Mosquito population and rainfall: summer 2013

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Question

Which rainfall period best predicted mosquito population for summer 2013?

Methods

Daily rainfall data for all of 2013 was ”webscraped” from wunderground.com (see webscraping code in appendix).

Mosquito trap data was provided by Clark Scientific and compiled by ACHD.

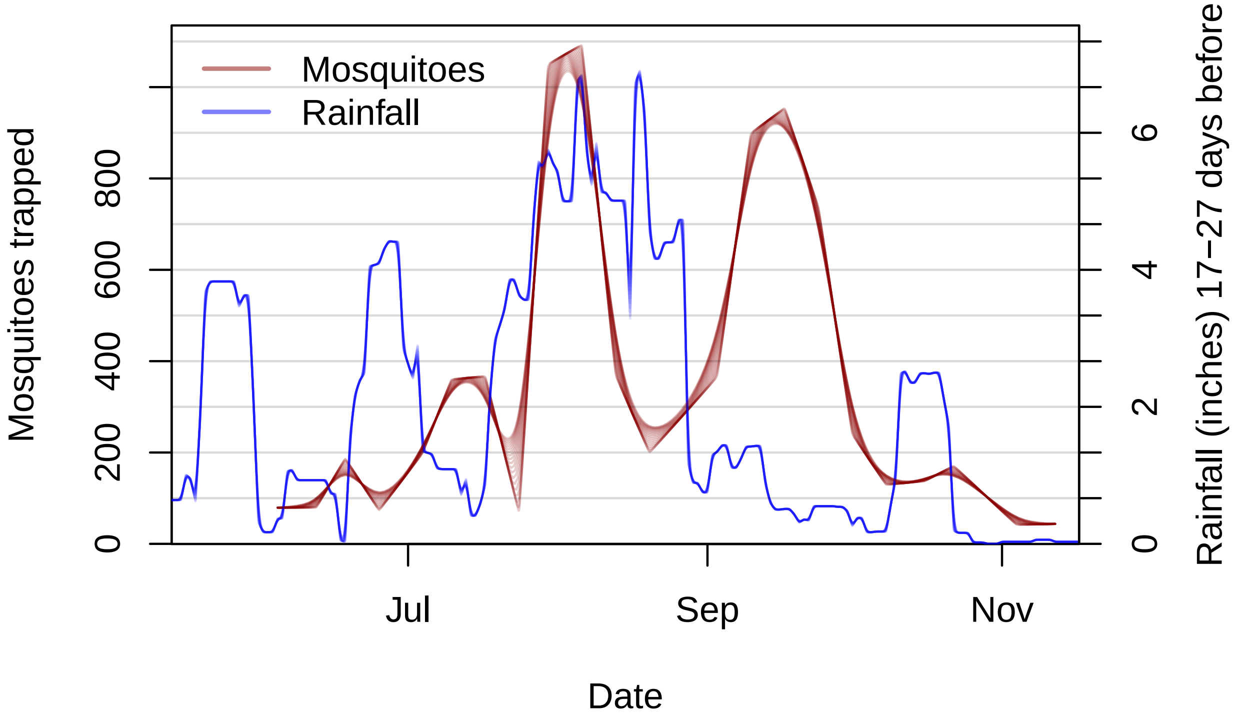
A simulation model was run to determine the highest possible R-squared between:

Y = Number of mosquitoes trapped on date Z
X = Cumulative rainfall for range Z_{range}
Z_{range} = Z-A and Z-B. The limits for A and B were set at 5 and 20.

The simulation compared 264 unique prediction possibilites for all the unique iterations of Z_{range}.

Results

The association between Z_{range} and Y was strongest (R-squared = 0.164) for the range from 17-27 days prior to trap collection. In other words, mosquito population is predicted to surge in the period 17-27 days following a heavy rain.



Appendix

Webscraping code

```
> #THE FOLLOWING SCRIPT TAKES RAINFALL DATA FROM WUNDERGROUND
>
> #Establish start and end dates
> startDate <- "2013-03-01"
> nDays <- 270
> #Set up URL
> linkPart1 <- "http://www.wunderground.com/history/airport/KGNV/"
> linkPart3 <-  "/DailyHistory.html"
> ts <- as.data.frame(c(as.Date(startDate, format="%Y-%m-%d"),
+                       as.Date(startDate, format="%Y-%m-%d")+1:(nDays-1)))
> colnames(ts) <- "date"
> ts$dateRec <- format(ts$date, format="%Y/%m/%d")
> ts$pui <- NA
> for (i in 1:nrow(ts)){
+   linkPart2 <- ts$dateRec[i]
+   link <- paste0(linkPart1, linkPart2, linkPart3)
+   webPage <- readLines(link)
+   webPage <- webPage[grepl("  <span class=\"nobr\"><span class=\"b\">", webPage) &
+                     grepl("</span>&nbsp;in</span>", webPage)][1]
+   ts$pui[i] <- as.numeric(gsub(paste0("  <span class=\"nobr\"><span class=\"b\">",
+                                       "|", "</span>&nbsp;in</span>"),
+                                "",
+                                webPage))
+ }
> ts$rain <- ts$pui
> ts$pui <- NULL
> ts$rain[is.na(ts$rain)] <- 0
> write.csv(ts, "E:/workingdirectory/mosquito/rainFall2013/rain2013.csv")
>
```

