png("Plots/tempTrendElevSeas.png", width=1500, height=450)
elevLevels <- cut(catchElev[edgesInBounds$RiverOrder > 10], breaks=c(0, 1750, 2500, 4000), dig.lab=5)
par(mar=c(4.1,4.2,4.1,1), mfrow=c(1,4), cex=1, cex.main=1.5, cex.lab=1.3, cex.axis=1.3)
for(seas in c("mam", "jja", "son", "djf")){
```

```
    sm::sm.density.compare(daymetTempSeasSlopes[[seas]][[1]][edgesInBounds$RiverOrder > 10], elevLevels
    colfill<-c(2:(2+length(levels(elevLevels))))
    legend("topright", levels(elevLevels), lwd=2, lty=1:3, col=2:4, title="Elevation (m)", bty="n")
    title(paste(toupper(seas), "Temp Trends"))
    abline(v=0)
}
dev.off()

### salmonoid growth graphs
png("Plots/snakeRiverFishHab.png", width=1000, height=300)
par(mar=c(4.1,5.5,4.1,2.1), mfrow=c(1,1))
plot(as.yearmon(rownames(tempSimGyeCpp$Tw))[240:420], sgm$YCT[240:420,"29277"], type="l", lwd=2, cex=1,
lines(as.yearmon(rownames(tempDataFrame$Tw))[240:420], sgm$RBT[240:420,"29277"], type="l", lwd=2, col="
lines(as.yearmon(rownames(tempDataFrame$Tw))[240:420], sgm$BKT[240:420,"29277"], type="l", lwd=2, col="
title("Simulated Salmonoid Growth on Snake River", cex.main=1.5)
legend("bottomleft", col=c("yellow", "green", "red"), legend=c("Yellowstone Cutthroat Trout", "Rainbow
dev.off()

#### Input Trend map for paper
png("Plots/inputTrends.png", width=800, height=1000)
par(mfrow=c(5,4), mar=c(1,1,1,5))
i <- 1
for(var in c("prcp", "tmean", "spack", "msro", "mssro")){
    lims <- c(2, .25, 10, 4, 2.5)
    for(seas in c("DJF", "MAM", "JJA", "SON")){
        colRamp <- colorRampPalette(c("darkred", "red", "grey", "blue", "darkblue"))
        if(var == "tmean"){
            colRamp <- colorRampPalette(rev(c("darkred", "red", "grey", "blue", "darkblue")))
        }
        rast <- raster::brick(paste0(setupList$ncdir, "trends/", "GYE_Daymet_Paper_stand_monthly_", var
        zlimit <- lims[i]
        zlimit <- c(-zlimit, zlimit)

        plot(rast, col=colRamp(1000), axes=F, box=F, legend.width=2, zlim=zlimit, zlimcol="darkred")

        #map("state", add=T)
        title(paste0(seas, " ", switch(var,
                                       msro = "Surface Runoff",
                                       mssro = "Subsurface Runoff",
                                       prcp = "Precip",
                                       spack = "Snowpack",
                                       tmean = "Tmean"), " Trend"))
    }
    i <- i + 1
    #readline()
}
dev.off()

statToPlot <- c("NSE", "mNSE", "rNSE")
statToPlot <- c("mNSE")

png("Plots/flowValidHist.png", width=900, height=450)
par(mfrow=c(1,2))
```

```
for(stat in statToPlot){
    hist(daymetGofs[stat, daymetGofs[stat,] > 0], breaks=seq(0, 1, .1), xlim=c(0,1), xlab=paste0(stat, 
}
for(stat in statToPlot){
    hist(topoGofs[stat, topoGofs[stat,] > 0], breaks=seq(0, 1, .1), xlim=c(0,1), ylim=c(0,12), xlab=pas
}
dev.off()

png("Plots/tempValidHist.png", width=600, height=300)
par(mfrow=c(1,2))
for(stat in statToPlot){
    hist(daymetTempGofs[stat, daymetTempGofs[stat,] > 0], breaks=seq(0, 1, .1), xlim=c(0,1), xlab=paste
}
for(stat in statToPlot){
    hist(topoTempGofs[stat, topoTempGofs[stat,] > 0], breaks=seq(0, 1, .1), xlim=c(0,1), ylim=c(0,3), x
}
dev.off()

### GYE Map
png("Plots/gyeEdgeMap.png", width=500, height=500)
par(mar=c(0,0,2,0))
plot(edgesInBounds, col="blue")
map("state", add=T, lwd=2)
title("GYE Stream Network", cex.main=1)
dev.off()

daymetGofs[,"21647"]


### Fish fig
as.yearmon(rownames(sgm$YCT))

elevBreaks <- list(names(catchElev[catchElev > 0 & catchElev <= 1750]),
names(catchElev[catchElev > 1750 & catchElev <= 2500]),
names(catchElev[catchElev > 2500 & catchElev <= 4000]))

annualSgm <- lapply(elevBreaks, function(y){lapply(sgm, function(x){rowMeans(aggregate(x[,y], list(subs

annualSgmSD <- lapply(elevBreaks, function(y){lapply(sgm, function(x){rowMeans(aggregate(x[,y], list(su

par(mfrow=c(1,3))
plot(1980:2014, annualSgm[[1]], type="l", ylim=c(-2,2))
lines(1980:2014, annualSgm[[2]], type="l")
lines(1980:2014, annualSgm[[3]], type="l")

annualYCT <- annualYCT[,-1]

head(annualYCT)
plot(1980:2014, rowMeans(annualYCT), type="l")

plot(rowMeans(sgm$YCT), type="l")

png("Plots/fishHabElev.png", width=1000, height=300)
```

```
par(mfrow=c(1,3))
for(i in 1:3){
    plot(1980:2014, annualSgm[[i]][[1]], type="l", ylim=c(-2.5,1), col=2, ylab="Mean Annual Growth Rate
    abline(lm(annualSgm[[i]][[1]] ~ c(1980:2014)), col=2, lty=2)
    for(j in 2:3){
        lines(1980:2014, annualSgm[[i]][[j]], col=1+j, lwd=2)
        abline(lm(annualSgm[[i]][[j]] ~ c(1980:2014)), col=1+j, lty=2)
    }
    title(paste0(c("Low", "Mid", "High")[i], " Elevation Streams (", c(0,1750,2500)[i], "-", c(1750, 250
    legend("bottomright", col=2:4, legend=c("Yellowstone Cutthroat Trout", "Rainbow Trout", "Brook Trou
}
dev.off()

############################
## END of paper figs
############################
```