PFNA 1 compartment Plots (v8)

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library(coda)  
library(bayesplot)

## This is bayesplot version 1.7.0

## - Online documentation and vignettes at mc-stan.org/bayesplot

## - bayesplot theme set to bayesplot::theme\_default()

## \* Does \_not\_ affect other ggplot2 plots

## \* See ?bayesplot\_theme\_set for details on theme setting

library(ggplot2)  
library(ggsci)  
library(khroma)  
library(tidyverse)

## ── Attaching packages ─────────────────────────────────────── tidyverse 1.3.0 ──

## ✔ tibble 2.1.3 ✔ dplyr 0.8.3  
## ✔ tidyr 1.0.0 ✔ stringr 1.4.0  
## ✔ readr 1.3.1 ✔ forcats 0.4.0  
## ✔ purrr 0.3.3

## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()

library(reshape2)

##   
## Attaching package: 'reshape2'

## The following object is masked from 'package:tidyr':  
##   
## smiths

library(here)

## here() starts at /media/projects/Projects/PFAS\_PBPK/user/weihsueh\_2021/PFAS\_1cpt\_v8-main/PFNA\_1cpt\_v8

knitr::opts\_chunk$set(echo = TRUE, dpi = 300 )

Set up MCSim file

# this markdown file must be saved in top level directory for the following to work; the mcsim code depends on getwd results.  
mdir <- "MCSim"  
source(here::here(mdir,"setup\_MCSim.R"))  
# Make mod.exe (used to create mcsim executable from model file)  
makemod()

## The mod.exe had been created.

## Set filenames and load data

## Set up dataset

id\_lut <- multicheck$df\_check %>% select(Level) %>% unique () %>%  
 mutate(dataset = c(   
 rep("Decatur M Train", 9),  
 rep("Decatur F Train", 9),  
 rep("Decatur M Test", 9),  
 rep("Decatur F Test", 10),  
 'Paulsboro-Train','Horsham-Train',  
 'Warminster-Test'),   
 Sex = c(   
 rep("M", 9),  
 rep("F", 9),  
 rep("M", 9),  
 rep("F", 10),  
 'Mixed', 'Mixed', 'Mixed'),  
 City = c(   
 rep("Decatur", 18),  
 rep("Decatur", 19),  
 'Paulsboro','Horsham','Warminster'),   
 Train\_Test = c(   
 rep("Train", 9),  
 rep("Train", 9),  
 rep("Test", 9),  
 rep("Test", 10),  
 'Train', 'Train', 'Test'),  
 datatype = c(  
 rep("Individual",9+9+9+10),  
 rep("Summary",3)),  
 Simulation = row\_number(),  
 variable = paste0(dataset, " ",Simulation))  
  
id\_lut$dataset <- factor(id\_lut$dataset,levels=  
 c("Decatur M Train","Decatur F Train","Arnsberg M Train",  
 "Arnsberg F Train","Decatur M Test","Decatur F Test","Arnsberg M Test",  
 "Arnsberg F Test","Minnesota Train","Minnesota Test",  
 'Lubeck-Bartell-Train', 'Lubeck-Bartell-Test',  
 'Little Hocking-Bartell-Train', 'Little Hocking-Bartell-Test',  
 'Little Hocking-Emmett-Test','Paulsboro-Train','Horsham-Train',  
 'Warminster-Test','Warrington-Train'))  
id\_lut$City <- factor(id\_lut$City,levels =   
 c("Decatur","Arnsberg","Minnesota",'Lubeck-Bartell',  
 'Little Hocking-Bartell','Little Hocking-Emmett',  
 'Paulsboro','Horsham','Warminster','Warrington'))  
   
indiv\_lut <- id\_lut %>%   
 filter(City %in% c("Decatur")) %>%  
 mutate( dataset = as.factor(dataset))  
  
nv <- data.frame(dataset =unique(indiv\_lut$dataset),   
 variable= rep("Pop GM", 4),  
 type= rep("Pop GM", 4), stringsAsFactors = FALSE)

## Scatter plot of predictions (median of multicheck samples) versus data.

This is a Figure 2 panel. Needed to use “scale=1.1” in ggsave to match PFOA.

nrow(multicheck$df\_check)

## [1] 38500

nrow(id\_lut)

## [1] 40

multicheck$df\_check %>% left\_join(id\_lut) %>% nrow()

## Joining, by = c("Level", "Simulation")

## [1] 38500

names(multicheck$df\_check)

## [1] "Level" "Simulation" "Output\_Var" "Time" "Data"   
## [6] "Prediction"

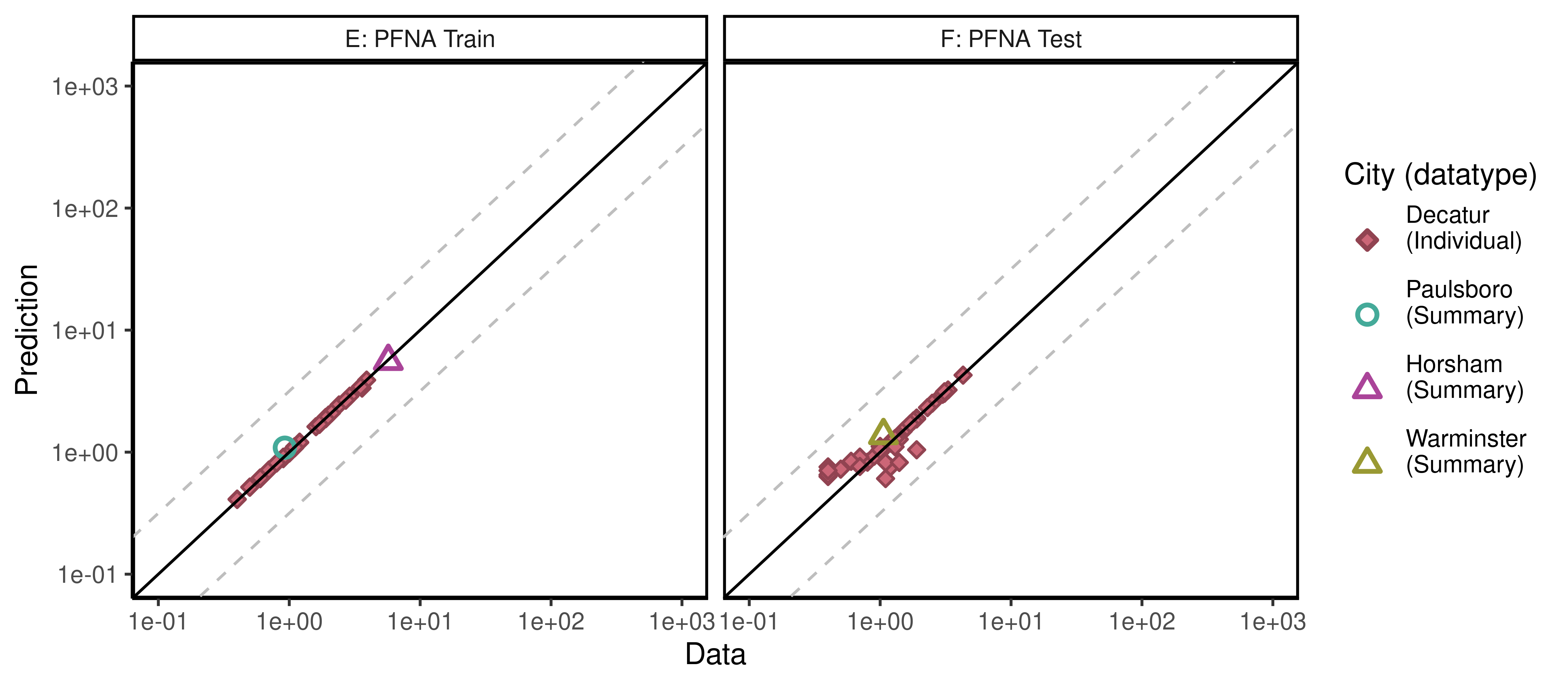
multicheck2 <- multicheck$df\_check %>% left\_join(id\_lut)%>%   
 group\_by\_at ( vars(-Prediction)) %>%   
 summarise(Prediction = median(Prediction)) %>%  
 ungroup() %>%  
 group\_by(City) %>%   
 mutate(Train\_Test = factor(Train\_Test, levels = c("Train", "Test")),  
 `City (datatype)` = factor (paste0(City, "\n(", datatype, ")\n") ),  
 label = case\_when(Train\_Test=="Train" ~ "E: PFNA Train",  
 Train\_Test=="Test" ~ "F: PFNA Test",  
 TRUE ~ ""))

## Joining, by = c("Level", "Simulation")

## Warning in mutate\_impl(.data, dots, caller\_env()): Unequal factor levels:  
## coercing to character

## Warning in mutate\_impl(.data, dots, caller\_env()): binding character and factor  
## vector, coercing into character vector  
  
## Warning in mutate\_impl(.data, dots, caller\_env()): binding character and factor  
## vector, coercing into character vector  
  
## Warning in mutate\_impl(.data, dots, caller\_env()): binding character and factor  
## vector, coercing into character vector  
  
## Warning in mutate\_impl(.data, dots, caller\_env()): binding character and factor  
## vector, coercing into character vector

#define color for testing boxplots  
bp\_cols <- c (as.character (khroma::colour("muted")(9)) , "#191919")   
bp\_cols <-bp\_cols[c(1, 7, 9:8)]# plot\_scheme\_colourblind(bp\_cols)   
  
### Create aesthetics lookup  
aes\_lut <- multicheck2 %>% ungroup() %>%   
 group\_by(City, datatype, `City (datatype)` ) %>% summarise () %>% ungroup() %>%  
 mutate( cols = bp\_cols, city\_fills = bp\_cols ,   
 # for individual level on point plot (multicheck2), darken outlines for visibility, use standard colors otherwise  
 city\_outlines = if\_else(datatype == "Individual" , colorspace::darken(city\_fills, 0.3), city\_fills) ,   
 shapes = case\_when(datatype == "Individual" & `City` %in% c('Decatur', 'Arnsberg', 'Minnesota') ~ 23,  
 datatype == "Summary" &`City` %in% c("Horsham", "Warminster", "Warrington") ~ 2,  
 datatype == "Summary" & `City` == "Paulsboro" ~ 1,  
 TRUE ~ 18 ),   
 size = if\_else(datatype =="Individual", 1.75, 2.5 ) )   
  
  
  
source( paste0(gsub(basename(here()), 'shared\_functions', here()), '/plot\_scatter\_mcheck.r'))  
  
p2 <- plot\_scatter\_mcheck(dframe = multicheck2, pfas\_nom = pfas\_name, aes\_lut\_fn = aes\_lut )  
print(p2)



ggsave(here ("output-plots", paste0( sa,"multicheckplot\_", pfas\_name,  
 ".pdf")),p2,dpi=600, scale=1.1)

## Saving 8.8 x 3.85 in image

## Parse multicheck

df\_check <- multicheck$df\_check  
df\_check <- subset(df\_check,Data > 0)   
  
n1 <- nrow(df\_check)  
id\_chks <- df\_check %>% select(Level) %>% unique() %>% bind\_cols(id\_lut) %>%  
 mutate(dataset = as.factor(dataset), Sex = as.factor(Sex), City = as.factor(City),   
 Train\_Test = as.factor(Train\_Test))  
  
df\_check <- df\_check %>% left\_join(id\_chks, by = "Simulation")%>%  
 mutate(Dataset = paste(as.character(dataset), Simulation),  
 Sex = ordered(Sex, levels = c("M", "F", "Mixed"),   
 labels = c("Male", "Female", "Mixed (all sexes)")))  
n2 <- nrow(df\_check)  
if(n1 != n2)print("duplicates created in id-lut join")

df\_check$Time.desc <- as.character(paste0("T=",df\_check$Time))  
df\_check$Time.desc[df\_check$Time.desc == "T=1e-06"] <- "SteadyState"  
df\_check$Dataset.Time <- interaction(df\_check$Dataset,  
 df\_check$Time.desc,lex.order=TRUE)  
df\_check$Dataset.Time <- factor(df\_check$Dataset.Time,  
 levels=levels(df\_check$Dataset.Time))  
calibdata <- df\_check[,names(df\_check) != "Prediction"]  
calibdata <- calibdata[!duplicated(calibdata),]  
print(calibdata)

