

Maine_Analysis

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4/26/2021

```
# Library
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.2.1 --

## v ggplot2 3.3.3     v purrr    0.3.4
## v tibble   3.1.1     v dplyr    1.0.5
## v tidyverse 1.1.3     v stringr  1.4.0
## v readr    1.3.1     vforcats  0.5.1

## Warning: package 'ggplot2' was built under R version 3.6.2

## Warning: package 'tibble' was built under R version 3.6.2

## Warning: package 'tidyverse' was built under R version 3.6.2

## Warning: package 'purrr' was built under R version 3.6.2

## Warning: package 'dplyr' was built under R version 3.6.2

## Warning: package 'forcats' was built under R version 3.6.2

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()   masks stats::lag()

library(ggplot2)
library(auk)

## Warning: package 'auk' was built under R version 3.6.2

## auk 0.4.2 is designed for EBD files downloaded after 2019-08-15.
## No EBD data directory set, see ?auk_set_ebd_path to set EBD_PATH
## eBird taxonomy version: 2019

library(agricolae)
library(lubridate)
```

```
##  
## Attaching package: 'lubridate'  
  
## The following object is masked from 'package:base':  
##  
##     date  
  
library(colormap)  
library(gggridges)  
  
## Warning: package 'gggridges' was built under R version 3.6.2  
  
library(RColorBrewer)  
library(corrplot)  
  
## corrplot 0.84 loaded  
  
library(viridis)  
  
## Warning: package 'viridis' was built under R version 3.6.2  
  
## Loading required package: viridisLite  
  
## Warning: package 'viridisLite' was built under R version 3.6.2  
  
library(cowplot)  
  
##  
## *****  
  
## Note: As of version 1.0.0, cowplot does not change the  
##     default ggplot2 theme anymore. To recover the previous  
##     behavior, execute:  
##     theme_set(theme_cowplot())  
  
## *****  
  
##  
## Attaching package: 'cowplot'  
  
## The following object is masked from 'package:lubridate':  
##  
##     stamp
```

```

OSPR_ME_month <- read.csv("../Data/Processed/Maine/OSPR_ME_month.csv")
WODU_ME_month <- read.csv("../Data/Processed/Maine/WODU_ME_month.csv")
RWBL_ME_month <- read.csv("../Data/Processed/Maine/RWBL_ME_month.csv")

OSPR_ME_month$Month_Year <- as.Date(OSPR_ME_month$Month_Year)
WODU_ME_month$Month_Year <- as.Date(WODU_ME_month$Month_Year)
RWBL_ME_month$Month_Year <- as.Date(RWBL_ME_month$Month_Year)

ME_birds_temps <- read.csv("../Data/Processed/Maine/ME_birds_temps.csv")
ME_birds_temps$Month_Year <- as.Date(ME_birds_temps$Month_Year)
Allbirds_ME <- read.csv("../Data/Processed/Maine/Allbirds_ME.csv")

OSPR_ME_firstlast <- read.csv("../Data/Processed/Maine/OSPR_ME_firstlast.csv")
WODU_ME_firstlast <- read.csv("../Data/Processed/Maine/WODU_ME_firstlast.csv")
RWBL_ME_firstlast <- read.csv("../Data/Processed/Maine/RWBL_ME_firstlast.csv")

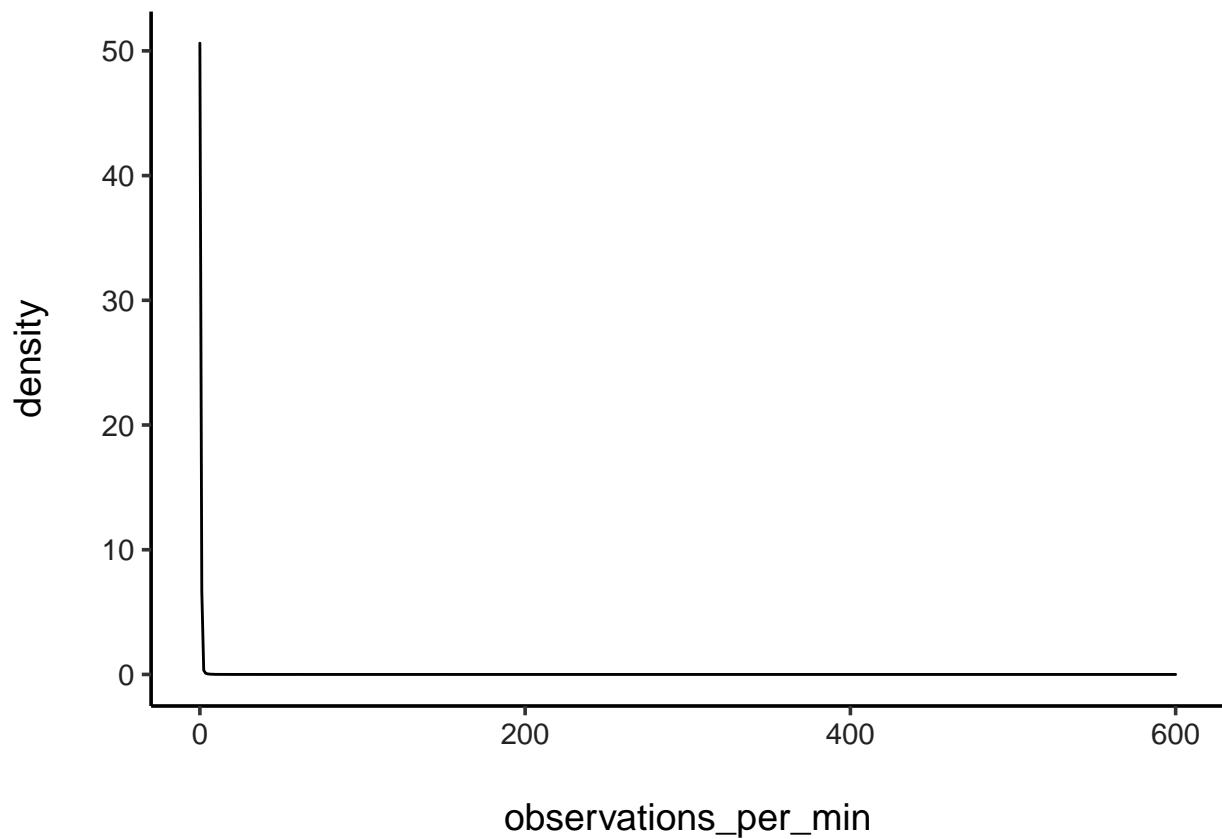
# ggplot theme
mytheme <- theme_classic( base_size = 14) +
  theme( axis.text = element_text( color = "#222222ff"),
        legend.position = "top",
        # remove legend title
        legend.title = element_blank(),
        # margins (top,right,bottom,left)
        axis.title.x = element_text( color = "black",
                                     margin = margin(20,0,0,0)),
        axis.title.y = element_text( color = "black",
                                     margin = margin(0,20,0,0)))
theme_set(mytheme)