Code for model

```
> #########################################
> #READ IN THE RAIN TIME SERIES DATA [CREATED FROM WEBSCRAPING WUNDERGROUND]
> #READ IN MOSQUITO TIME SERIES DATA [CREATED FROM 2013 MOSQ SEASON SURVEIL]
> #########################################
> tsRain <- read.csv("E:/workingdirectory/mosquito/rainFall2013/rain2013.csv")
> tsMosq <- read.csv("E:/workingdirectory/mosquito/rainFall2013/tsMosq13.csv")
> #########################################
> #CONVERT DATES INTO R DATE OBJECTS
> #########################################
> tsRain$date <- as.Date(tsRain$date, format="%Y-%m-%d")
> tsMosq$date <- as.Date(tsMosq$date, format="%Y-%m-%d")
> #########################################
> #ADD MOSQUITOES (TOTAL AND VECTOR) TO RAINFALL
> #########################################
> tsRain$total <- NA
> for (i in tsMosq$date){
+   tsRain$total[which(tsRain$date == i)] <-
+     tsMosq$total[which(tsMosq$date == i)]
+ }
> tsRain$vector <- NA
> for (i in tsMosq$date){
+   tsRain$vector[which(tsRain$date == i)] <-
+     tsMosq$vector[which(tsMosq$date == i)]
+ }
> #########################################
> #ADD RAINFALL RANGES
> #########################################
>
> #Make columns for a range of 5-20 days old, plus 5-20 days older than that
> for (j in 5:20){
+   for (k in 5:20){
+     tsRain[,paste0("rain", j, ".", j+k)] <- NA
+   }
+ }
> #Add rainfall for each of the columns
> for (j in colnames(tsRain)[grepl("rain", colnames(tsRain))][-1]){
+   for (i in 30:nrow(tsRain)){
+     tsRain[i,j] <-
+       sum(tsRain$rain[which(tsRain$date <= tsRain$date[i-min(as.numeric(unlist(strsplit(gsub("rain"
+                             tsRain$date >= tsRain$date[i-max(as.numeric(unlist(strsplit(gsub("rain"
+   }
+ }
> #########################################
> #Test the r-squared for each column
> #########################################
> #Create a dataframe with the R-squared and correlation coefficient for each range
> pred <- as.data.frame(colnames(tsRain)[grepl("rain", colnames(tsRain))][-1])
> colnames(pred) <- "range"
> for (i in pred$range){
+   mylm <- summary(lm(tsRain[,"total"] ~ tsRain[,i]))
+   mycor <- cor(tsRain[,i], tsRain[,"total"], use="complete.obs")
+
+   pred$r.squared[which(pred$range == i)] <- mylm$r.squared
+   pred$cor[which(pred$range == i)] <- mycor
+
+ }
> pred <- pred[order(pred$r.squared),]
> #########################################
> #Select best predicition model
> #########################################
> best <- as.character(pred$range[which(pred$r.squared == max(pred$r.squared))])
> #########################################
> #PLOT TOGETHER THE PREDICTED RANGE OF IMPORTANCE AND THE NUMBER OF TOTAL MOSQUITOES
> #########################################
> library(splines)
> par(mar=c(5,4,4,5))
> plot(tsRain$date, tsRain$total, xlab="Date", ylab="Mosquitoes trapped",
+      type="n",
+      xlim=c(min(tsRain$date)+80, max(tsRain$date)-15))
> for (i in seq(0.1,1,.05)){
+   xspline(tsRain$date[which(is.na(tsRain$total)==FALSE)],
+           tsRain$total[which(is.na(tsRain$total)==FALSE)],
+           shape=i, border=adjustcolor("darkred", alpha.f=0.2), lwd=1)
+   xspline(tsRain$date, tsRain[,best]*150, shape=i,lwd=1,
+           border=adjustcolor("blue", alpha.f=0.2))
+ }
> xspline(tsRain$date[which(is.na(tsRain$total)==FALSE)],
+         tsRain$total[which(is.na(tsRain$total)==FALSE)],
+         shape=0.8, border=adjustcolor("darkred", alpha.f=0.6), lwd=3)
> xspline(tsRain$date, tsRain[,best]*150, shape=1,lwd=3,
+       border=adjustcolor("blue", alpha.f=0.6))
> plot(tsRain$date, tsRain$total, xlab="Date", ylab="Mosquitoes trapped",
+      pch=16, col=adjustcolor("darkred", alpha.f=0.4), cex=0.7)
> lines(tsRain$date[which(is.na(tsRain$total)==FALSE)],
+       tsRain$total[which(is.na(tsRain$total)==FALSE)],
+       col=adjustcolor("darkred", alpha.f=0.4), lwd=3)
> abline(h=seq(0,2000,200), col=adjustcolor("black", alpha.f=0.15))
> lines(tsRain$date, tsRain[,best]*150, lwd=3,
+       col=adjustcolor("blue", alpha.f=0.3))
> points(tsRain$date, tsRain[,best]*150, pch=17,
+        col=adjustcolor("blue", alpha.f=0.2), cex=0.7)
> legend(x="topleft", lty=1, lwd=3, pch=c(16,17),
+        legend=c("Mosquitoes", "Rainfall"),
+        col=adjustcolor(c("darkred", "blue"), alpha.f=0.4),
+        bty="n")
> axis(side=4, at=seq(0, 2000, 100), labels=seq(0, 2000, 100)/150)
> mtext(gsub("[.]", "-",gsub("rain", "",  paste0("Rainfall (inches) ", best," days before"))),
+       side=4, line=2.5, cex.lab=1,las=3 )
>
```