## Level.x Simulation Output\_Var Time Data Level.y Level1  
## 1 1\_1\_1\_1\_1 1 Cserum 0.000 1.900 1\_1\_1\_1\_1 1\_1\_1\_1\_1  
## 2 1\_1\_1\_1\_1 1 Cserum 5.802 1.100 1\_1\_1\_1\_1 1\_1\_1\_1\_1  
## 3 1\_1\_1\_1\_2 2 Cserum 0.000 1.100 1\_1\_1\_1\_2 1\_1\_1\_1\_2  
## 4 1\_1\_1\_1\_2 2 Cserum 5.802 0.900 1\_1\_1\_1\_2 1\_1\_1\_1\_2  
## 5 1\_1\_1\_1\_3 3 Cserum 0.000 2.100 1\_1\_1\_1\_3 1\_1\_1\_1\_3  
## 6 1\_1\_1\_1\_3 3 Cserum 5.802 0.700 1\_1\_1\_1\_3 1\_1\_1\_1\_3  
## 7 1\_1\_1\_1\_4 4 Cserum 0.000 1.900 1\_1\_1\_1\_4 1\_1\_1\_1\_4  
## 8 1\_1\_1\_1\_4 4 Cserum 5.802 0.500 1\_1\_1\_1\_4 1\_1\_1\_1\_4  
## 9 1\_1\_1\_1\_5 5 Cserum 0.000 3.500 1\_1\_1\_1\_5 1\_1\_1\_1\_5  
## 10 1\_1\_1\_1\_5 5 Cserum 5.802 0.900 1\_1\_1\_1\_5 1\_1\_1\_1\_5  
## 11 1\_1\_1\_1\_6 6 Cserum 0.000 1.200 1\_1\_1\_1\_6 1\_1\_1\_1\_6  
## 12 1\_1\_1\_1\_6 6 Cserum 5.802 0.600 1\_1\_1\_1\_6 1\_1\_1\_1\_6  
## 13 1\_1\_1\_1\_7 7 Cserum 0.000 2.700 1\_1\_1\_1\_7 1\_1\_1\_1\_7  
## 14 1\_1\_1\_1\_7 7 Cserum 5.802 0.800 1\_1\_1\_1\_7 1\_1\_1\_1\_7  
## 15 1\_1\_1\_1\_8 8 Cserum 0.000 1.700 1\_1\_1\_1\_8 1\_1\_1\_1\_8  
## 16 1\_1\_1\_1\_8 8 Cserum 5.802 0.500 1\_1\_1\_1\_8 1\_1\_1\_1\_8  
## 17 1\_1\_1\_1\_9 9 Cserum 0.000 1.100 1\_1\_1\_1\_9 1\_1\_1\_1\_9  
## 18 1\_1\_1\_1\_9 9 Cserum 5.802 0.600 1\_1\_1\_1\_9 1\_1\_1\_1\_9  
## 19 1\_1\_1\_1\_10 10 Cserum 0.000 1.600 1\_1\_1\_1\_10 1\_1\_1\_1\_10  
## 20 1\_1\_1\_1\_10 10 Cserum 5.802 1.000 1\_1\_1\_1\_10 1\_1\_1\_1\_10  
## 21 1\_1\_1\_1\_11 11 Cserum 0.000 2.000 1\_1\_1\_1\_11 1\_1\_1\_1\_11  
## 22 1\_1\_1\_1\_11 11 Cserum 5.802 1.100 1\_1\_1\_1\_11 1\_1\_1\_1\_11  
## 23 1\_1\_1\_1\_12 12 Cserum 0.000 1.000 1\_1\_1\_1\_12 1\_1\_1\_1\_12  
## 24 1\_1\_1\_1\_12 12 Cserum 5.802 0.400 1\_1\_1\_1\_12 1\_1\_1\_1\_12  
## 25 1\_1\_1\_1\_13 13 Cserum 0.000 1.700 1\_1\_1\_1\_13 1\_1\_1\_1\_13  
## 26 1\_1\_1\_1\_13 13 Cserum 5.802 0.400 1\_1\_1\_1\_13 1\_1\_1\_1\_13  
## 27 1\_1\_1\_1\_14 14 Cserum 0.000 3.900 1\_1\_1\_1\_14 1\_1\_1\_1\_14  
## 28 1\_1\_1\_1\_14 14 Cserum 5.802 1.200 1\_1\_1\_1\_14 1\_1\_1\_1\_14  
## 29 1\_1\_1\_1\_15 15 Cserum 0.000 2.400 1\_1\_1\_1\_15 1\_1\_1\_1\_15  
## 30 1\_1\_1\_1\_15 15 Cserum 5.802 3.600 1\_1\_1\_1\_15 1\_1\_1\_1\_15  
## 31 1\_1\_1\_1\_16 16 Cserum 0.000 1.200 1\_1\_1\_1\_16 1\_1\_1\_1\_16  
## 32 1\_1\_1\_1\_16 16 Cserum 5.802 0.600 1\_1\_1\_1\_16 1\_1\_1\_1\_16  
## 33 1\_1\_1\_1\_17 17 Cserum 0.000 2.900 1\_1\_1\_1\_17 1\_1\_1\_1\_17  
## 34 1\_1\_1\_1\_17 17 Cserum 5.802 0.900 1\_1\_1\_1\_17 1\_1\_1\_1\_17  
## 35 1\_1\_1\_1\_18 18 Cserum 0.000 1.200 1\_1\_1\_1\_18 1\_1\_1\_1\_18  
## 36 1\_1\_1\_1\_18 18 Cserum 5.802 0.400 1\_1\_1\_1\_18 1\_1\_1\_1\_18  
## 37 1\_1\_1\_2\_1 19 Cserum 0.000 1.500 1\_1\_1\_2\_1 1\_1\_1\_2\_1  
## 38 1\_1\_1\_2\_1 19 Cserum 5.802 0.400 1\_1\_1\_2\_1 1\_1\_1\_2\_1  
## 39 1\_1\_1\_2\_2 20 Cserum 0.000 3.300 1\_1\_1\_2\_2 1\_1\_1\_2\_2  
## 40 1\_1\_1\_2\_2 20 Cserum 5.802 1.000 1\_1\_1\_2\_2 1\_1\_1\_2\_2  
## 41 1\_1\_1\_2\_3 21 Cserum 0.000 1.800 1\_1\_1\_2\_3 1\_1\_1\_2\_3  
## 42 1\_1\_1\_2\_3 21 Cserum 5.802 0.600 1\_1\_1\_2\_3 1\_1\_1\_2\_3  
## 43 1\_1\_1\_2\_4 22 Cserum 0.000 1.600 1\_1\_1\_2\_4 1\_1\_1\_2\_4  
## 44 1\_1\_1\_2\_4 22 Cserum 5.802 0.700 1\_1\_1\_2\_4 1\_1\_1\_2\_4  
## 45 1\_1\_1\_2\_5 23 Cserum 0.000 4.300 1\_1\_1\_2\_5 1\_1\_1\_2\_5  
## 46 1\_1\_1\_2\_5 23 Cserum 5.802 1.400 1\_1\_1\_2\_5 1\_1\_1\_2\_5  
## 47 1\_1\_1\_2\_6 24 Cserum 0.000 1.700 1\_1\_1\_2\_6 1\_1\_1\_2\_6  
## 48 1\_1\_1\_2\_6 24 Cserum 5.802 1.400 1\_1\_1\_2\_6 1\_1\_1\_2\_6  
## 49 1\_1\_1\_2\_7 25 Cserum 0.000 1.300 1\_1\_1\_2\_7 1\_1\_1\_2\_7  
## 50 1\_1\_1\_2\_7 25 Cserum 5.802 0.400 1\_1\_1\_2\_7 1\_1\_1\_2\_7  
## 51 1\_1\_1\_2\_8 26 Cserum 0.000 3.000 1\_1\_1\_2\_8 1\_1\_1\_2\_8  
## 52 1\_1\_1\_2\_8 26 Cserum 5.802 1.000 1\_1\_1\_2\_8 1\_1\_1\_2\_8  
## 53 1\_1\_1\_2\_9 27 Cserum 0.000 3.100 1\_1\_1\_2\_9 1\_1\_1\_2\_9  
## 54 1\_1\_1\_2\_9 27 Cserum 5.802 1.300 1\_1\_1\_2\_9 1\_1\_1\_2\_9  
## 55 1\_1\_1\_2\_10 28 Cserum 0.000 1.500 1\_1\_1\_2\_10 1\_1\_1\_2\_10  
## 56 1\_1\_1\_2\_10 28 Cserum 5.802 1.200 1\_1\_1\_2\_10 1\_1\_1\_2\_10  
## 57 1\_1\_1\_2\_11 29 Cserum 0.000 3.100 1\_1\_1\_2\_11 1\_1\_1\_2\_11  
## 58 1\_1\_1\_2\_11 29 Cserum 5.802 1.900 1\_1\_1\_2\_11 1\_1\_1\_2\_11  
## 59 1\_1\_1\_2\_12 30 Cserum 0.000 1.900 1\_1\_1\_2\_12 1\_1\_1\_2\_12  
## 60 1\_1\_1\_2\_12 30 Cserum 5.802 0.800 1\_1\_1\_2\_12 1\_1\_1\_2\_12  
## 61 1\_1\_1\_2\_13 31 Cserum 0.000 1.000 1\_1\_1\_2\_13 1\_1\_1\_2\_13  
## 62 1\_1\_1\_2\_13 31 Cserum 5.802 1.100 1\_1\_1\_2\_13 1\_1\_1\_2\_13  
## 63 1\_1\_1\_2\_14 32 Cserum 0.000 1.200 1\_1\_1\_2\_14 1\_1\_1\_2\_14  
## 64 1\_1\_1\_2\_14 32 Cserum 5.802 0.400 1\_1\_1\_2\_14 1\_1\_1\_2\_14  
## 65 1\_1\_1\_2\_15 33 Cserum 0.000 2.500 1\_1\_1\_2\_15 1\_1\_1\_2\_15  
## 66 1\_1\_1\_2\_15 33 Cserum 5.802 0.900 1\_1\_1\_2\_15 1\_1\_1\_2\_15  
## 67 1\_1\_1\_2\_16 34 Cserum 0.000 1.200 1\_1\_1\_2\_16 1\_1\_1\_2\_16  
## 68 1\_1\_1\_2\_16 34 Cserum 5.802 0.400 1\_1\_1\_2\_16 1\_1\_1\_2\_16  
## 69 1\_1\_1\_2\_17 35 Cserum 0.000 2.300 1\_1\_1\_2\_17 1\_1\_1\_2\_17  
## 70 1\_1\_1\_2\_17 35 Cserum 5.802 0.700 1\_1\_1\_2\_17 1\_1\_1\_2\_17  
## 71 1\_1\_1\_2\_18 36 Cserum 0.000 1.500 1\_1\_1\_2\_18 1\_1\_1\_2\_18  
## 72 1\_1\_1\_2\_18 36 Cserum 5.802 0.500 1\_1\_1\_2\_18 1\_1\_1\_2\_18  
## 73 1\_1\_1\_2\_19 37 Cserum 0.000 1.900 1\_1\_1\_2\_19 1\_1\_1\_2\_19  
## 74 1\_1\_1\_2\_19 37 Cserum 5.802 1.100 1\_1\_1\_2\_19 1\_1\_1\_2\_19  
## 75 1\_2\_1 38 M\_Cbgd\_Css 2.200 5.710 1\_2\_1 1\_2\_1  
## 76 1\_3\_1 39 M\_Cbgd\_Css 2.000 0.925 1\_3\_1 1\_3\_1  
## 77 1\_4\_1 40 M\_Cbgd\_Css 2.000 1.060 1\_4\_1 1\_4\_1  
## dataset Sex City Train\_Test datatype  
## 1 Decatur M Train Male Decatur Train Individual  
## 2 Decatur M Train Male Decatur Train Individual  
## 3 Decatur M Train Male Decatur Train Individual  
## 4 Decatur M Train Male Decatur Train Individual  
## 5 Decatur M Train Male Decatur Train Individual  
## 6 Decatur M Train Male Decatur Train Individual  
## 7 Decatur M Train Male Decatur Train Individual  
## 8 Decatur M Train Male Decatur Train Individual  
## 9 Decatur M Train Male Decatur Train Individual  
## 10 Decatur M Train Male Decatur Train Individual  
## 11 Decatur M Train Male Decatur Train Individual  
## 12 Decatur M Train Male Decatur Train Individual  
## 13 Decatur M Train Male Decatur Train Individual  
## 14 Decatur M Train Male Decatur Train Individual  
## 15 Decatur M Train Male Decatur Train Individual  
## 16 Decatur M Train Male Decatur Train Individual  
## 17 Decatur M Train Male Decatur Train Individual  
## 18 Decatur M Train Male Decatur Train Individual  
## 19 Decatur F Train Female Decatur Train Individual  
## 20 Decatur F Train Female Decatur Train Individual  
## 21 Decatur F Train Female Decatur Train Individual  
## 22 Decatur F Train Female Decatur Train Individual  
## 23 Decatur F Train Female Decatur Train Individual  
## 24 Decatur F Train Female Decatur Train Individual  
## 25 Decatur F Train Female Decatur Train Individual  
## 26 Decatur F Train Female Decatur Train Individual  
## 27 Decatur F Train Female Decatur Train Individual  
## 28 Decatur F Train Female Decatur Train Individual  
## 29 Decatur F Train Female Decatur Train Individual  
## 30 Decatur F Train Female Decatur Train Individual  
## 31 Decatur F Train Female Decatur Train Individual  
## 32 Decatur F Train Female Decatur Train Individual  
## 33 Decatur F Train Female Decatur Train Individual  
## 34 Decatur F Train Female Decatur Train Individual  
## 35 Decatur F Train Female Decatur Train Individual  
## 36 Decatur F Train Female Decatur Train Individual  
## 37 Decatur M Test Male Decatur Test Individual  
## 38 Decatur M Test Male Decatur Test Individual  
## 39 Decatur M Test Male Decatur Test Individual  
## 40 Decatur M Test Male Decatur Test Individual  
## 41 Decatur M Test Male Decatur Test Individual  
## 42 Decatur M Test Male Decatur Test Individual  
## 43 Decatur M Test Male Decatur Test Individual  
## 44 Decatur M Test Male Decatur Test Individual  
## 45 Decatur M Test Male Decatur Test Individual  
## 46 Decatur M Test Male Decatur Test Individual  
## 47 Decatur M Test Male Decatur Test Individual  
## 48 Decatur M Test Male Decatur Test Individual  
## 49 Decatur M Test Male Decatur Test Individual  
## 50 Decatur M Test Male Decatur Test Individual  
## 51 Decatur M Test Male Decatur Test Individual  
## 52 Decatur M Test Male Decatur Test Individual  
## 53 Decatur M Test Male Decatur Test Individual  
## 54 Decatur M Test Male Decatur Test Individual  
## 55 Decatur F Test Female Decatur Test Individual  
## 56 Decatur F Test Female Decatur Test Individual  
## 57 Decatur F Test Female Decatur Test Individual  
## 58 Decatur F Test Female Decatur Test Individual  
## 59 Decatur F Test Female Decatur Test Individual  
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## 66 Decatur F Test Female Decatur Test Individual  
## 67 Decatur F Test Female Decatur Test Individual  
## 68 Decatur F Test Female Decatur Test Individual  
## 69 Decatur F Test Female Decatur Test Individual  
## 70 Decatur F Test Female Decatur Test Individual  
## 71 Decatur F Test Female Decatur Test Individual  
## 72 Decatur F Test Female Decatur Test Individual  
## 73 Decatur F Test Female Decatur Test Individual  
## 74 Decatur F Test Female Decatur Test Individual  
## 75 Paulsboro-Train Mixed (all sexes) Paulsboro Train Summary  
## 76 Horsham-Train Mixed (all sexes) Horsham Train Summary  
## 77 Warminster-Test Mixed (all sexes) Warminster Test Summary  
## variable Dataset Time.desc Dataset.Time  
## 1 Decatur M Train 1 Decatur M Train 1 T=0 Decatur M Train 1.T=0  
## 2 Decatur M Train 1 Decatur M Train 1 T=5.802 Decatur M Train 1.T=5.802  
## 3 Decatur M Train 2 Decatur M Train 2 T=0 Decatur M Train 2.T=0  
## 4 Decatur M Train 2 Decatur M Train 2 T=5.802 Decatur M Train 2.T=5.802  
## 5 Decatur M Train 3 Decatur M Train 3 T=0 Decatur M Train 3.T=0  
## 6 Decatur M Train 3 Decatur M Train 3 T=5.802 Decatur M Train 3.T=5.802  
## 7 Decatur M Train 4 Decatur M Train 4 T=0 Decatur M Train 4.T=0  
## 8 Decatur M Train 4 Decatur M Train 4 T=5.802 Decatur M Train 4.T=5.802  
## 9 Decatur M Train 5 Decatur M Train 5 T=0 Decatur M Train 5.T=0  
## 10 Decatur M Train 5 Decatur M Train 5 T=5.802 Decatur M Train 5.T=5.802  
## 11 Decatur M Train 6 Decatur M Train 6 T=0 Decatur M Train 6.T=0  
## 12 Decatur M Train 6 Decatur M Train 6 T=5.802 Decatur M Train 6.T=5.802  
## 13 Decatur M Train 7 Decatur M Train 7 T=0 Decatur M Train 7.T=0  
## 14 Decatur M Train 7 Decatur M Train 7 T=5.802 Decatur M Train 7.T=5.802  
## 15 Decatur M Train 8 Decatur M Train 8 T=0 Decatur M Train 8.T=0  
## 16 Decatur M Train 8 Decatur M Train 8 T=5.802 Decatur M Train 8.T=5.802  
## 17 Decatur M Train 9 Decatur M Train 9 T=0 Decatur M Train 9.T=0  
## 18 Decatur M Train 9 Decatur M Train 9 T=5.802 Decatur M Train 9.T=5.802  
## 19 Decatur F Train 10 Decatur F Train 10 T=0 Decatur F Train 10.T=0  
## 20 Decatur F Train 10 Decatur F Train 10 T=5.802 Decatur F Train 10.T=5.802  
## 21 Decatur F Train 11 Decatur F Train 11 T=0 Decatur F Train 11.T=0  
## 22 Decatur F Train 11 Decatur F Train 11 T=5.802 Decatur F Train 11.T=5.802  
## 23 Decatur F Train 12 Decatur F Train 12 T=0 Decatur F Train 12.T=0  
## 24 Decatur F Train 12 Decatur F Train 12 T=5.802 Decatur F Train 12.T=5.802  
## 25 Decatur F Train 13 Decatur F Train 13 T=0 Decatur F Train 13.T=0  
## 26 Decatur F Train 13 Decatur F Train 13 T=5.802 Decatur F Train 13.T=5.802  
## 27 Decatur F Train 14 Decatur F Train 14 T=0 Decatur F Train 14.T=0  
## 28 Decatur F Train 14 Decatur F Train 14 T=5.802 Decatur F Train 14.T=5.802  
## 29 Decatur F Train 15 Decatur F Train 15 T=0 Decatur F Train 15.T=0  
## 30 Decatur F Train 15 Decatur F Train 15 T=5.802 Decatur F Train 15.T=5.802  
## 31 Decatur F Train 16 Decatur F Train 16 T=0 Decatur F Train 16.T=0  
## 32 Decatur F Train 16 Decatur F Train 16 T=5.802 Decatur F Train 16.T=5.802  
## 33 Decatur F Train 17 Decatur F Train 17 T=0 Decatur F Train 17.T=0  
## 34 Decatur F Train 17 Decatur F Train 17 T=5.802 Decatur F Train 17.T=5.802  
## 35 Decatur F Train 18 Decatur F Train 18 T=0 Decatur F Train 18.T=0  
## 36 Decatur F Train 18 Decatur F Train 18 T=5.802 Decatur F Train 18.T=5.802  
## 37 Decatur M Test 19 Decatur M Test 19 T=0 Decatur M Test 19.T=0  
## 38 Decatur M Test 19 Decatur M Test 19 T=5.802 Decatur M Test 19.T=5.802  
## 39 Decatur M Test 20 Decatur M Test 20 T=0 Decatur M Test 20.T=0  
## 40 Decatur M Test 20 Decatur M Test 20 T=5.802 Decatur M Test 20.T=5.802  
## 41 Decatur M Test 21 Decatur M Test 21 T=0 Decatur M Test 21.T=0  
## 42 Decatur M Test 21 Decatur M Test 21 T=5.802 Decatur M Test 21.T=5.802  
## 43 Decatur M Test 22 Decatur M Test 22 T=0 Decatur M Test 22.T=0  
## 44 Decatur M Test 22 Decatur M Test 22 T=5.802 Decatur M Test 22.T=5.802  
## 45 Decatur M Test 23 Decatur M Test 23 T=0 Decatur M Test 23.T=0  
## 46 Decatur M Test 23 Decatur M Test 23 T=5.802 Decatur M Test 23.T=5.802  
## 47 Decatur M Test 24 Decatur M Test 24 T=0 Decatur M Test 24.T=0  
## 48 Decatur M Test 24 Decatur M Test 24 T=5.802 Decatur M Test 24.T=5.802  
## 49 Decatur M Test 25 Decatur M Test 25 T=0 Decatur M Test 25.T=0  
## 50 Decatur M Test 25 Decatur M Test 25 T=5.802 Decatur M Test 25.T=5.802  
## 51 Decatur M Test 26 Decatur M Test 26 T=0 Decatur M Test 26.T=0  
## 52 Decatur M Test 26 Decatur M Test 26 T=5.802 Decatur M Test 26.T=5.802  
## 53 Decatur M Test 27 Decatur M Test 27 T=0 Decatur M Test 27.T=0  
## 54 Decatur M Test 27 Decatur M Test 27 T=5.802 Decatur M Test 27.T=5.802  
## 55 Decatur F Test 28 Decatur F Test 28 T=0 Decatur F Test 28.T=0  
## 56 Decatur F Test 28 Decatur F Test 28 T=5.802 Decatur F Test 28.T=5.802  
## 57 Decatur F Test 29 Decatur F Test 29 T=0 Decatur F Test 29.T=0  
## 58 Decatur F Test 29 Decatur F Test 29 T=5.802 Decatur F Test 29.T=5.802  
## 59 Decatur F Test 30 Decatur F Test 30 T=0 Decatur F Test 30.T=0  
## 60 Decatur F Test 30 Decatur F Test 30 T=5.802 Decatur F Test 30.T=5.802  
## 61 Decatur F Test 31 Decatur F Test 31 T=0 Decatur F Test 31.T=0  
## 62 Decatur F Test 31 Decatur F Test 31 T=5.802 Decatur F Test 31.T=5.802  
## 63 Decatur F Test 32 Decatur F Test 32 T=0 Decatur F Test 32.T=0  
## 64 Decatur F Test 32 Decatur F Test 32 T=5.802 Decatur F Test 32.T=5.802  
## 65 Decatur F Test 33 Decatur F Test 33 T=0 Decatur F Test 33.T=0  
## 66 Decatur F Test 33 Decatur F Test 33 T=5.802 Decatur F Test 33.T=5.802  
## 67 Decatur F Test 34 Decatur F Test 34 T=0 Decatur F Test 34.T=0  
## 68 Decatur F Test 34 Decatur F Test 34 T=5.802 Decatur F Test 34.T=5.802  
## 69 Decatur F Test 35 Decatur F Test 35 T=0 Decatur F Test 35.T=0  
## 70 Decatur F Test 35 Decatur F Test 35 T=5.802 Decatur F Test 35.T=5.802  
## 71 Decatur F Test 36 Decatur F Test 36 T=0 Decatur F Test 36.T=0  
## 72 Decatur F Test 36 Decatur F Test 36 T=5.802 Decatur F Test 36.T=5.802  
## 73 Decatur F Test 37 Decatur F Test 37 T=0 Decatur F Test 37.T=0  
## 74 Decatur F Test 37 Decatur F Test 37 T=5.802 Decatur F Test 37.T=5.802  
## 75 Paulsboro-Train 38 Paulsboro-Train 38 T=2.2 Paulsboro-Train 38.T=2.2  
## 76 Horsham-Train 39 Horsham-Train 39 T=2 Horsham-Train 39.T=2  
## 77 Warminster-Test 40 Warminster-Test 40 T=2 Warminster-Test 40.T=2

#Multicheck plot  
  
# Split Steady State Group into different populations for boxplot grouping  
#df\_check[df\_check$Time.desc == "SteadyState" & grepl("Lubeck",df\_check$Dataset),]$Time.desc <- "Lubeck"  
#df\_check[df\_check$Time.desc == "SteadyState" & grepl("Little Hocking",df\_check$Dataset),]$Time.desc <- "Little Hocking"

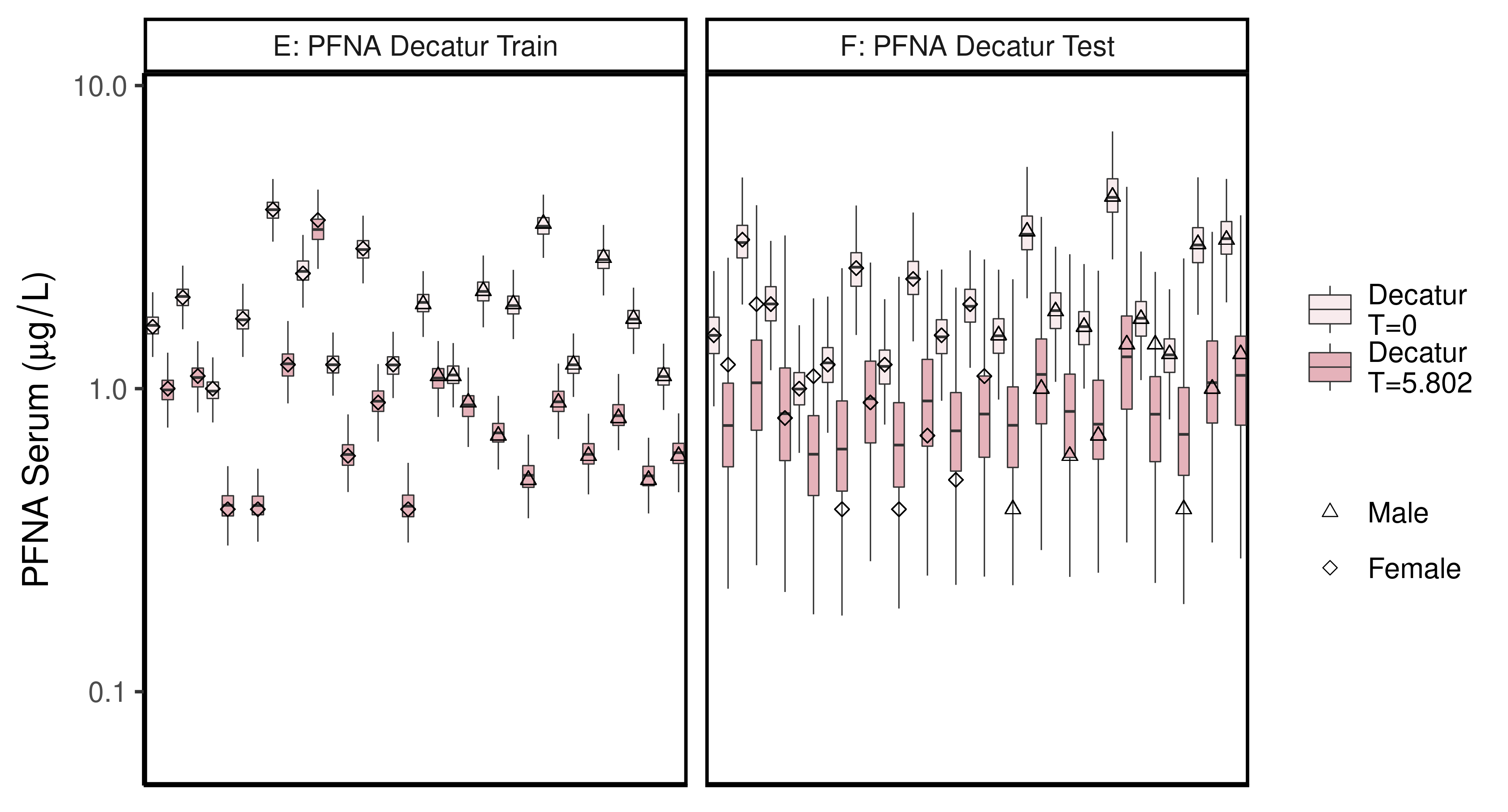
Modify aesthetics lookup table for boxplots

## additional source aesthetic lookup table for grey-scale time (years); merged legends save space on plotting output  
times <- df\_check%>% select(Time.desc, Time) %>% unique () %>%   
 mutate(rank = rank(Time) , grey = grey.colors(start=1,end=0.4, n = n()),  
 alpha = (rank)/8) %>%   
 select(-Time)  
   
df\_check <- df\_check %>% mutate (legend\_label = (paste0(City, "\n", Time.desc ) )) # add legend-labels  
aes\_lut <- df\_check %>%   
 select(City, Train\_Test, datatype,Time, Time.desc, legend\_label) %>% unique () %>%  
 left\_join(aes\_lut[, c("City", "cols")], by = "City") %>% ungroup () %>% unique ()%>%  
 left\_join (times, by = "Time.desc") %>%   
 arrange(datatype, City, Train\_Test, Time) %>%   
 mutate(alpha = if\_else(City == "Horsham", alpha/2, alpha)) %>% # otherwise too dark with this color  
 mutate\_if(is.factor, as.character)

## Decatur boxplots

Changed grey start to 1 instead of 0.8, end at 0.6 instead of 0.4. Changed shape of symbols so they are filled.