```

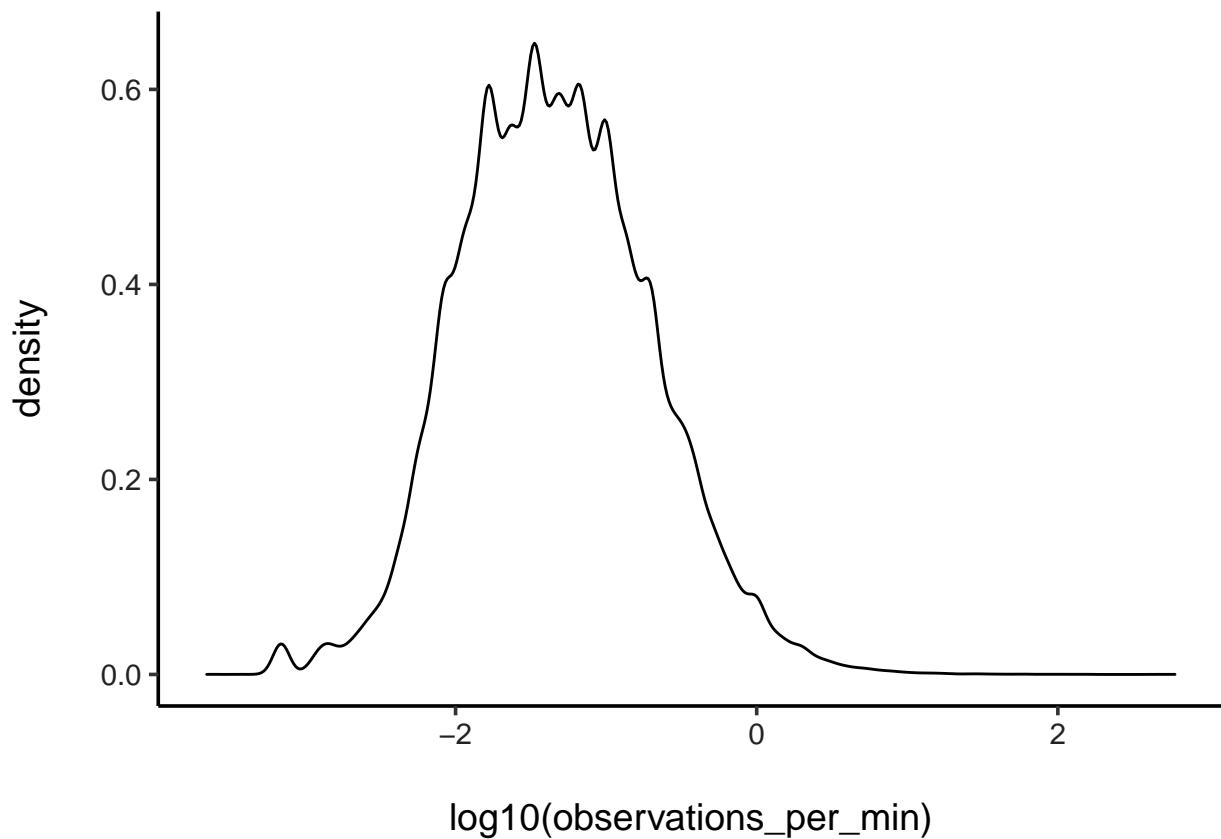
```
summary(Allbirds_ME$observations_per_min)
```

```
##      Min.    1st Qu.     Median      Mean    3rd Qu.      Max.
##  0.0002   0.0167   0.0444   0.1683   0.1212 600.0000
```

```
ggplot(Allbirds_ME, aes(x=observations_per_min)) +
  geom_density()
```



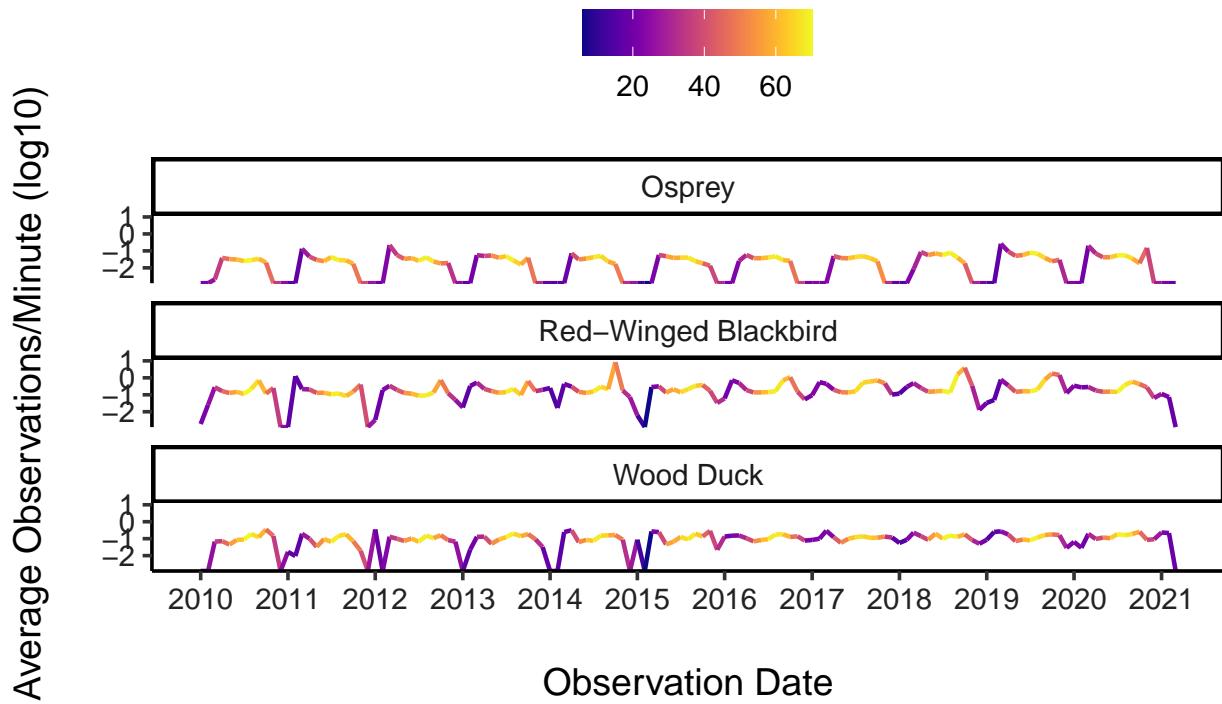
```
ggplot(Allbirds_ME, aes(x=log10(observations_per_min))) +  
  geom_density()
```



```
ggplot(ME_birds_temps,
       aes(x=Month_Year, y=log10(observation_per_min_avg), color=Mean_Temperature)) +
  geom_line(lwd=0.8) +
  #Set color to average monthly temperature
  scale_color_viridis(option='plasma') +
  #Create legible date break labels
  scale_x_date(date_breaks = '1 year', date_labels = '%Y') +
  #Create figure labels
  labs(x='Observation Date',
       y='Average Observations/Minute (log10)',
       color='Mean Monthly Temperature (F)',
       title= 'Effort-Corrected Bird Observations by Species',
       subtitle = 'Maine: 2010-2020') +
  #Facet by species
  facet_wrap(~common_name, nrow=3)
```