##EF  
  
df\_decat <- df\_check %>%   
 filter(City == "Decatur" & Train\_Test %in% c ("Train", "Test")) %>%   
 mutate(panel = ordered (Train\_Test, levels = c ("Train", "Test"),   
 labels = c("E: PFNA Decatur Train", "F: PFNA Decatur Test") ))  
  
aes\_lut\_df\_df\_decat <- aes\_lut %>%   
 filter(City == "Decatur" & Train\_Test %in% c ("Train", "Test")) %>%   
 mutate\_if(is.factor, as.character)   
  
source( paste0(gsub(basename(here()), 'shared\_functions', here()), '/plot\_sum\_boxplot.r'))  
  
  
plt\_train <- plot\_sum\_boxplot (dframe = df\_decat, aes\_lut= aes\_lut\_df\_df\_decat, facets = TRUE , pfas\_nom = pfas\_name )   
print(plt\_train)



ggsave(here ("output-plots",paste0( sa,"DecaturTrainTestboxplot",pfas\_name,".pdf")),plt\_train,dpi=600)

## Saving 6.5 x 3.5 in image

## All boxplots

Changed grey start to 1 instead of 0.8, end at 0.6 instead of 0.4. Added shapes and fills to data points.

lets <- LETTERS;  
names(lets)[1:(length(unique(df\_check$dataset))-4)]<-as.character(unique(df\_check$dataset))[5:length(unique(df\_check$dataset))]  
  
for (d in unique(df\_check$dataset)) { # d = unique(df\_check$dataset)[11]  
 ddset <- df\_check %>%   
 filter(dataset == d)   
   
 aes\_lut\_ddset <- ddset %>% select(legend\_label, City,Train\_Test,datatype, Time.desc ) %>% unique () %>% inner\_join(aes\_lut)  
   
 gt <- ifelse(is.na(lets[d]),d,paste0(lets[d],": ", d))  
 plt <- plot\_sum\_boxplot(dframe = ddset, aes\_lut= aes\_lut\_ddset, gtitle= gt, facets = FALSE, pfas\_nom = pfas\_name)  
   
 print(plt)  
 ggsave(here ("output-plots",  
 paste0( sa, d,"-boxplot-",   
 pfas\_name,".pdf")) ,  
 plt,dpi=600)  
  
}

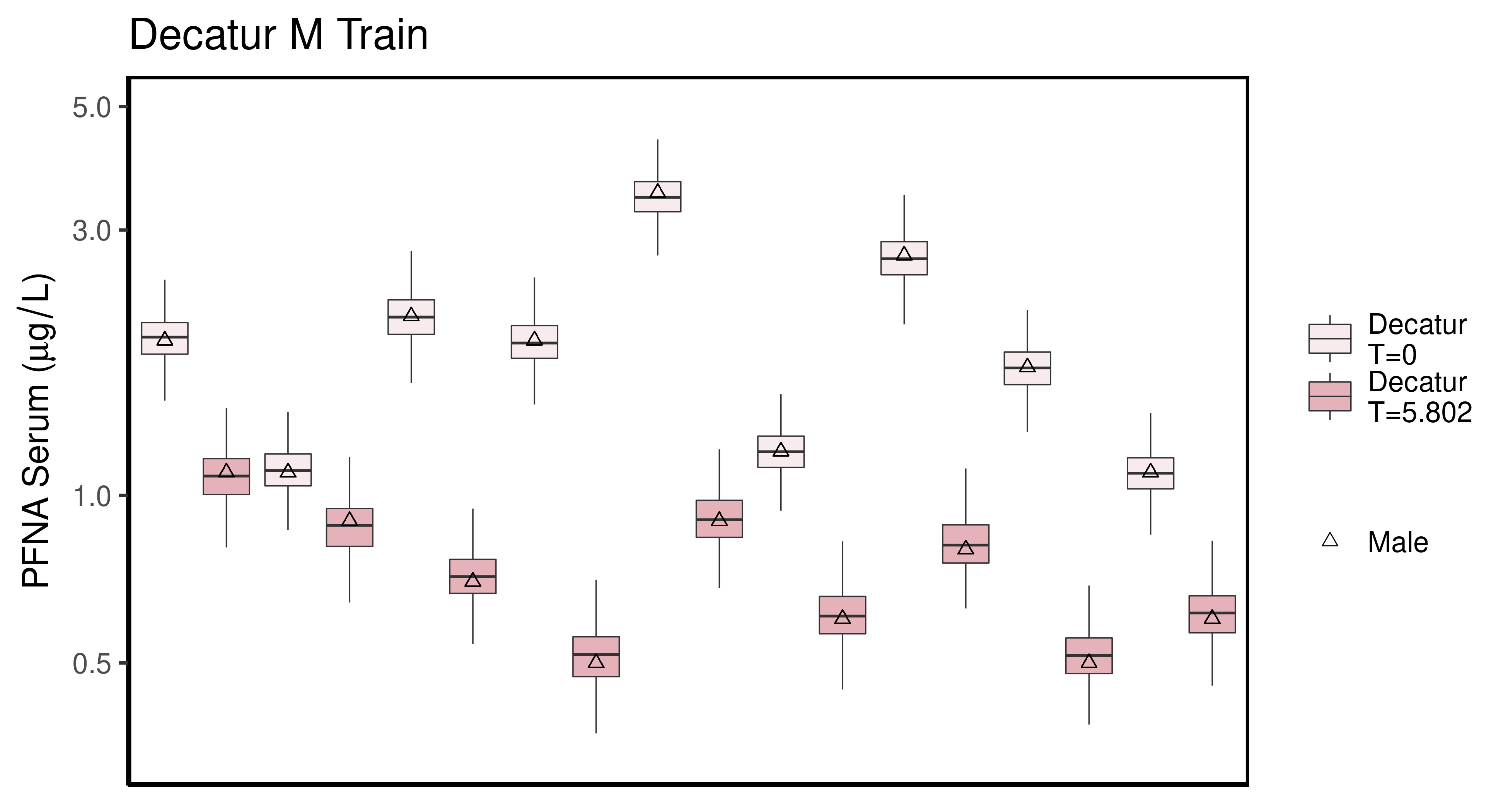
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector

## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector

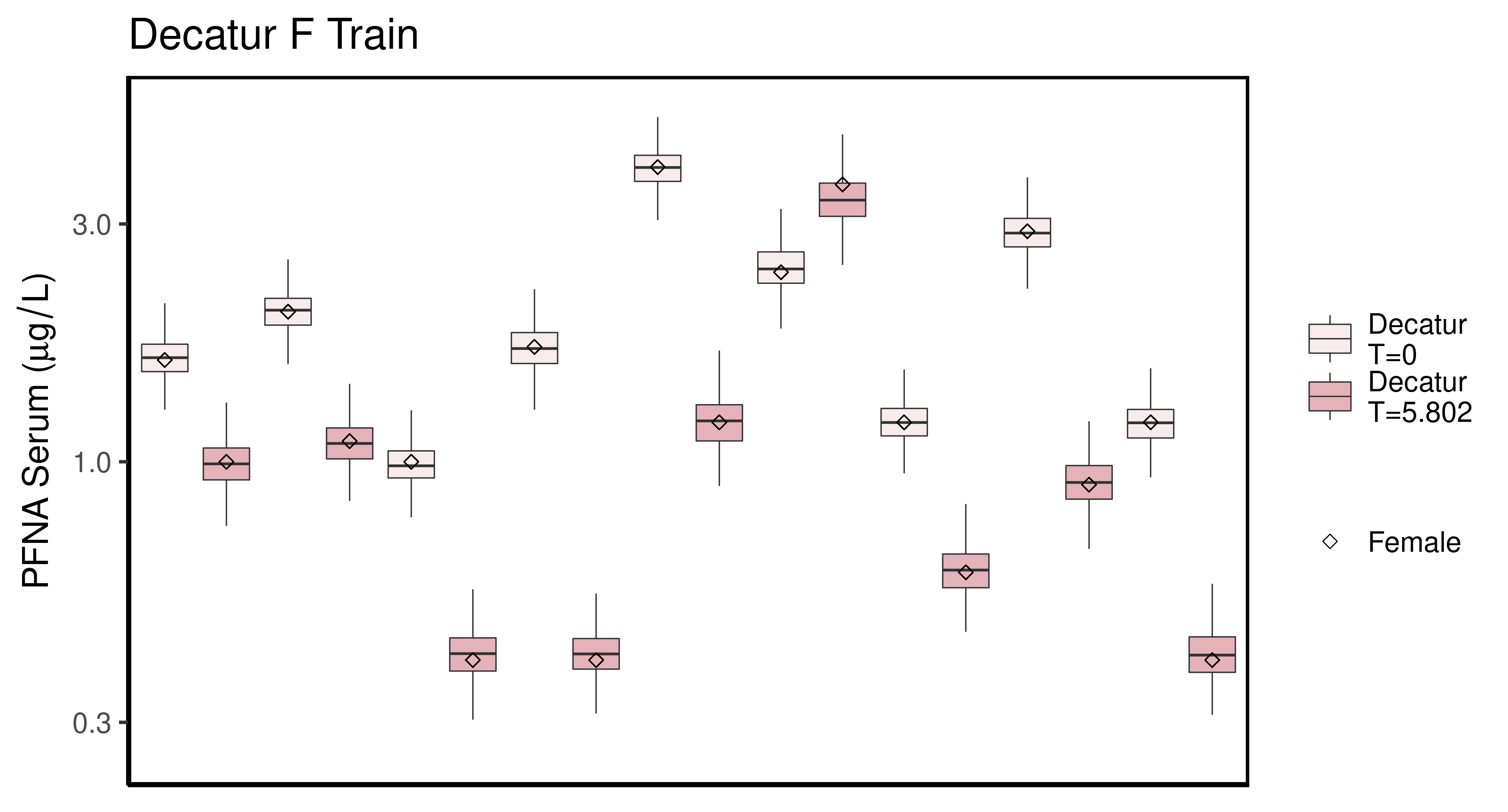
## Saving 6.5 x 3.5 in image  
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector  
  
## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector



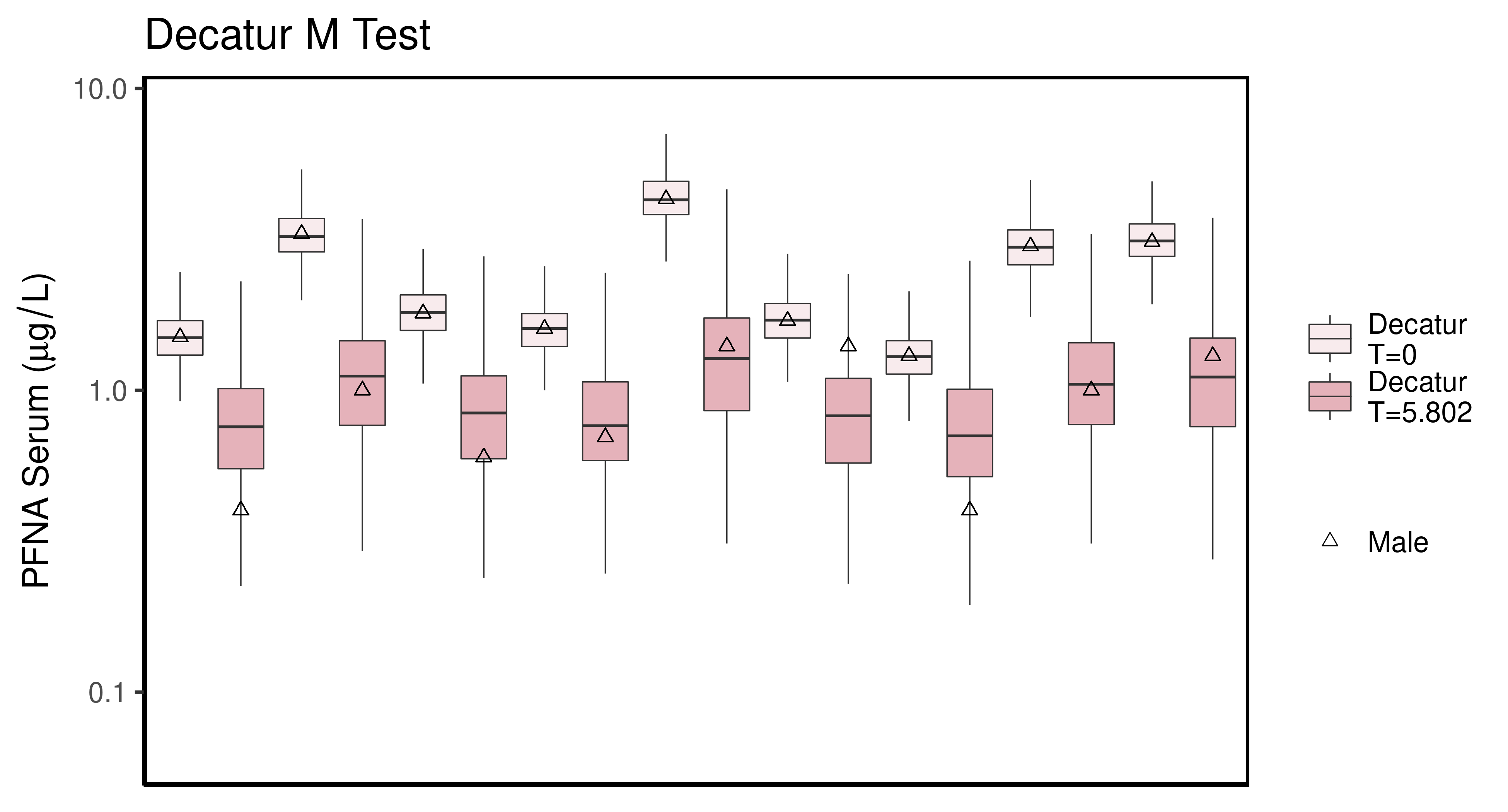
## Saving 6.5 x 3.5 in image  
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector  
  
## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector



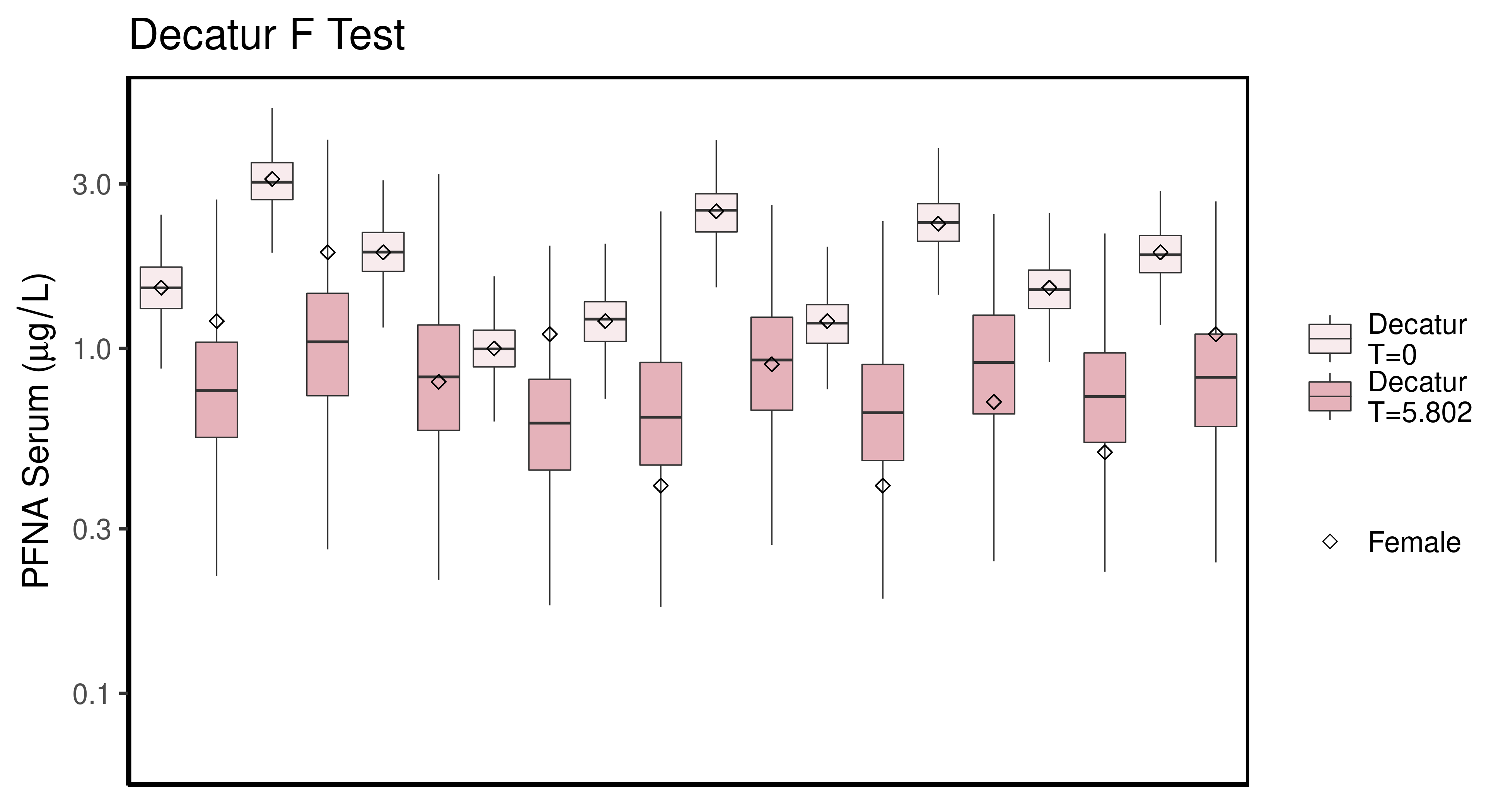
## Saving 6.5 x 3.5 in image  
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector  
  
## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector



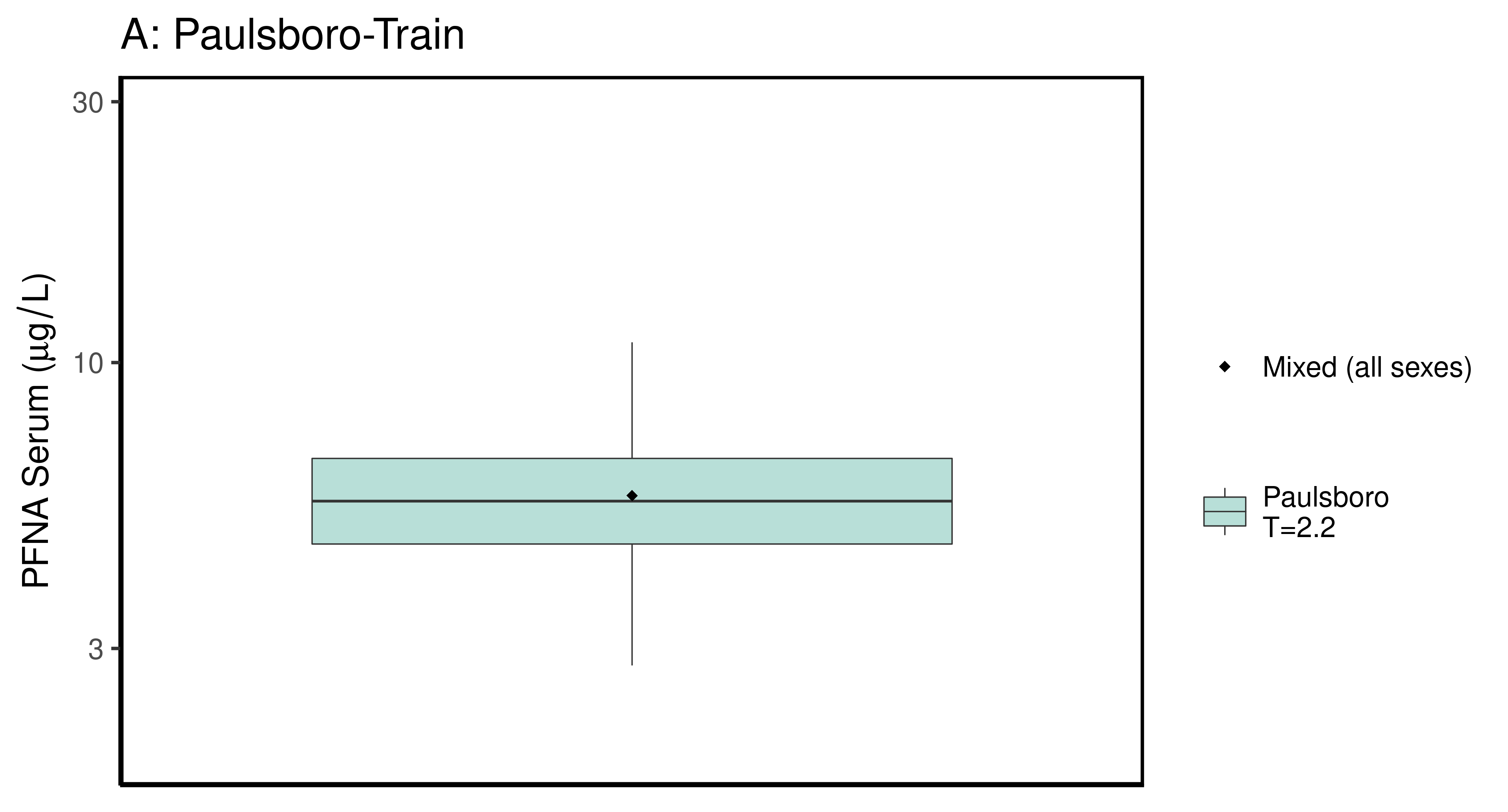
## Saving 6.5 x 3.5 in image  
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector  
  
## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector



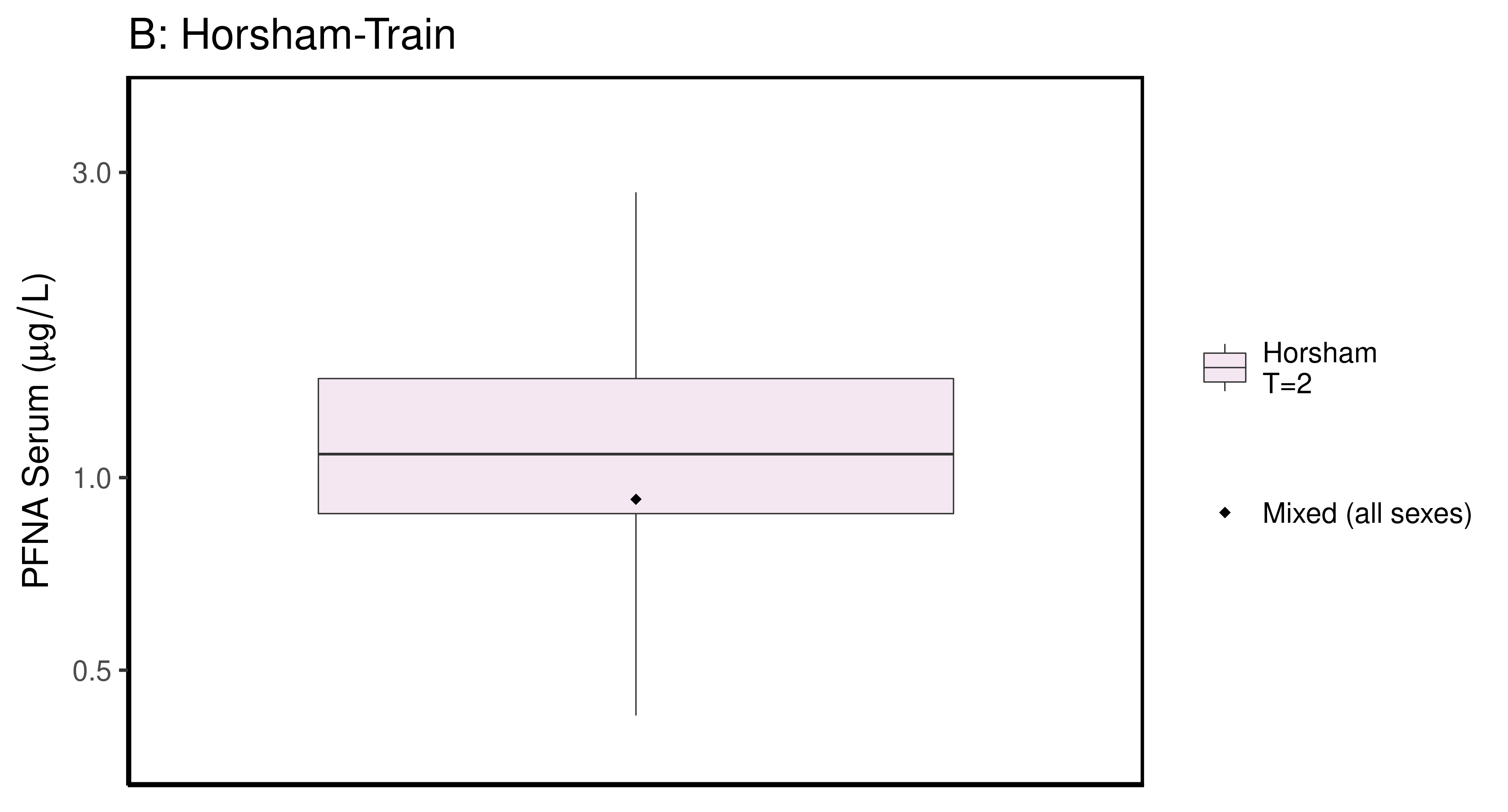
## Saving 6.5 x 3.5 in image  
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector  
  
## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector

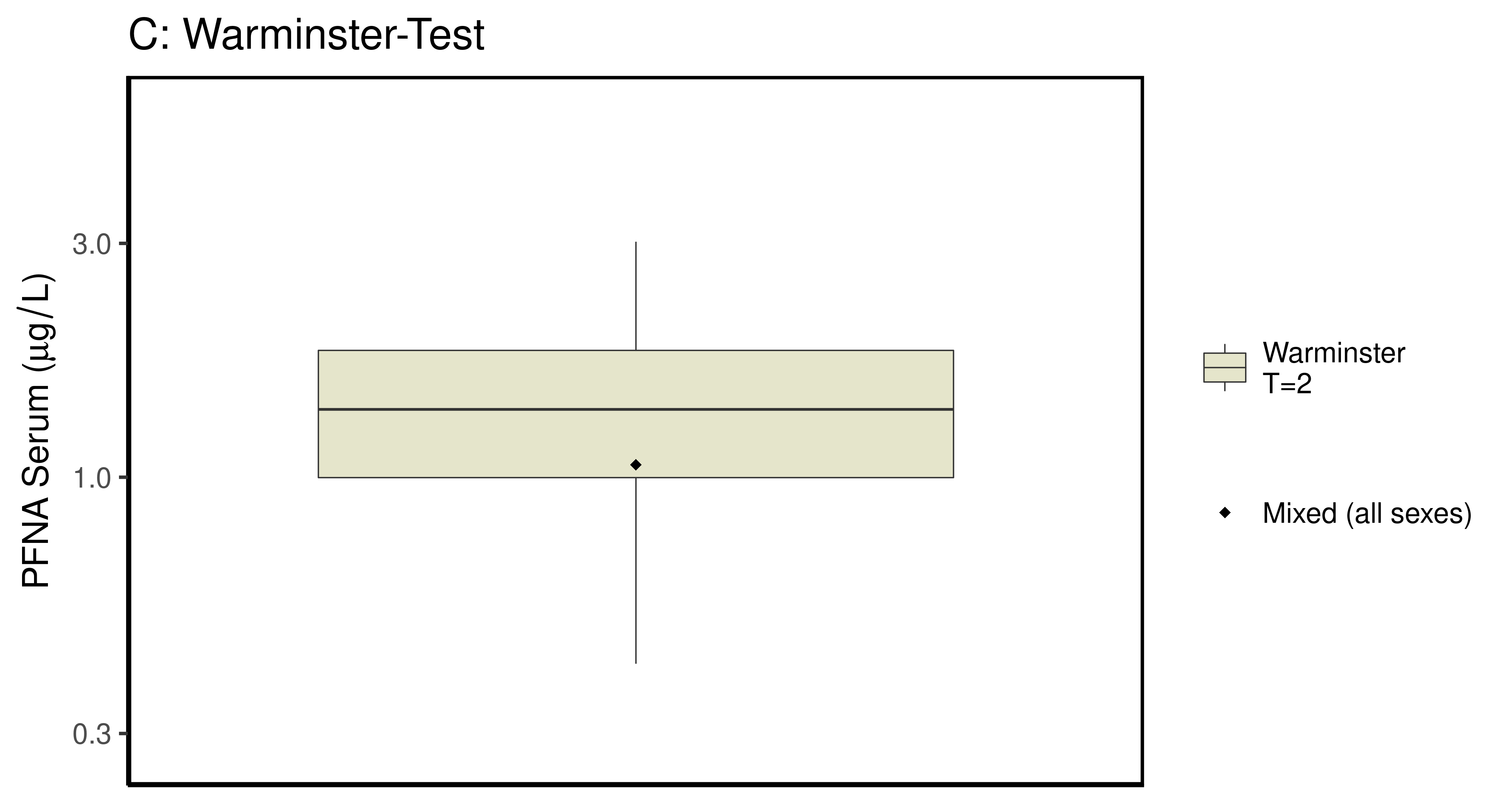


## Saving 6.5 x 3.5 in image  
## Joining, by = c("legend\_label", "City", "Train\_Test", "datatype", "Time.desc")

## Warning: Column `City` joining factor and character vector, coercing into  
## character vector  
  
## Warning: Column `Train\_Test` joining factor and character vector, coercing into  
## character vector



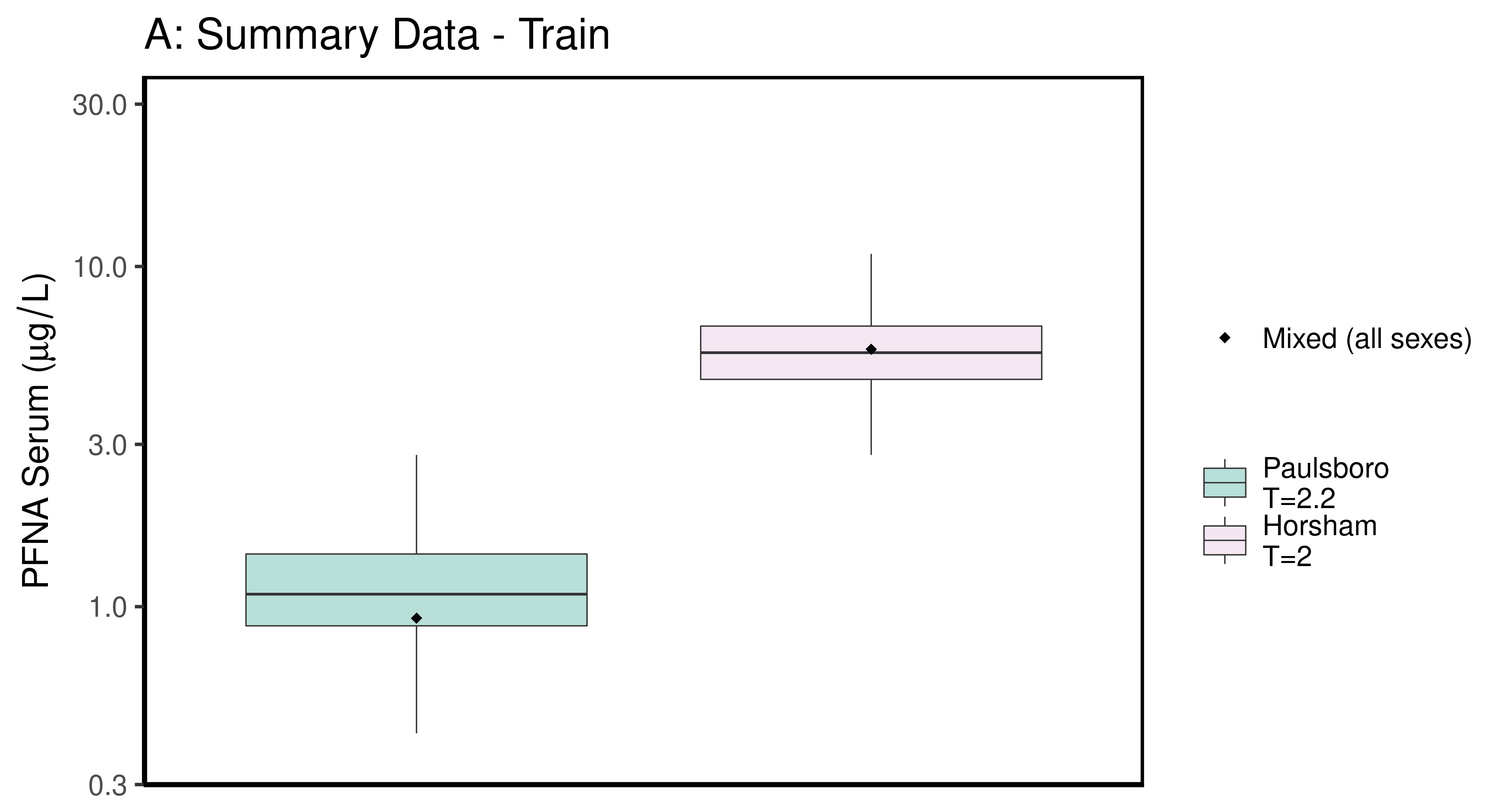
## Saving 6.5 x 3.5 in image



### make Training plot   
  
df\_d\_trt <- df\_check %>%   
 filter( (Train\_Test == "Train") & ((Output\_Var == "M\_Cbgd\_Css") | (Output\_Var == "M\_Cserum"))) %>%  
 mutate\_if(is.factor, as.character) %>% # drop factor levels unused  
 mutate(Dataset.Time = factor(Dataset.Time))   
   
  
 aes\_lut\_df\_d\_trt <- df\_d\_trt %>% select(City, datatype,Time, Time.desc, legend\_label) %>%   
 inner\_join(aes\_lut ) %>%   
 select(-Train\_Test) %>% ungroup () %>% unique ()

## Joining, by = c("City", "datatype", "Time", "Time.desc", "legend\_label")

plt\_train <- plot\_sum\_boxplot(dframe = df\_d\_trt, aes\_lut= aes\_lut\_df\_d\_trt,   
 gtitle="A: Summary Data - Train" , facets = FALSE, pfas\_nom = pfas\_name )  
 print(plt\_train)



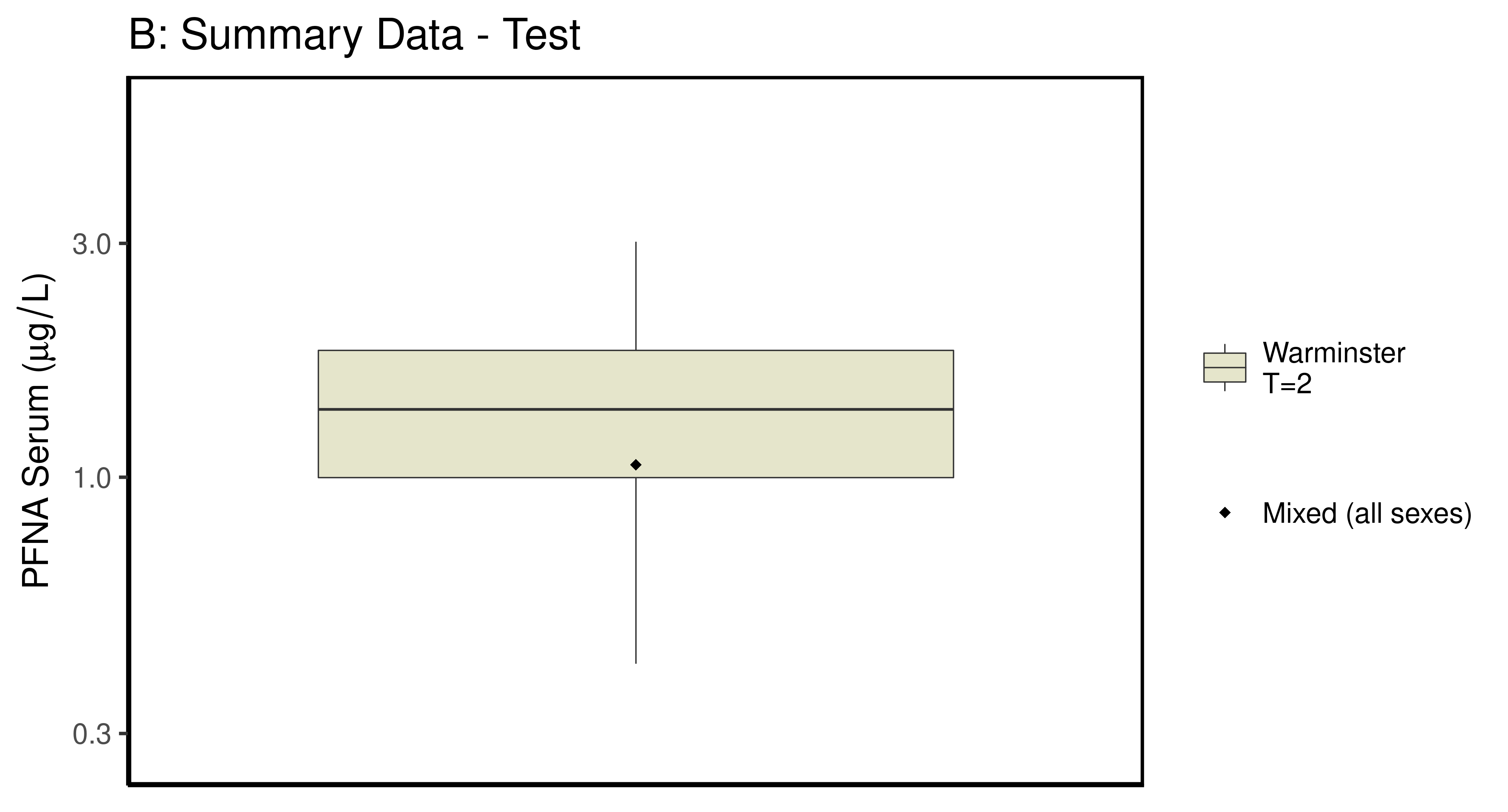
ggsave(here ("output-plots", paste0( sa, "SummaryTrainDataboxplot",pfas\_name,".pdf")), plt\_train,dpi=600)

## Saving 6.5 x 3.5 in image

### make Test plot  
df\_d\_test <- df\_check %>%   
 filter((Train\_Test == "Test") &   
 ((Output\_Var == "M\_Cbgd\_Css") | (Output\_Var == "M\_Cserum"))) %>%  
 mutate\_if(is.factor, as.character) %>% # drop factor levels unused  
 mutate(Dataset.Time = factor(Dataset.Time))   
  
aes\_lut\_df\_d\_test <- df\_d\_test %>% select(City, datatype,Time, Time.desc, legend\_label) %>%   
 inner\_join(aes\_lut ) %>%   
 select(-Train\_Test) %>% ungroup () %>% unique ()

## Joining, by = c("City", "datatype", "Time", "Time.desc", "legend\_label")

plt\_test <- plot\_sum\_boxplot(dframe = df\_d\_test, aes\_lut= aes\_lut\_df\_d\_test,   
 gtitle="B: Summary Data - Test", facets = FALSE, pfas\_nom = pfas\_name)  
 print(plt\_test)



ggsave(here ("output-plots",paste0( sa, "SummaryTestDataboxplot",pfas\_name,".pdf")), plt\_test,dpi=600)