Effort–Corrected Bird Observations by Species

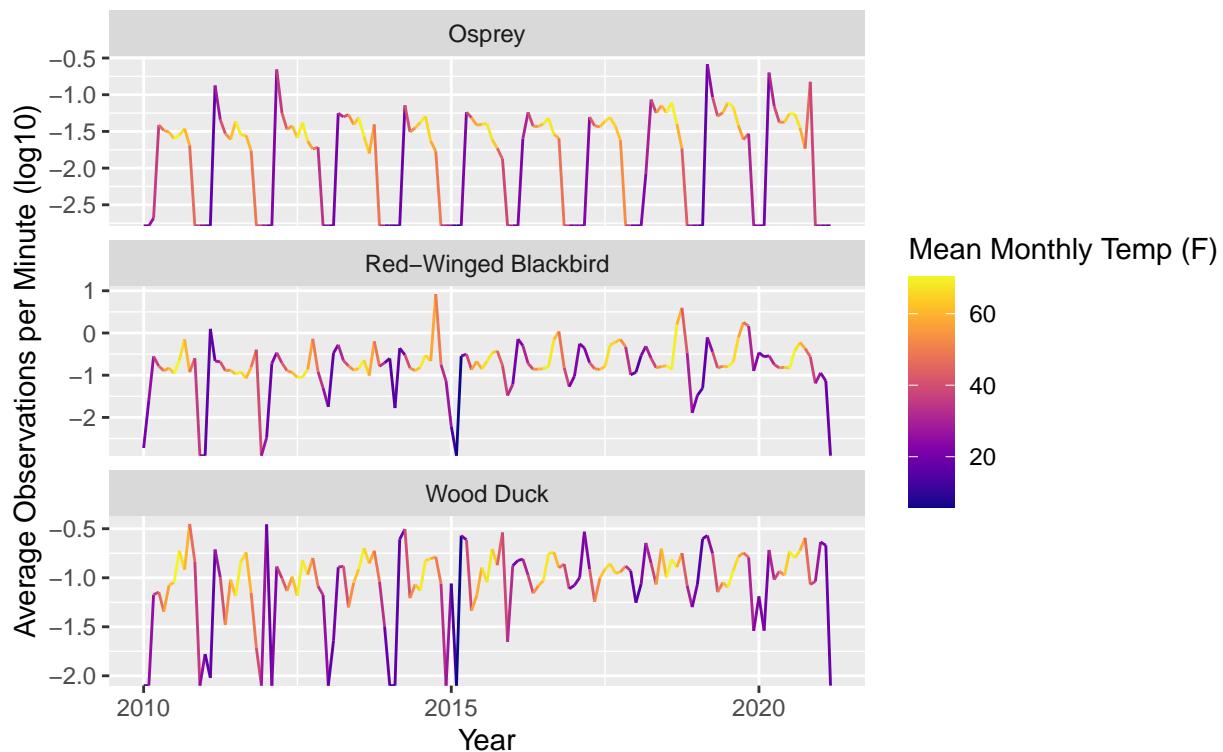
Maine: 2010–2020



```
#facet plot of obs/min by species
plot.obs.min <- ggplot(ME_birds_temps, aes(x = Month_Year, y = obs_per_min_log10)) +
  geom_line(aes(color = Mean_Temperature)) + scale_color_viridis(option = "C") + labs(title = "Maine Bi...")
  facet_wrap(~common_name, nrow = 3, scales = "free_y") + theme_grey()
print(plot.obs.min)
```