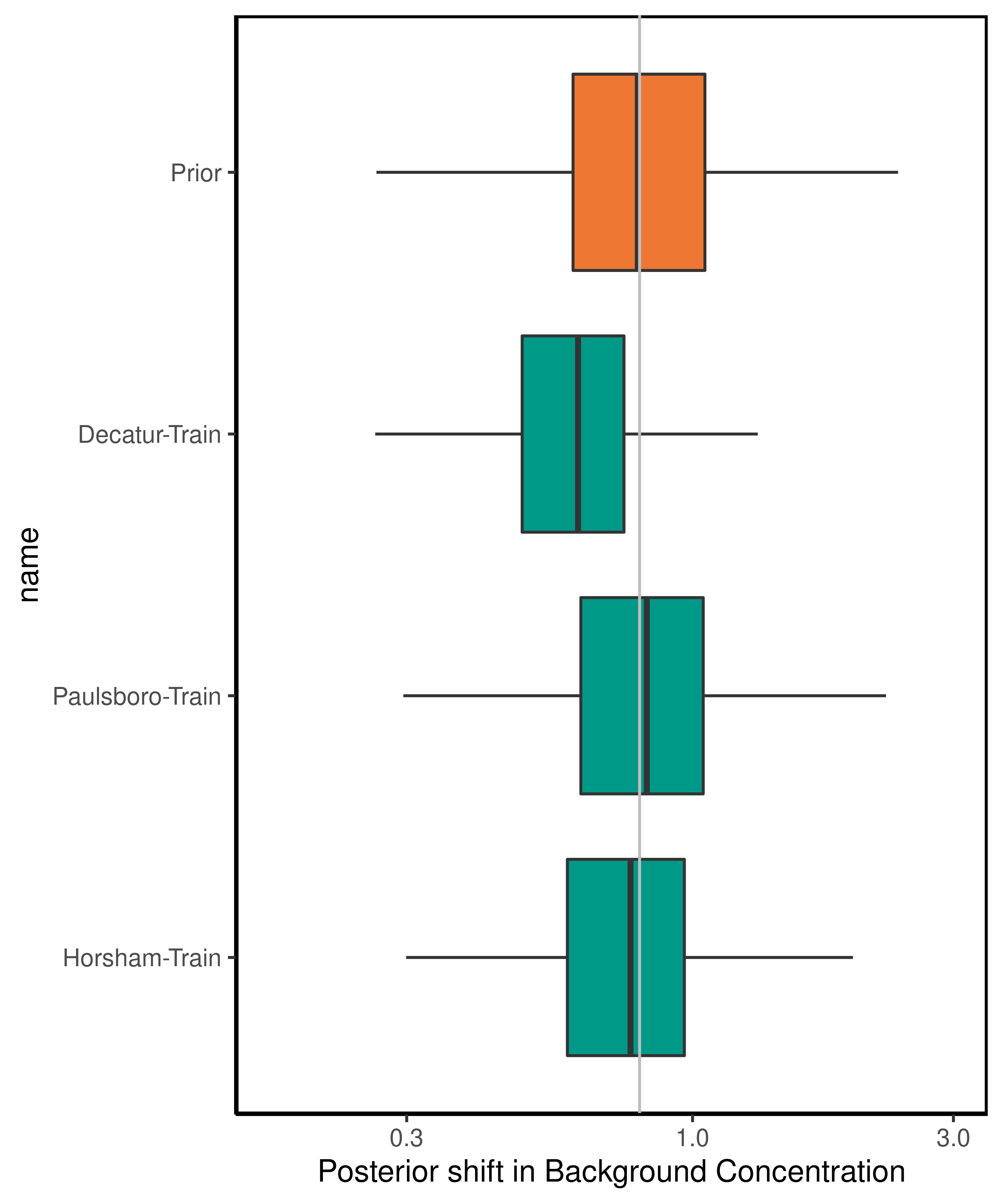
## Saving 6.5 x 3.5 in image

## PFNA

### Background posteriors

Shows shift in background estimate.

gmscale<-0.8  
  
dat <- multicheck$parms.samp[,grep("M\_ln\_Cbgd",names(multicheck$parms.samp))]  
datasetnames <- as.character(unique(calibdata$dataset))  
datasetnames <- gsub(" Train","-Train",datasetnames)  
datasetnames <- gsub(" Test","-Train",datasetnames)  
datasetnames <- gsub(" M","",datasetnames)  
datasetnames <- gsub(" F","",datasetnames)  
datasetnames<-datasetnames[!duplicated(datasetnames)]  
names(dat) <- datasetnames  
dat <- dat[,grep("Train",names(dat))]  
dat.df <- pivot\_longer(dat,1:ncol(dat))  
dat.df <- rbind(dat.df,  
 data.frame(name="Prior",value=rnorm(5000,m=log(gmscale),sd=0.4055)))  
dat.df$name <- factor(dat.df$name,levels=rev(  
 c("Prior",datasetnames[grep("Train",datasetnames)])))  
dat.df$value <- exp(dat.df$value)  
  
p<-ggplot(dat.df)+  
 #geom\_violin(aes(x=name,y=value,fill=name=="Prior"))+  
 geom\_boxplot(aes(x=name,y=value,fill=name=="Prior"),outlier.shape=NA)+  
 scale\_y\_log10()+coord\_flip()+  
 scale\_fill\_manual(name=NULL,   
 values=c("#009988", "#EE7733" ))+  
 theme\_classic() +   
 geom\_hline(yintercept = gmscale,color="grey")+  
 theme(legend.position="none",  
 panel.background = element\_rect(color="black",size=1))+  
 ylab("Posterior shift in Background Concentration")  
  
print(p)



ggsave(here ("output-plots",paste0( sa, "PFNA\_GM\_Cbgd.pdf")) ,p,dpi=600)

## Saving 5 x 6 in image

### Half-life

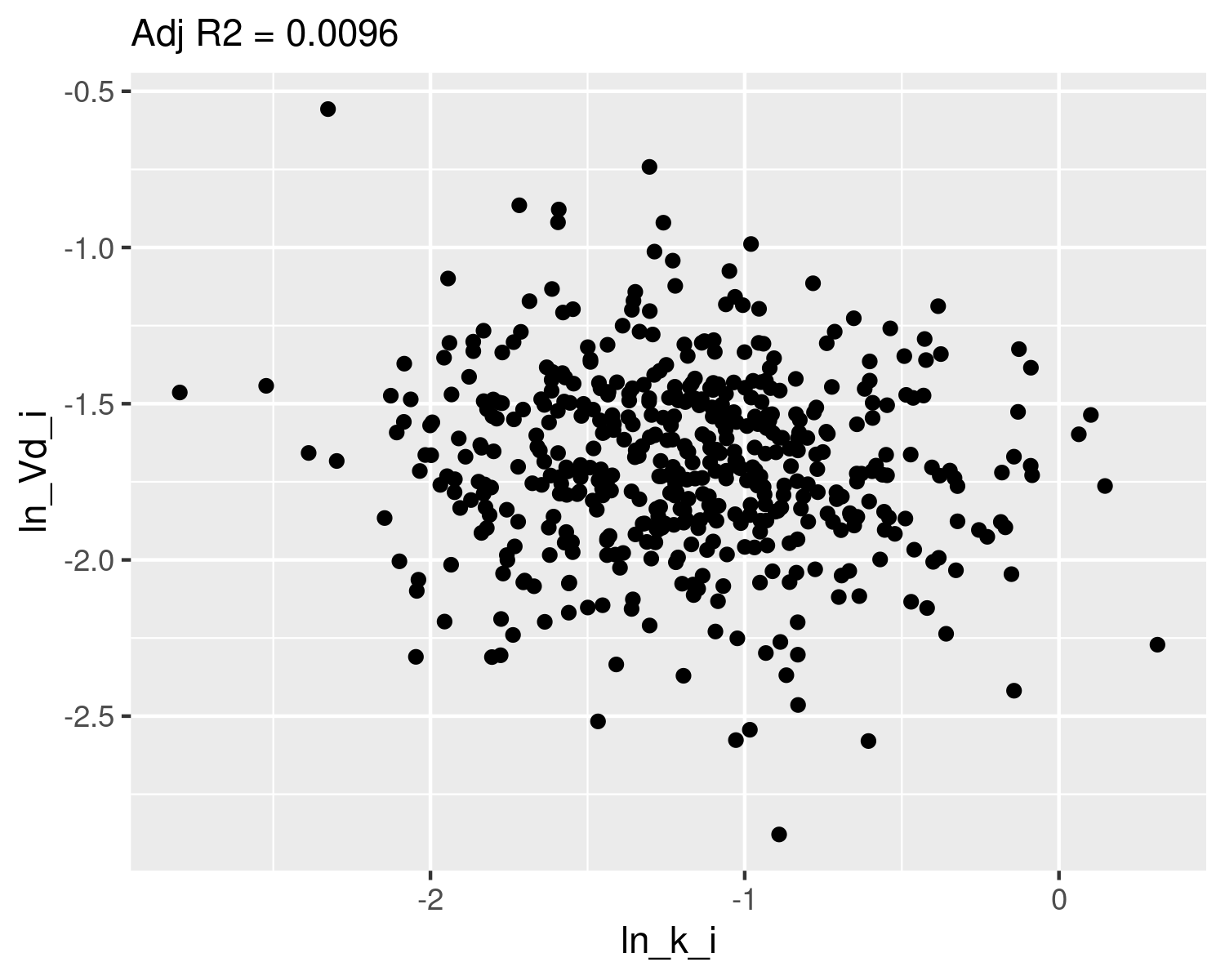
For PFNA, the population GM of the half-life has a posterior distribution that is narrower than the prior, with a posterior median (95% CI) estimate of 3.06 (2.16-4.37) years. The population GSD posterior is larger than the prior at 1.47(1.44-1.75).

dat <- multicheck$parms.samp[,c("M\_ln\_k.1.","V\_ln\_k.1.", "M\_ln\_Vd.1.", "SD\_ln\_Vd.1.")]  
names(dat) <- c("M\_ln\_k(1)","V\_ln\_k(1)", "M\_ln\_Vd(1)", "SD\_ln\_Vd(1)")  
   
set.seed(3.14159)  
dat$z\_ln\_k <- rnorm(nrow(dat))  
dat$z\_ln\_Vd <- rnorm(nrow(dat))  
dat %>% rename\_()

## Warning: rename\_() is deprecated.   
## Please use rename() instead  
##   
## The 'programming' vignette or the tidyeval book can help you  
## to program with rename() : https://tidyeval.tidyverse.org  
## This warning is displayed once per session.

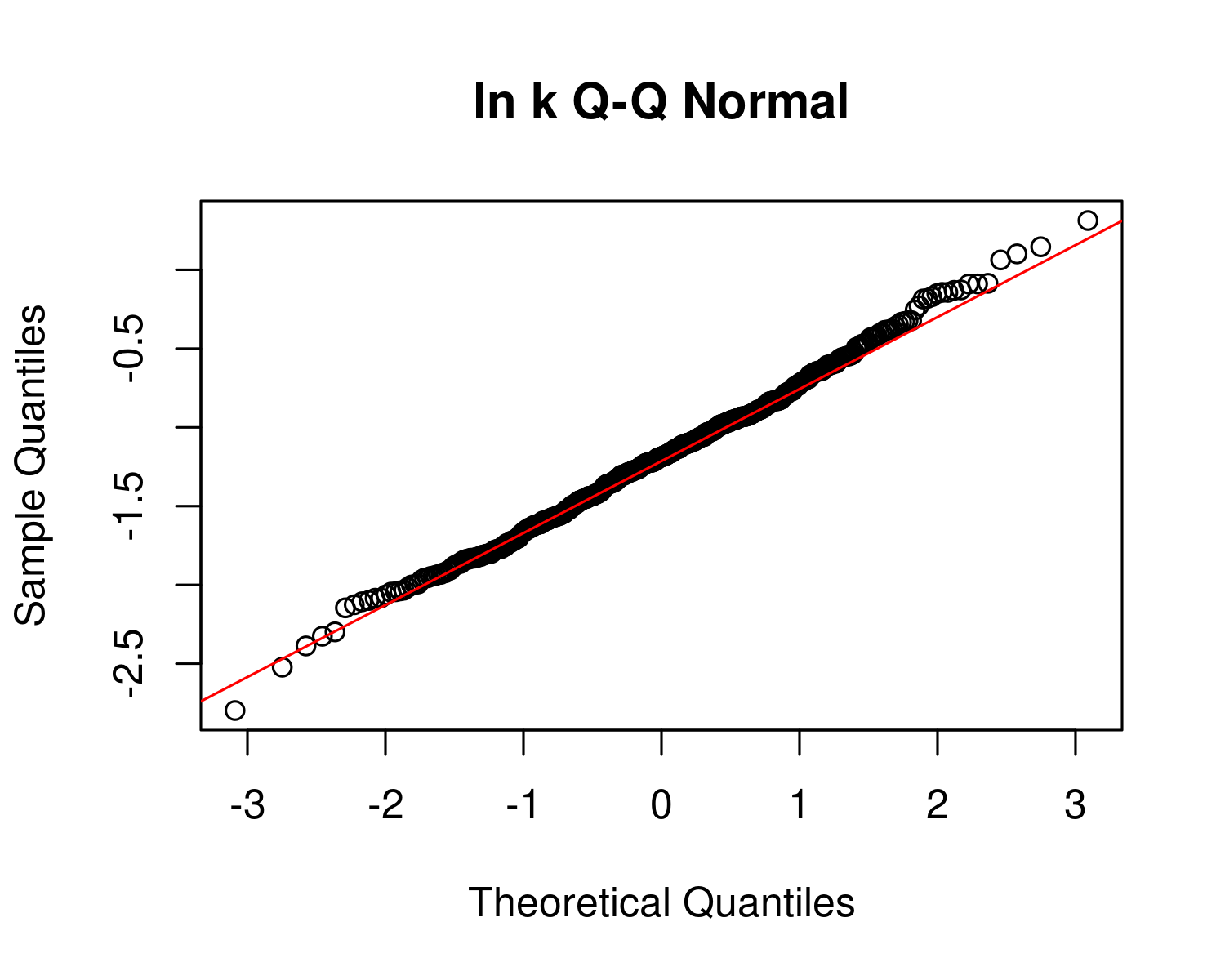
## M\_ln\_k(1) V\_ln\_k(1) M\_ln\_Vd(1) SD\_ln\_Vd(1) z\_ln\_k z\_ln\_Vd  
## 12503 -1.148890 0.1521450 -1.644860 0.033445100 -0.961933416 -2.139841913  
## 15901 -1.002320 0.2060560 -1.694370 0.034291900 -0.292525723 -1.263479244  
## 17543 -1.055780 0.2534080 -1.581000 0.119517000 0.258788216 0.083307969  
## 18721 -1.487880 0.1567170 -1.116290 0.090183900 -1.152131886 0.188325130  
## 11662 -1.292670 0.1257340 -1.729690 0.069338800 0.195782826 0.189814193  
## 13403 -1.270390 0.1332800 -1.571610 0.123823000 0.030123945 0.217615352  
## 13192 -1.322610 0.1972070 -1.570780 0.042810200 0.085417732 -0.648814142  
## 15663 -1.166540 0.2739130 -1.750370 0.204899000 1.116610213 0.254774383  
## 1246 -1.541050 0.1699320 -1.954920 0.307553000 -1.218857416 -0.468830015  
## 16132 -0.879350 0.1893850 -1.966390 0.056025200 1.267368722 -1.192510054  
## 10602 -1.249670 0.1313740 -1.544400 0.043984900 -0.744781596 0.121228235  
## 10563 -1.461480 0.2405850 -1.614720 0.047697700 -1.131218571 -1.035932658  
## 15932 -1.383280 0.1528040 -1.569850 0.164226000 -0.716358490 -0.191888295  
## 1114 -1.297140 0.1640490 -2.220420 0.154966000 0.252652370 -0.970546336  
## 1699 -1.152140 0.1985670 -1.444610 0.120178000 0.152045707 0.057771938  
## 1141 -1.178850 0.1854660 -1.256510 0.324982000 -0.307656430 -2.110692675  
## 13383 -1.275550 0.1117450 -1.408290 0.499785000 -0.953017331 0.978176274  
## 12832 -1.297250 0.1902310 -1.478650 0.206337000 -0.648242811 0.371021737  
## 19552 -1.006070 0.1985060 -1.986540 0.026646300 1.224313624 0.720910931  
## 14423 -1.176370 0.1173450 -2.178930 0.171581000 0.199811608 1.879594880  
## 12372 -1.235080 0.1808280 -1.577460 0.165649000 -0.578483722 -0.396316112  
## 12042 -1.350500 0.1844130 -2.019890 0.176727000 -0.942300733 0.110322947  
## 10473 -1.526280 0.1624130 -1.732740 0.216899000 -0.203728180 -0.593140881  
## 1509 -1.110140 0.1343630 -1.704000 0.004860840 -1.666474840 0.419621770  
## 1552 -1.092160 0.1715180 -1.190030 0.162174000 -0.484455109 -0.545738743  
## 19513 -1.203980 0.1737090 -1.507090 0.005604350 -0.741072661 1.160921499  
## 17471 -1.441230 0.1352880 -1.708930 0.004171310 1.160615779 0.639817834  
## 18092 -1.043930 0.1107730 -1.781350 0.198875000 1.012067125 -0.122020443  
## 1613 -0.908095 0.1933200 -1.782390 0.087617900 -0.072078474 0.184645026  
## 14383 -0.994470 0.1972190 -2.129090 0.044906900 -1.136782298 -0.517806023  
## 14263 -1.079830 0.2136990 -1.866520 0.140176000 0.900624729 0.067988352  
## 18291 -1.212370 0.2009270 -1.642030 0.040445900 0.851770447 -0.184797156  
## 1945 -1.210880 0.2226610 -1.862430 0.360906000 0.727715174 -1.403691615  
## 19613 -1.359880 0.1562270 -1.530230 0.037197400 0.736502146 0.229740706  
## 1842 -1.370210 0.1948250 -1.683180 0.110479000 -0.352129617 -0.889081301  
## 1873 -1.381120 0.1286330 -1.287650 0.075345400 0.705515513 -0.160401177  
## 19423 -1.337190 0.1232990 -1.551320 0.238411000 1.300357989 -0.242136794  
## 19352 -0.940684 0.1100470 -1.951660 0.070556600 0.038252014 -0.028837196  
## 11812 -1.002080 0.1239260 -1.628970 0.063945200 -0.979283770 -0.316215474  
## 14982 -1.007010 0.1489250 -1.947040 0.412745000 0.793761231 -0.416160087  
## 11263 -1.295550 0.1972890 -1.478610 0.015491400 0.786506872 -1.023895957  
## 1028 -1.100740 0.1689520 -1.745430 0.039382000 -0.310463131 1.099495275  
## 1051 -1.215460 0.1923220 -2.142890 0.010908300 1.698884846 0.817712470  
## 17222 -0.762399 0.2218630 -1.494810 0.054188700 -0.794593709 0.168875510  
## 1747 -0.970160 0.3950510 -1.662360 0.199804000 0.348437716 0.038665440  
## 1284 -1.293490 0.1351090 -1.591640 0.108788000 -2.265401074 1.078174892  
## 1564 -1.280160 0.2069320 -1.243720 0.192766000 -0.162205279 0.379427297  
## 18632 -1.272020 0.2242500 -1.746310 0.097674300 1.130864991 -1.078174559  
## 19142 -1.045890 0.2665000 -1.844500 0.041960400 -0.455545976 0.188763468  
## 15793 -1.198640 0.1910660 -1.324320 0.281682000 -0.899166316 1.583133508  
## 1126 -1.505250 0.1950870 -1.661810 0.325596000 0.726838902 -0.250112295  
## 16502 -0.900348 0.2037790 -1.795750 0.184344000 -0.809440902 0.342994219  
## 15103 -1.053320 0.1502970 -1.848110 0.210119000 0.267085116 -0.124701883  
## 11251 -0.924291 0.1440950 -1.648460 0.108575000 -1.737263711 -0.993314763  
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## 13433 -1.379720 0.1899890 -1.383700 0.138141000 -1.035491275 0.849573118  
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## 1589 -1.410330 0.2089860 -1.365140 0.383078000 0.573518173 -1.897945965  
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## 18363 -1.370560 0.1351710 -1.526220 0.129331000 0.186197433 -0.626426919  
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## 14062 -1.117930 0.1747590 -1.636790 0.076441500 0.439760291 -0.301192859  
## 1964 -1.431390 0.2031620 -1.824300 0.073339100 -0.886389751 0.491361149  
## 18413 -1.478350 0.1771790 -1.821550 0.102423000 -0.853818454 -0.898156496  
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## 19872 -1.161140 0.2372220 -1.808170 0.428886000 -0.279741696 -0.437523579  
## 1953 -1.320800 0.1031930 -1.861780 0.095176900 -0.413690145 0.942726154  
## 15883 -1.420980 0.1604670 -1.680470 0.020340300 1.618766521 0.891044960  
## 1663 -1.112870 0.1443020 -1.757520 0.130221000 -0.721055711 -1.691785958  
## 18913 -1.438350 0.1938370 -1.684970 0.000622974 -0.453093157 -0.712147393  
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## 1878 -1.385100 0.1479570 -1.351570 0.150457000 0.215764621 0.983033453  
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## 15642 -1.096520 0.2069020 -2.263360 0.057454500 -1.495419632 -0.728186155  
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## 1857 -1.267580 0.2760140 -1.727480 0.028811000 -0.484335465 -0.272173202  
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## 12581 -0.997721 0.2357290 -1.526580 0.069789900 -0.762448605 0.846734123  
## 1974 -1.441960 0.1627870 -1.630060 0.055930800 0.386073791 0.518125984  
## 13822 -1.007520 0.1597030 -2.040110 0.107257000 -0.664003345 1.579413771  
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## 1374 -1.227730 0.1689690 -1.335630 0.058564100 0.127846023 -1.871305162  
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## 13082 -1.365240 0.2792340 -1.692020 0.037004300 -0.989944235 0.601591759  
## 14941 -1.251280 0.2346260 -1.423070 0.322700000 -0.151684601 -1.429557536  
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## 16911 -1.174190 0.1695050 -1.452290 0.126665000 2.635045375 0.532564109  
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## 12893 -1.445750 0.1776920 -1.629900 0.054283000 0.912862648 0.871555415  
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## 12143 -1.162150 0.2929790 -2.196810 0.091211000 -1.633423995 -1.243838156  
## 1075 -1.348220 0.1911510 -1.615170 0.151644000 0.488932473 0.116308174  
## 18021 -1.159890 0.1569430 -1.858580 0.118455000 -1.019179409 1.197547370  
## 17623 -1.083010 0.1275620 -1.797920 0.153072000 1.090553483 -0.698130988  
## 1499 -1.420770 0.2530700 -1.669230 0.373396000 -1.139469805 0.293604948  
## 18673 -1.329800 0.2247650 -1.760590 0.213349000 -0.015725635 0.437297744  
## 1093 -1.344090 0.1470580 -1.706570 0.145846000 0.297491282 0.627762573  
## 13553 -1.258670 0.1705540 -1.560090 0.032589800 3.200590040 -1.160543514  
## 12592 -1.248530 0.1749740 -1.486560 0.139641000 0.089244244 -0.020788418  
## 12912 -1.259470 0.2055960 -1.342680 0.007414460 0.570972338 1.044724089  
## 1785 -1.278190 0.1704140 -1.319920 0.105045000 0.528685630 1.311594585  
## 14041 -1.030720 0.1339080 -1.287960 0.272206000 -0.440904798 -0.082439028  
## 1624 -1.150740 0.2430760 -1.594140 0.081809100 -0.672793368 0.919224762  
## 1841 -1.381060 0.2177520 -1.312610 0.117235000 2.154313365 -0.243269921  
## 19553 -1.173570 0.1542610 -1.352790 0.127490000 0.593852716 0.351094377  
## 12722 -1.481960 0.1339950 -1.282300 0.207273000 -0.384063768 -1.340384172  
## 15122 -1.100180 0.1947170 -1.284740 0.399640000 0.719783276 0.425846094  
## 1348 -1.327960 0.1973640 -1.898100 0.123360000 1.708173402 -0.814353733  
## 15183 -0.893438 0.2581560 -1.734980 0.030148900 1.075215667 0.693374081  
## 14432 -1.228600 0.1647800 -1.615580 0.116352000 0.777420367 0.705544556  
## 1468 -1.056130 0.3296350 -1.638600 0.287617000 0.052200047 0.278350539  
## 17953 -1.438420 0.1541050 -1.197040 0.086812100 -1.083698485 -1.202692142  
## 1557 -0.930346 0.1897400 -1.955180 0.206831000 -0.008856207 0.642761817  
## 19642 -1.016430 0.1904750 -1.482470 0.072050700 2.030643112 -0.605973945  
## 16191 -1.013930 0.2475180 -1.595300 0.229066000 -1.113328933 -1.377257613  
## 17011 -1.269110 0.1203700 -1.629310 0.142751000 1.138271925 -0.925992687  
## 1820 -1.291130 0.1052950 -1.535270 0.298035000 -0.614892642 0.567243857  
## 10851 -1.116600 0.1407670 -1.678320 0.143690000 -2.193536615 2.595481260  
## 13483 -1.270700 0.2077540 -1.772490 0.246260000 -1.215686372 -0.239984547  
## 13183 -0.955247 0.1587530 -1.484440 0.083875200 -0.045326362 0.687536401  
## 18462 -1.303210 0.2238330 -1.434190 0.465465000 1.598812624 -0.151788986  
## 15542 -1.296150 0.1732730 -1.616400 0.099121700 0.927542200 0.227544260  
## 18752 -1.552990 0.1604060 -1.462730 0.015831600 0.829284552 -0.668648038  
## 12081 -1.281540 0.1715570 -1.646070 0.070379800 1.024603876 0.030829067  
## 1014 -1.270060 0.1201080 -1.474480 0.117319000 -0.476238068 0.028429558  
## 15612 -1.198060 0.1873550 -1.855840 0.032189900 1.638868393 -0.365455074  
## 14833 -1.252720 0.2172760 -1.851060 0.056223400 -0.632050958 -2.208012195  
## 1639 -1.250320 0.1704420 -1.547500 0.100388000 -1.379618576 0.297039427  
## 10353 -1.235000 0.2323190 -1.338930 0.065478600 -0.257455748 2.129700659  
## 15011 -1.318120 0.2163190 -1.576520 0.239615000 1.679972711 1.325041143  
## 12253 -1.030050 0.2843570 -1.651820 0.050472600 -2.545858038 -0.116171447  
## 10793 -1.273770 0.1554400 -1.420120 0.279225000 0.012078784 -1.470146221  
## 10103 -1.214790 0.1801720 -1.892480 0.265947000 1.960925111 -0.379271835  
## 1903 -1.394550 0.1828180 -2.057140 0.012390100 -0.385905481 -1.465005931  
## 1679 -0.979064 0.1695630 -1.885510 0.067393900 0.910757548 1.075148263  
## 1795 -1.206960 0.2103120 -1.527350 0.229186000 -1.448130794 -1.226124877  
## 1489 -0.973331 0.1935460 -1.437530 0.353152000 -1.121614596 -3.056328234  
## 1881 -1.297160 0.1585240 -1.529640 0.246627000 -0.973617906 1.450657775  
## 15061 -1.149900 0.1908490 -1.656620 0.003690420 -0.067186922 0.717976859

dat$ln\_k\_i <- dat$`M\_ln\_k(1)` + sqrt(dat$`V\_ln\_k(1)`)\*dat$z\_ln\_k  
dat$ln\_Vd\_i <- dat$`M\_ln\_Vd(1)`+ dat$`SD\_ln\_Vd(1)`\*dat$z\_ln\_Vd  
linmod <- lm(ln\_Vd\_i ~ ln\_k\_i,data=dat)  
ggplot(dat) + geom\_point(aes(ln\_k\_i,ln\_Vd\_i)) +   
 labs(subtitle=paste("Adj R2 =",signif(summary(linmod)$adj.r.squared,2)))

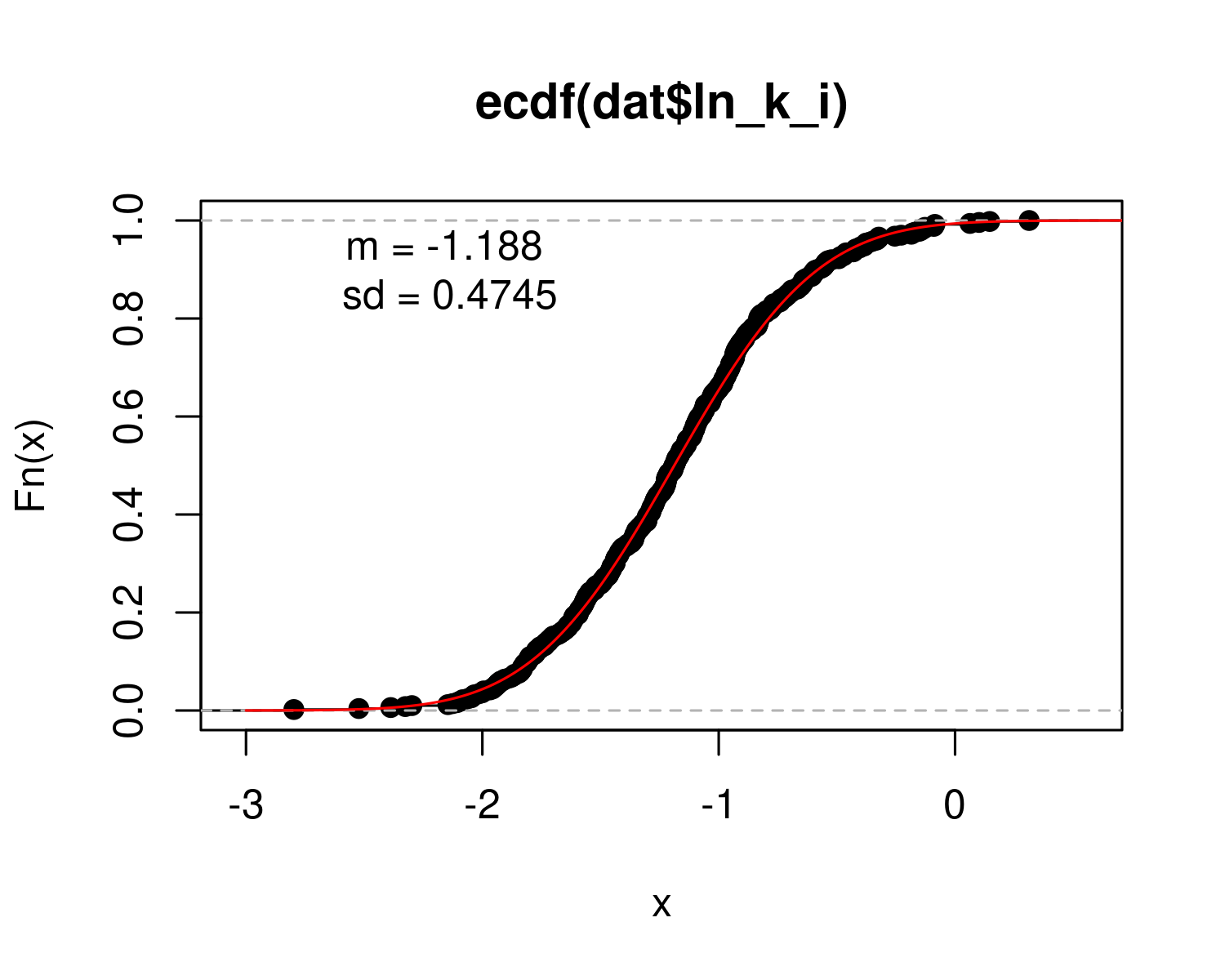


## Check normality

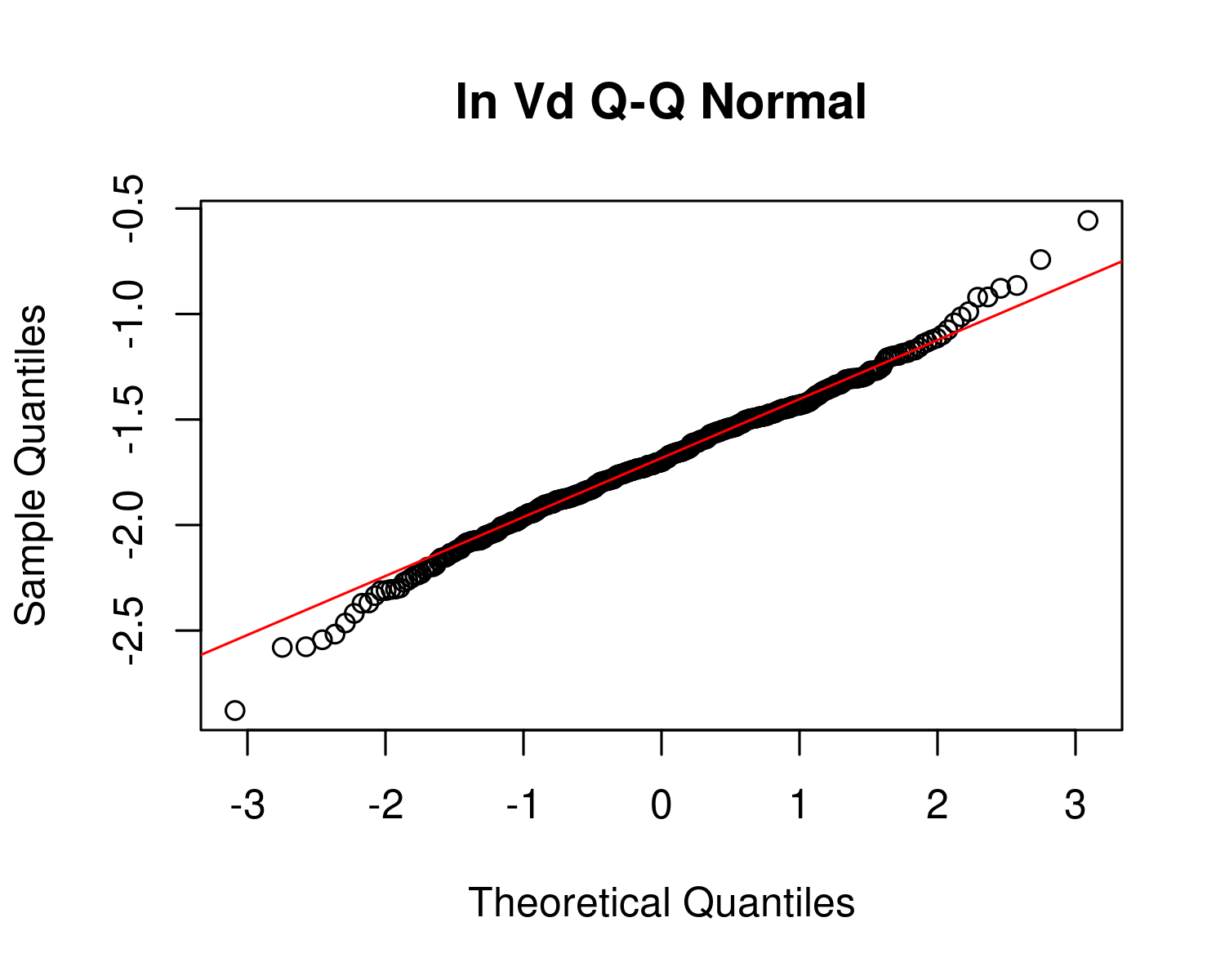
qqnorm(dat$ln\_k\_i,main="ln k Q-Q Normal")  
qqline(dat$ln\_k\_i,col="red")



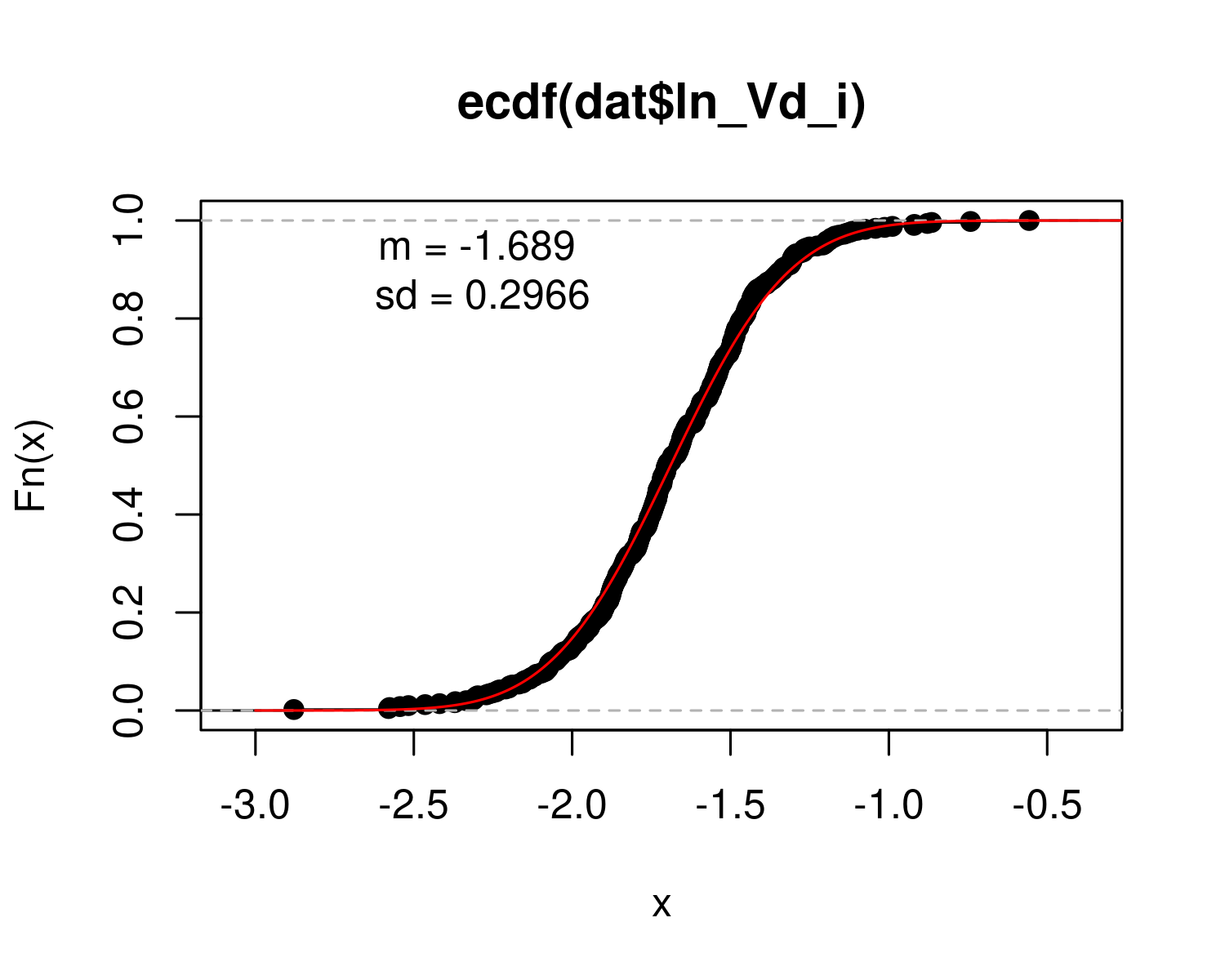
plot(ecdf(dat$ln\_k\_i))  
x <- seq(-3,1,0.01)  
m\_ln\_k\_i <- mean(dat$ln\_k\_i)  
sd\_ln\_k\_i <- sd(dat$ln\_k\_i)  
lines(x,pnorm(x,mean=m\_ln\_k\_i,sd=sd\_ln\_k\_i),col="red")  
text(m\_ln\_k\_i-2\*sd\_ln\_k\_i,0.9,paste("m =",signif(m\_ln\_k\_i,4),"\nsd =",signif(sd\_ln\_k\_i,4)))



qqnorm(dat$ln\_Vd\_i,main="ln Vd Q-Q Normal")  
qqline(dat$ln\_Vd\_i,col="red")



plot(ecdf(dat$ln\_Vd\_i))  
x <- seq(-3,1,0.01)  
m\_ln\_Vd\_i <- mean(dat$ln\_Vd\_i)  
sd\_ln\_Vd\_i <- sd(dat$ln\_Vd\_i)  
  
lines(x,pnorm(x,mean=m\_ln\_Vd\_i,sd=sd\_ln\_Vd\_i),col="red")  
text(m\_ln\_Vd\_i-2\*sd\_ln\_Vd\_i,0.9,paste("m =",signif(m\_ln\_Vd\_i,4),"\nsd =",signif(sd\_ln\_Vd\_i,4)))

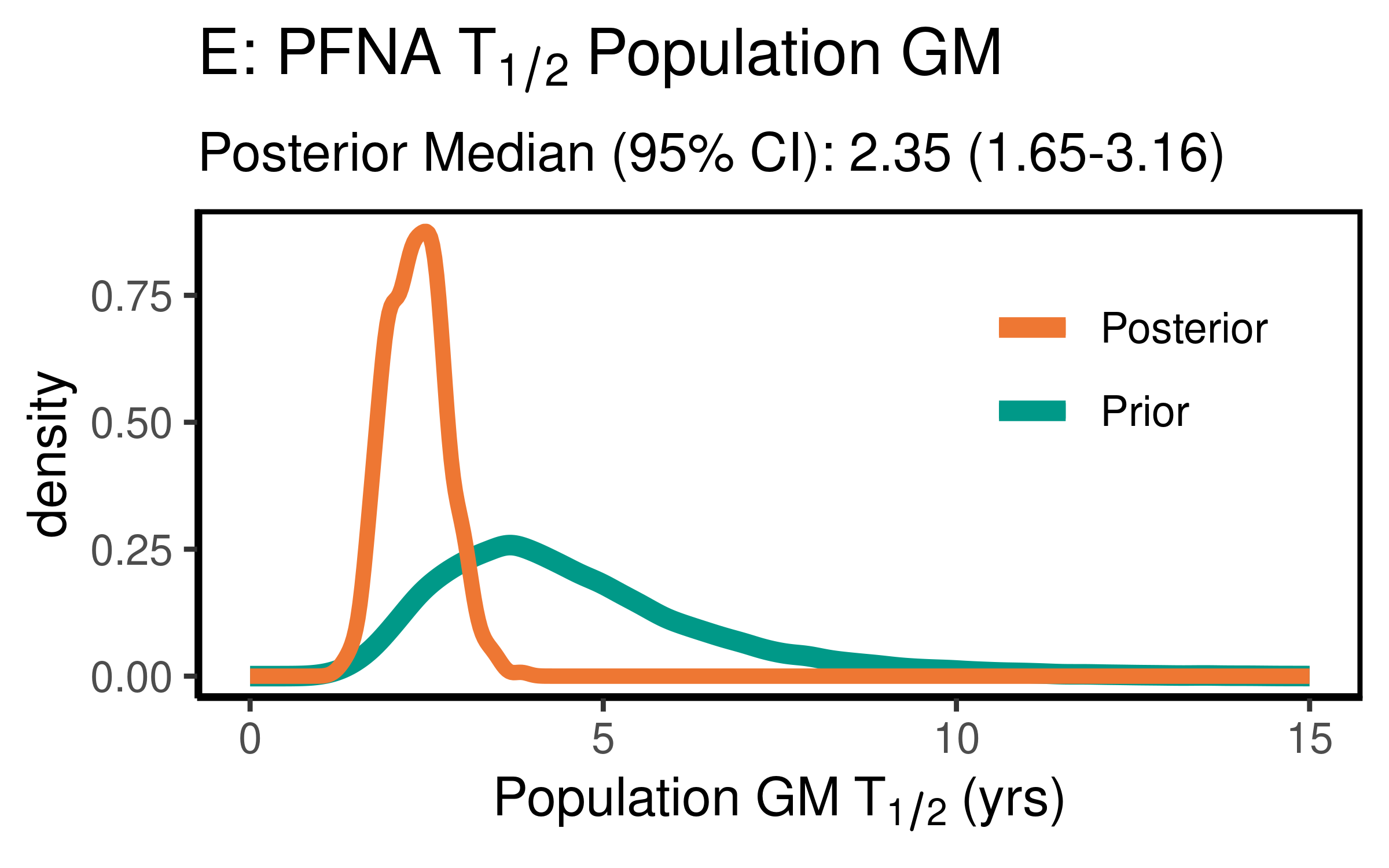


## Calculate table values for individual-level

hl\_i <- log(2)/ exp(dat$ln\_k\_i) # individual half-life   
med\_hl\_i <- paste(signif (median (hl\_i), 3)) # median of individual half-life  
ci\_med\_hl\_i <- paste(signif (quantile(hl\_i, prob=c(0.025,0.975)), 3),collapse="-") # 95ci med individual halflife  
gm\_hl\_i <- paste(signif (exp(mean(log(hl\_i))), 3)) # gm (which should be really close)  
gsd\_hl\_i <- paste(signif (exp(sd(log(hl\_i))), 3)) # gsd individual  
  
med\_Vd\_i <- paste(signif (median(exp(dat$ln\_Vd\_i)), 3)) # median individual Vd  
ci\_med\_Vd\_i <-paste(signif (quantile(exp(dat$ln\_Vd\_i), prob=c(0.025,0.975)), 3),collapse="-") # 95ci med individual Vd  
gm\_vd\_i <- paste(signif (exp(mean(dat$ln\_Vd\_i)), 3)) # gm (which should be really close)  
gsd\_vd\_i<- paste(signif (exp(sd(dat$ln\_Vd\_i)), 3)) # gsd indiv

PFNA\_priors <- data.frame(  
 halflife\_GM= log(2)/rlnorm(50000,  
 meanlog=-1.80181,sdlog=0.4055))  
M\_k <- exp(as.numeric(dat$`M\_ln\_k(1)`))  
PFNA\_halflife\_GM <- log(2)/M\_k  
  
PFNA\_hlgm\_pr\_med <- signif(median(PFNA\_priors$halflife\_GM,3))  
PFNA\_hlgm\_pr\_med\_95ci <-paste(signif(quantile(PFNA\_priors$halflife\_GM,  
 prob=c(0.025,0.975)),  
 3),  
 collapse="-")  
  
PFNA\_hl\_median\_gm <- signif(median(PFNA\_halflife\_GM),3)  
PFNA\_hl\_median\_gm\_95ci <- paste(signif(quantile(PFNA\_halflife\_GM,  
 prob=c(0.025,0.975)),3),collapse="-")  
  
p<-ggplot()+  
 stat\_density(aes(halflife\_GM, color = "Prior"),data=PFNA\_priors,geom="line",size=2)+  
 stat\_density(aes(PFNA\_halflife\_GM,stat(density),color="Posterior"),geom="line",size=1.5)+  
 xlim(0,15)+  
 labs(title = bquote("E: PFNA"~T[1/2]~"Population GM") ,  
 subtitle=paste("Posterior Median (95% CI): ",  
 PFNA\_hl\_median\_gm," (",  
 PFNA\_hl\_median\_gm\_95ci,  
 ")",sep=""))+  
 xlab(bquote("Population GM"~T[1/2]~"(yrs)")) +  
 scale\_color\_manual(name=NULL,   
 values=c(Prior="#009988", Posterior="#EE7733" )) +   
 theme\_classic() +   
 theme(legend.title = element\_blank(),legend.position=c(0.8,0.7),  
 panel.background = element\_rect(color="black",size=1),  
 legend.background = element\_rect(fill="transparent", color=NA))  
print(p)

## Warning: Removed 41 rows containing non-finite values (stat\_density).

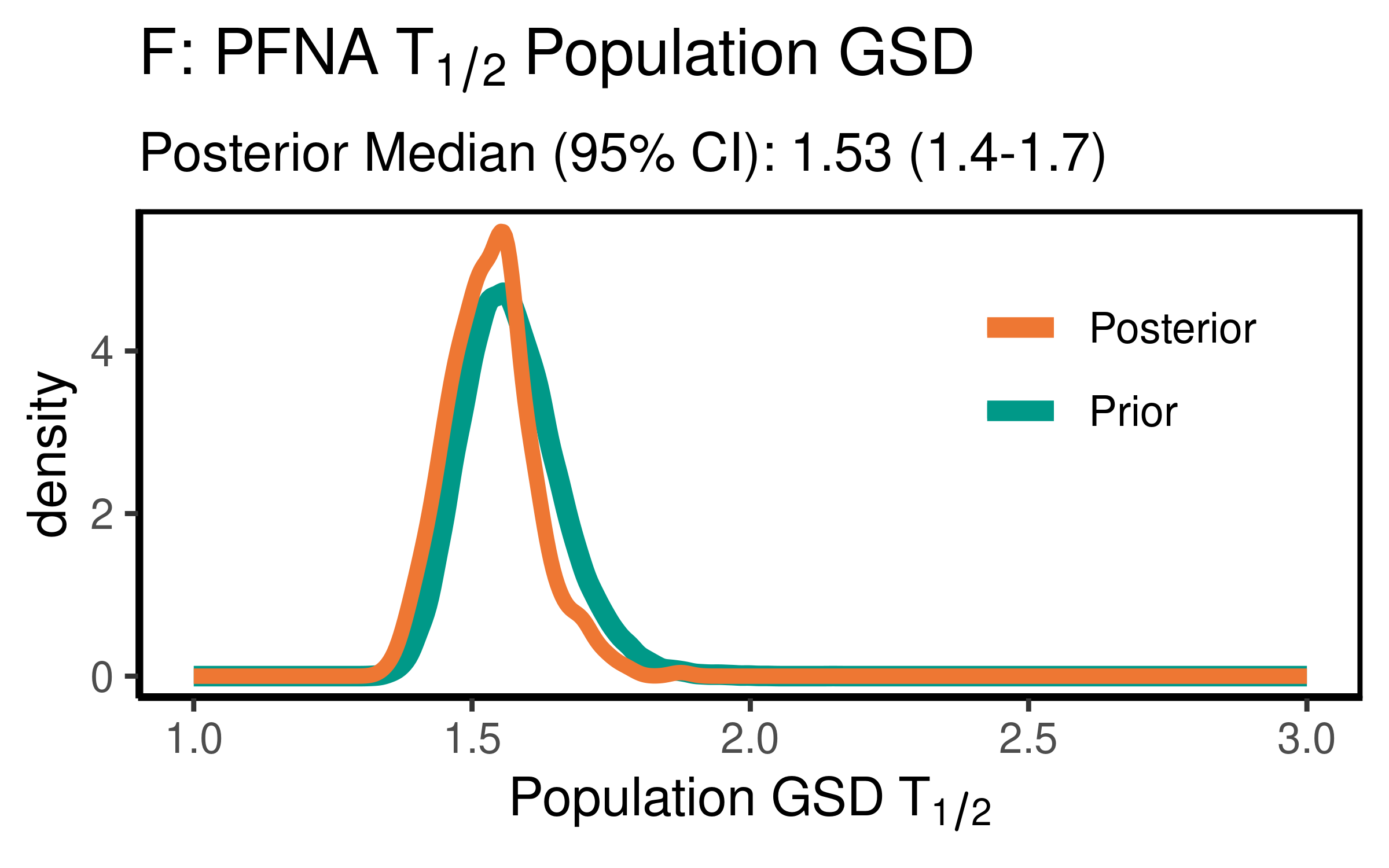


ggsave(here ("output-plots", paste0( sa, "PFNA\_hl\_gm.pdf")) ,p,dpi=600)

## Saving 4 x 2.5 in image

## Warning: Removed 41 rows containing non-finite values (stat\_density).

PFNA\_priors$halflife\_GSD = exp(sqrt(exp(rnorm(50000,m=log(0.2000),sd=log(1.275)))))   
PFNA\_halflife\_GSD <- exp(sqrt(dat$`V\_ln\_k(1)`))  
  
PFNA\_hlgsd\_pr\_med <- signif(median(PFNA\_priors$halflife\_GSD,3))  
PFNA\_hlgsd\_pr\_med\_95ci <-paste(signif(quantile(PFNA\_priors$halflife\_GSD,  
 prob=c(0.025,0.975)),  
 3),  
 collapse="-")  
PFNA\_hl\_gsd\_med <- signif(median(PFNA\_halflife\_GSD),3)  
PFNA\_hl\_gsd\_med\_95ci <- paste(signif(quantile(PFNA\_halflife\_GSD,  
 prob=c(0.025,0.975)),3),collapse="-")  
p<-ggplot()+  
 stat\_density(aes(halflife\_GSD, color = "Prior"),data=PFNA\_priors,geom="line",size=2)+  
 stat\_density(aes(PFNA\_halflife\_GSD,stat(density), color = "Posterior"),geom="line",size=1.5)+  
 xlim(1,3)+  
 labs(title = bquote("F: PFNA"~T[1/2]~"Population GSD"),   
 subtitle=paste("Posterior Median (95% CI): ",  
 PFNA\_hl\_gsd\_med," (",  
 PFNA\_hl\_gsd\_med\_95ci,  
 ")",sep=""))+  
 xlab(bquote("Population GSD"~T[1/2]))+  
 scale\_color\_manual(name=NULL,   
 values=c(Prior="#009988", Posterior="#EE7733" )) +   
 theme\_classic() +   
 theme(legend.title = element\_blank(),legend.position=c(0.8,0.7),  
 panel.background = element\_rect(color="black",size=1),  
 legend.background = element\_rect(fill="transparent", color=NA))  
print(p)

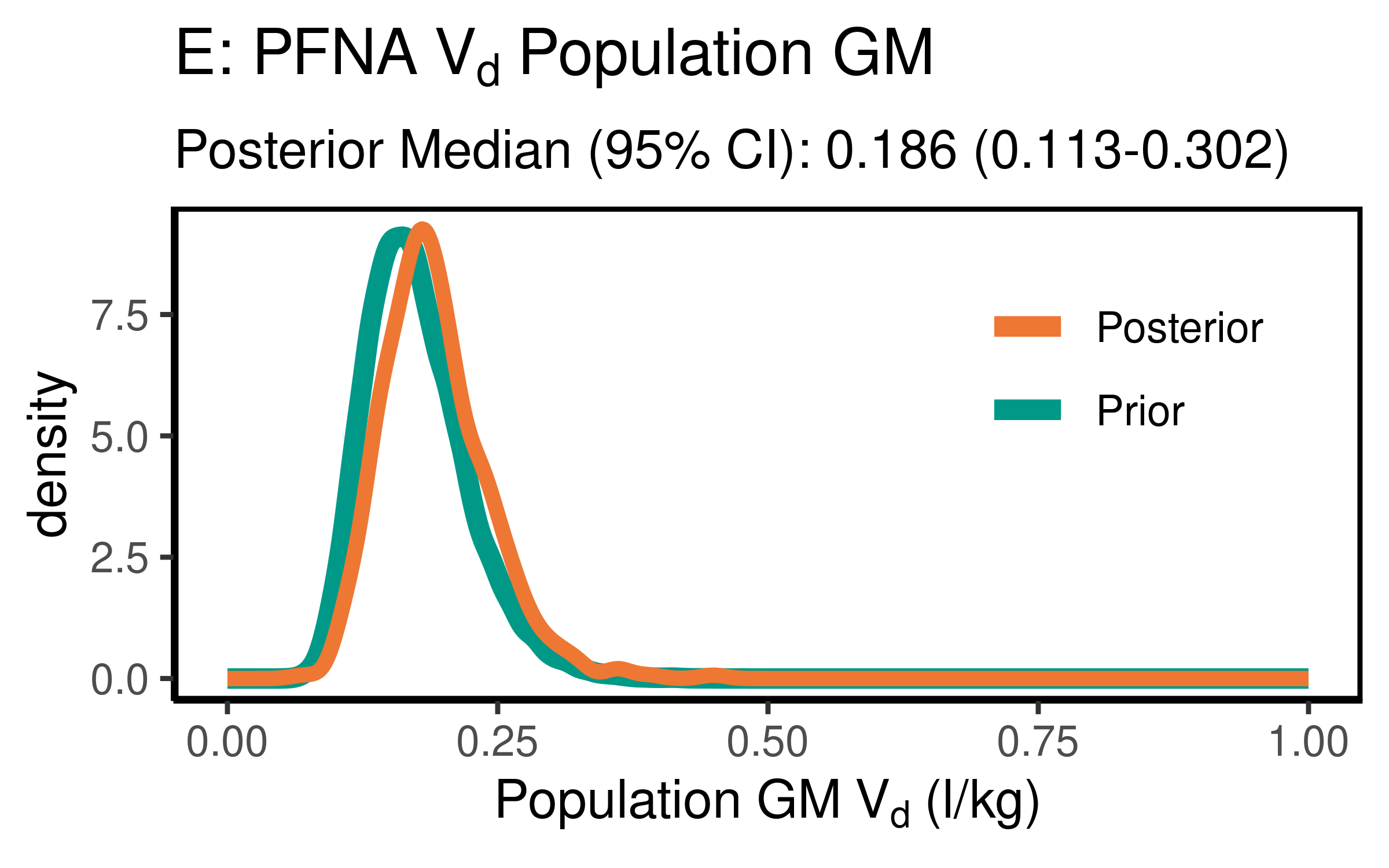


ggsave(here ("output-plots", paste0( sa, "PFNA\_hl\_gsd.pdf")), p,dpi=600)

### Distribution Volume

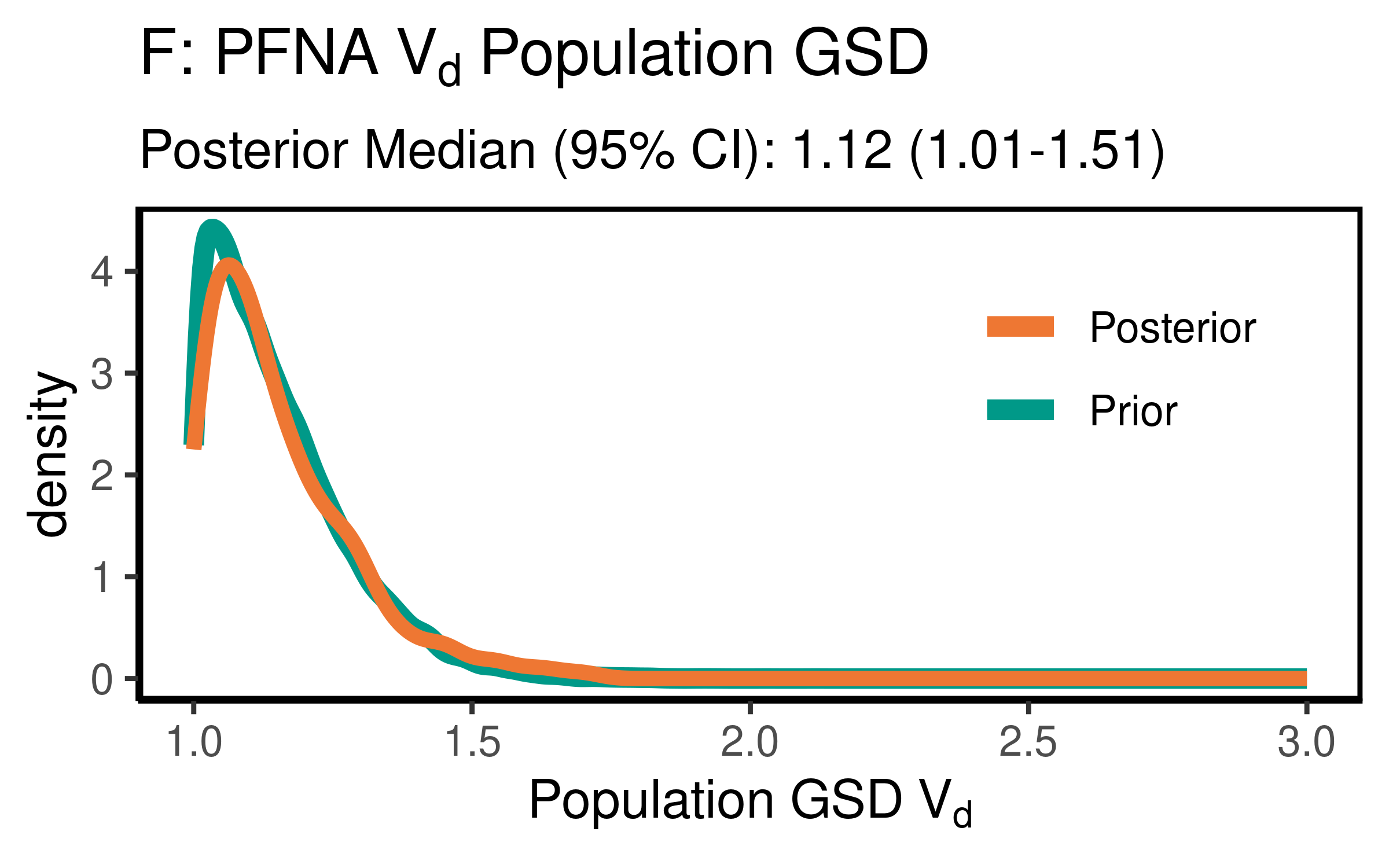
For PFNA, the data were not particularly informative, but slightly increased the estimate of the median to 0.308(0.223-0.548) slightly. They were not informative as to the population GSD, with the posterior distributions essentially unchanged from the priors.

PFNA\_priors$Vd\_GM <- rlnorm(50000,  
 meanlog=-1.77196,  
 sdlog=0.2624)  
PFNA\_Vd\_GM <- exp(dat$`M\_ln\_Vd(1)`)  
  
   
  
PFNA\_vd\_gm\_pr\_med <- signif(median(PFNA\_priors$Vd\_GM,3))  
PFNA\_vd\_gm\_pr\_med\_95ci <- paste(signif(quantile(PFNA\_priors$Vd\_GM,  
 prob=c(0.025,0.975)), 3), collapse="-")  
PFNA\_vd\_gm\_med <- signif(median(PFNA\_Vd\_GM),3)  
PFNA\_vd\_gm\_med\_95ci <- paste(signif(quantile(PFNA\_Vd\_GM,  
 prob=c(0.025,0.975)),3),collapse="-")  
  
p<-ggplot()+  
 stat\_density(aes(Vd\_GM, color = "Prior"),data=PFNA\_priors,geom="line",size=2)+  
 stat\_density(aes(PFNA\_Vd\_GM,stat(density), color = "Posterior"),geom="line",size=1.5)+  
 xlim(0,1)+labs(title = bquote("E: PFNA"~V[d]~"Population GM"),  
 subtitle=paste("Posterior Median (95% CI): ",  
 PFNA\_vd\_gm\_med," (",   
 PFNA\_vd\_gm\_med\_95ci,")",sep=""))+  
 xlab(bquote("Population GM"~V[d]~"(l/kg)"))+  
 scale\_color\_manual(name=NULL,   
 values=c(Prior="#009988", Posterior="#EE7733" )) +   
 theme\_classic() +   
 theme(legend.title = element\_blank(),legend.position=c(0.8,0.7),  
 panel.background = element\_rect(color="black",size=1),  
 legend.background = element\_rect(fill="transparent", color=NA))  
print(p)



ggsave(here ("output-plots",paste0( sa, "PFNA\_vd\_gm.pdf")), p,dpi=600)

PFNA\_priors$Vd\_GSD = exp(abs(rnorm(50000,sd=0.17)))  
PFNA\_Vd\_GSD <- exp(dat$`SD\_ln\_Vd(1)`)  
  
PFNA\_vd\_gsd\_pr\_med <- signif(median(PFNA\_priors$Vd\_GSD,3))  
PFNA\_vd\_gsd\_pr\_med\_95ci <- paste(signif(quantile(PFNA\_priors$Vd\_GSD,  
 prob=c(0.025,0.975)), 3), collapse="-")  
  
PFNA\_vd\_gsd\_med <- signif(median(PFNA\_Vd\_GSD),3)  
PFNA\_vd\_gsd\_med\_95ci <- paste(signif(quantile(PFNA\_Vd\_GSD,  
 prob=c(0.025,0.975)),3),collapse="-")  
  
p<-ggplot()+  
 stat\_density(aes(Vd\_GSD, color = "Prior"),data=PFNA\_priors,geom="line",size=2)+  
 stat\_density(aes(PFNA\_Vd\_GSD,stat(density), color = "Posterior"),geom="line",size=1.5)+  
 xlim(1,3)+  
 labs(title = bquote("F: PFNA"~V[d]~"Population GSD "),  
 subtitle=paste("Posterior Median (95% CI): ",  
 PFNA\_vd\_gsd\_med," (",  
 PFNA\_vd\_gsd\_med\_95ci,  
 ")",sep=""))+  
 xlab(bquote("Population GSD"~V[d]))+  
 scale\_color\_manual(name=NULL,   
 values=c(Prior="#009988", Posterior="#EE7733" )) +   
 theme\_classic() +   
 theme(legend.title = element\_blank(),legend.position=c(0.8,0.7),  
 panel.background = element\_rect(color="black",size=1),  
 legend.background = element\_rect(fill="transparent", color=NA))  
print(p)

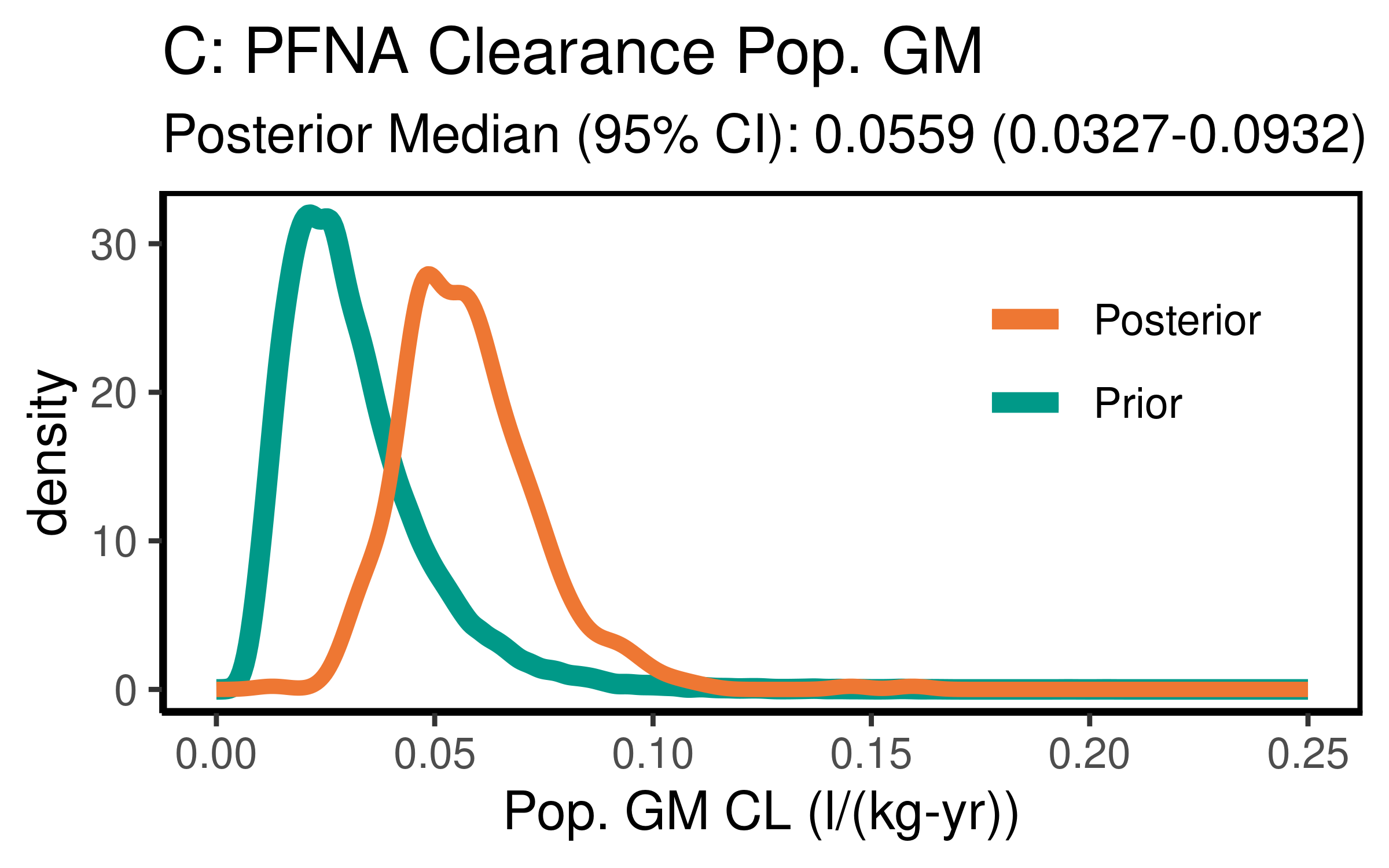


ggsave(here ("output-plots",paste0( sa, "PFNA\_vd\_gsd.pdf")), p,dpi=600)

### Clearance (just pop GM)

Cl is k \* Vd

PFNA\_priors$CL\_GM <- PFNA\_priors$Vd\_GM \* (log(2)/PFNA\_priors$halflife\_GM)  
PFNA\_CL\_GM <- exp(dat$`M\_ln\_Vd(1)` + dat$`M\_ln\_k(1)`)  
  
PFNA\_cl\_gm\_pr\_med <- signif(median(PFNA\_priors$CL\_GM,3))  
PFNA\_cl\_gm\_pr\_med\_95ci <- paste(signif(quantile(PFNA\_priors$CL\_GM,  
 prob=c(0.025,0.975)), 3), collapse="-")  
PFNA\_cl\_gm\_med <- signif(median(PFNA\_CL\_GM),3)  
PFNA\_cl\_gm\_med\_95ci <- paste(signif(quantile(PFNA\_CL\_GM,  
 prob=c(0.025,0.975)),3),collapse="-")  
  
p<-ggplot()+  
 stat\_density(aes(CL\_GM, color = "Prior"),data=PFNA\_priors,geom="line",size=2)+  
 stat\_density(aes(PFNA\_CL\_GM,stat(density), color = "Posterior"),geom="line",size=1.5)+  
 xlim(0,0.25)+labs(title = "C: PFNA Clearance Pop. GM ",subtitle=paste("Posterior Median (95% CI): ",  
 PFNA\_cl\_gm\_med," (",  
 PFNA\_cl\_gm\_med\_95ci,  
 ")",sep=""))+  
 xlab("Pop. GM CL (l/(kg-yr))")+  
 scale\_color\_manual(name=NULL,   
 values=c(Prior="#009988", Posterior="#EE7733" )) +   
 theme\_classic() +   
 theme(legend.title = element\_blank(),legend.position=c(0.8,0.7),  
 panel.background = element\_rect(color="black",size=1),  
 legend.background = element\_rect(fill="transparent", color=NA))  
print(p)



ggsave(here ("output-plots",paste0( sa, "PFNA\_CL\_gm.pdf")) ,p,dpi=600)

## Table significant digit values

PFNA\_hlgm\_pr\_med <- paste(signif(PFNA\_hlgm\_pr\_med, 3))  
PFNA\_hl\_median\_gm<- paste(signif(PFNA\_hl\_median\_gm, 3))  
PFNA\_hlgsd\_pr\_med<- paste(signif(PFNA\_hlgsd\_pr\_med, 3))  
PFNA\_hl\_gsd\_med<- paste(signif(PFNA\_hl\_gsd\_med, 3))  
PFNA\_vd\_gm\_pr\_med<- paste(signif(PFNA\_vd\_gm\_pr\_med, 3))  
PFNA\_vd\_gm\_med<- paste(signif(PFNA\_vd\_gm\_med, 3))  
PFNA\_vd\_gsd\_pr\_med<- paste(signif(PFNA\_vd\_gsd\_pr\_med, 3))  
PFNA\_vd\_gsd\_med<- paste(signif(PFNA\_vd\_gsd\_med, 3))  
PFNA\_cl\_gm\_pr\_med<- paste(signif(PFNA\_cl\_gm\_pr\_med, 3))  
PFNA\_cl\_gm\_med<- paste(signif(PFNA\_cl\_gm\_med, 3))

### Population median estimates [95% CI]

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Prior GM | Posterior GM | Prior GSD | Posterior GSD |
| Half-life (years) | 4.2 | 2.35 | 1.56 | 1.53 |
| HL [95% CI] | [1.89-9.37] | [1.65-3.16] | [1.42-1.77] | [1.4-1.7] |
| Volume of distribution | 0.17 | 0.186 | 1.12 | 1.12 |
| [95% CI] | [0.102-0.284] | [0.113-0.302] | [1.01-1.46] | [1.01-1.51] |
| Clearance | 0.028 | 0.0559 |  |  |
| [95% CI] | [0.0108-0.0727] | [0.0327-0.0932] | [] | [] |

### Individual Posterior estimates

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | median GM [95% CI] | GM calculator input | GSD individual |
| Half-life (years) | 2.27 [ 0.826-5.36 ] | 2.27 | 1.61 |
| Volume of distribution | 0.183 [ 0.0998-0.324 ] | 0.185 | 1.35 |

## ─ Session info ───────────────────────────────────────────────────────────────  
## setting value   
## version R version 3.6.1 (2019-07-05)   
## os Red Hat Enterprise Linux Server 7.9 (Maipo)  
## system x86\_64, linux-gnu   
## ui X11   
## language (EN)   
## collate en\_US.UTF-8   
## ctype en\_US.UTF-8   
## tz America/New\_York   
## date 2021-03-01   
##   
## ─ Packages ───────────────────────────────────────────────────────────────────  
## package \* version date lib source   
## assertthat 0.2.1 2019-03-21 [2] CRAN (R 3.6.1)  
## backports 1.1.5 2019-10-02 [2] CRAN (R 3.6.1)  
## bayesplot \* 1.7.0 2019-05-23 [2] CRAN (R 3.6.1)  
## broom 0.5.2 2019-04-07 [2] CRAN (R 3.6.1)  
## callr 3.3.2 2019-09-22 [2] CRAN (R 3.6.1)  
## cellranger 1.1.0 2016-07-27 [2] CRAN (R 3.6.1)  
## cli 1.1.0 2019-03-19 [2] CRAN (R 3.6.1)  
## coda \* 0.19-3 2019-07-05 [2] CRAN (R 3.6.1)  
## codetools 0.2-16 2018-12-24 [2] CRAN (R 3.6.1)  
## colorspace 1.4-1 2019-03-18 [2] CRAN (R 3.6.1)  
## crayon 1.3.4 2017-09-16 [2] CRAN (R 3.6.1)  
## DBI 1.0.0 2018-05-02 [2] CRAN (R 3.6.1)  
## dbplyr 1.4.2 2019-06-17 [2] CRAN (R 3.6.1)  
## desc 1.2.0 2018-05-01 [2] CRAN (R 3.6.1)  
## devtools 2.2.1 2019-09-24 [2] CRAN (R 3.6.1)  
## digest 0.6.23 2019-11-23 [2] CRAN (R 3.6.1)  
## dplyr \* 0.8.3 2019-07-04 [2] CRAN (R 3.6.1)  
## ellipsis 0.3.0 2019-09-20 [2] CRAN (R 3.6.1)  
## evaluate 0.14 2019-05-28 [2] CRAN (R 3.6.1)  
## farver 2.0.1 2019-11-13 [2] CRAN (R 3.6.1)  
## forcats \* 0.4.0 2019-02-17 [2] CRAN (R 3.6.1)  
## fs 1.3.1 2019-05-06 [2] CRAN (R 3.6.1)  
## generics 0.0.2 2018-11-29 [2] CRAN (R 3.6.1)  
## ggplot2 \* 3.2.1 2019-08-10 [2] CRAN (R 3.6.1)  
## ggridges 0.5.1 2018-09-27 [2] CRAN (R 3.6.1)  
## ggsci \* 2.9 2018-05-14 [2] CRAN (R 3.6.1)  
## glue 1.3.1 2019-03-12 [2] CRAN (R 3.6.1)  
## gtable 0.3.0 2019-03-25 [2] CRAN (R 3.6.1)  
## haven 2.2.0 2019-11-08 [2] CRAN (R 3.6.1)  
## here \* 0.1 2017-05-28 [2] CRAN (R 3.6.1)  
## hms 0.5.2 2019-10-30 [2] CRAN (R 3.6.1)  
## htmltools 0.4.0 2019-10-04 [2] CRAN (R 3.6.1)  
## httr 1.4.1 2019-08-05 [2] CRAN (R 3.6.1)  
## jsonlite 1.6 2018-12-07 [2] CRAN (R 3.6.1)  
## khroma \* 1.4.0 2020-10-05 [1] CRAN (R 3.6.1)  
## knitr 1.26 2019-11-12 [2] CRAN (R 3.6.1)  
## labeling 0.3 2014-08-23 [2] CRAN (R 3.6.1)  
## lattice 0.20-38 2018-11-04 [2] CRAN (R 3.6.1)  
## lazyeval 0.2.2 2019-03-15 [2] CRAN (R 3.6.1)  
## lifecycle 0.1.0 2019-08-01 [2] CRAN (R 3.6.1)  
## lubridate 1.7.4 2018-04-11 [2] CRAN (R 3.6.1)  
## magrittr 1.5 2014-11-22 [2] CRAN (R 3.6.1)  
## memoise 1.1.0 2017-04-21 [2] CRAN (R 3.6.1)  
## modelr 0.1.5 2019-08-08 [2] CRAN (R 3.6.1)  
## munsell 0.5.0 2018-06-12 [2] CRAN (R 3.6.1)  
## nlme 3.1-142 2019-11-07 [2] CRAN (R 3.6.1)  
## pillar 1.4.2 2019-06-29 [2] CRAN (R 3.6.1)  
## pkgbuild 1.0.6 2019-10-09 [2] CRAN (R 3.6.1)  
## pkgconfig 2.0.3 2019-09-22 [2] CRAN (R 3.6.1)  
## pkgload 1.0.2 2018-10-29 [2] CRAN (R 3.6.1)  
## plyr 1.8.4 2016-06-08 [2] CRAN (R 3.6.1)  
## prettyunits 1.0.2 2015-07-13 [2] CRAN (R 3.6.1)  
## processx 3.4.1 2019-07-18 [2] CRAN (R 3.6.1)  
## ps 1.3.0 2018-12-21 [2] CRAN (R 3.6.1)  
## purrr \* 0.3.3 2019-10-18 [2] CRAN (R 3.6.1)  
## R6 2.4.1 2019-11-12 [2] CRAN (R 3.6.1)  
## Rcpp 1.0.3 2019-11-08 [2] CRAN (R 3.6.1)  
## readr \* 1.3.1 2018-12-21 [2] CRAN (R 3.6.1)  
## readxl 1.3.1 2019-03-13 [2] CRAN (R 3.6.1)  
## remotes 2.1.0 2019-06-24 [2] CRAN (R 3.6.1)  
## reprex 0.3.0 2019-05-16 [2] CRAN (R 3.6.1)  
## reshape2 \* 1.4.3 2017-12-11 [2] CRAN (R 3.6.1)  
## rlang 0.4.2 2019-11-23 [2] CRAN (R 3.6.1)  
## rmarkdown 1.18 2019-11-27 [2] CRAN (R 3.6.1)  
## rprojroot 1.3-2 2018-01-03 [2] CRAN (R 3.6.1)  
## rstudioapi 0.10 2019-03-19 [2] CRAN (R 3.6.1)  
## rvest 0.3.5 2019-11-08 [2] CRAN (R 3.6.1)  
## scales 1.1.0 2019-11-18 [2] CRAN (R 3.6.1)  
## sessioninfo 1.1.1 2018-11-05 [2] CRAN (R 3.6.1)  
## stringi 1.4.3 2019-03-12 [2] CRAN (R 3.6.1)  
## stringr \* 1.4.0 2019-02-10 [2] CRAN (R 3.6.1)  
## testthat 2.3.0 2019-11-05 [2] CRAN (R 3.6.1)  
## tibble \* 2.1.3 2019-06-06 [2] CRAN (R 3.6.1)  
## tidyr \* 1.0.0 2019-09-11 [2] CRAN (R 3.6.1)  
## tidyselect 0.2.5 2018-10-11 [2] CRAN (R 3.6.1)  
## tidyverse \* 1.3.0 2019-11-21 [2] CRAN (R 3.6.1)  
## usethis 1.5.1 2019-07-04 [2] CRAN (R 3.6.1)  
## vctrs 0.2.0 2019-07-05 [2] CRAN (R 3.6.1)  
## withr 2.1.2 2018-03-15 [2] CRAN (R 3.6.1)  
## xfun 0.11 2019-11-12 [2] CRAN (R 3.6.1)  
## xml2 1.2.2 2019-08-09 [2] CRAN (R 3.6.1)  
## yaml 2.2.0 2018-07-25 [2] CRAN (R 3.6.1)  
## zeallot 0.1.0 2018-01-28 [2] CRAN (R 3.6.1)  
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## [1] /home/ad.abt.local/wchiu/R/library  
## [2] /opt/R/3.6.1/lib64/R/library