Maine Bird Observations (2010–2021)

by Average Monthly Temperature



```
#ggridges
#This plot represents bird observations uncorrected for effort
ggplot(Allbirds_ME, aes(x = observation_date, fill = common_name, color = common_name)) +
  geom_density(alpha = .2) +
  facet_wrap(~common_name, ncol = 3) +
  theme(legend.position = 'none',
        axis.text.x = element_text(angle = 45, hjust = 1)) +
  #Set color and fill
  scale_color_brewer(palette = 'Dark2') +
  scale_fill_brewer(palette = 'Dark2') +
  #Create figure labels
  labs(x = "Observation Date", title="Bird Observation Density by Species",
       subtitle = "Maine: 2010:2020")
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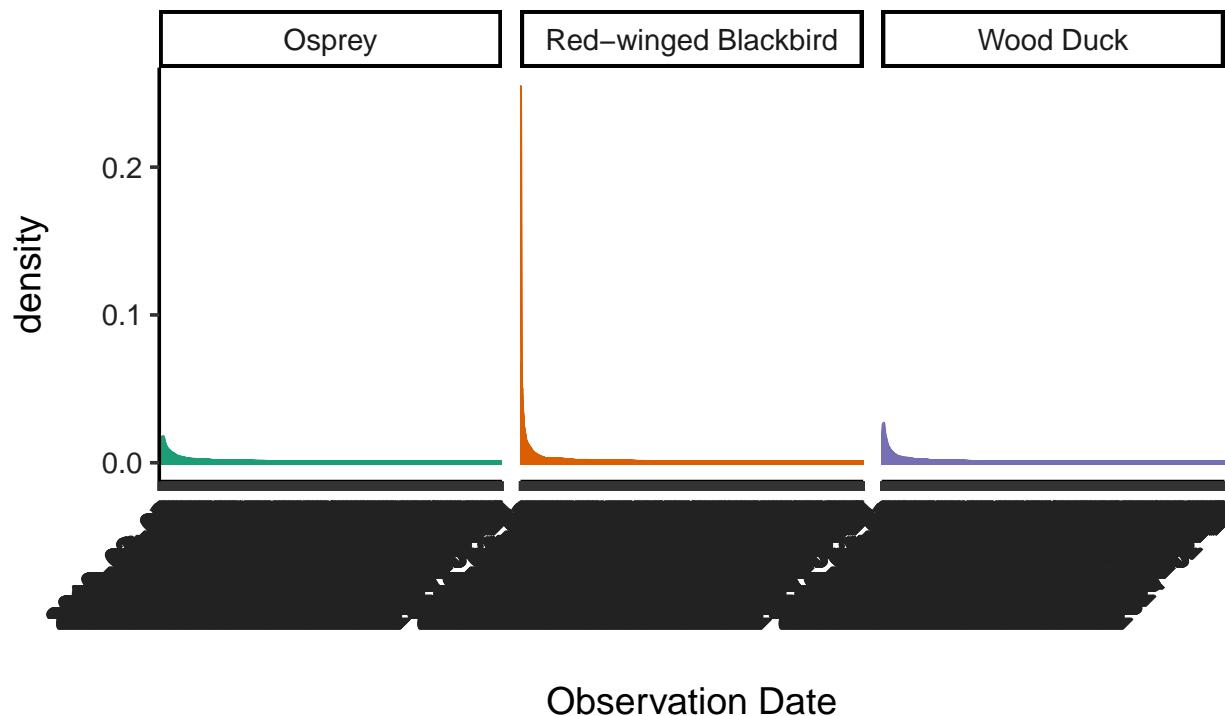
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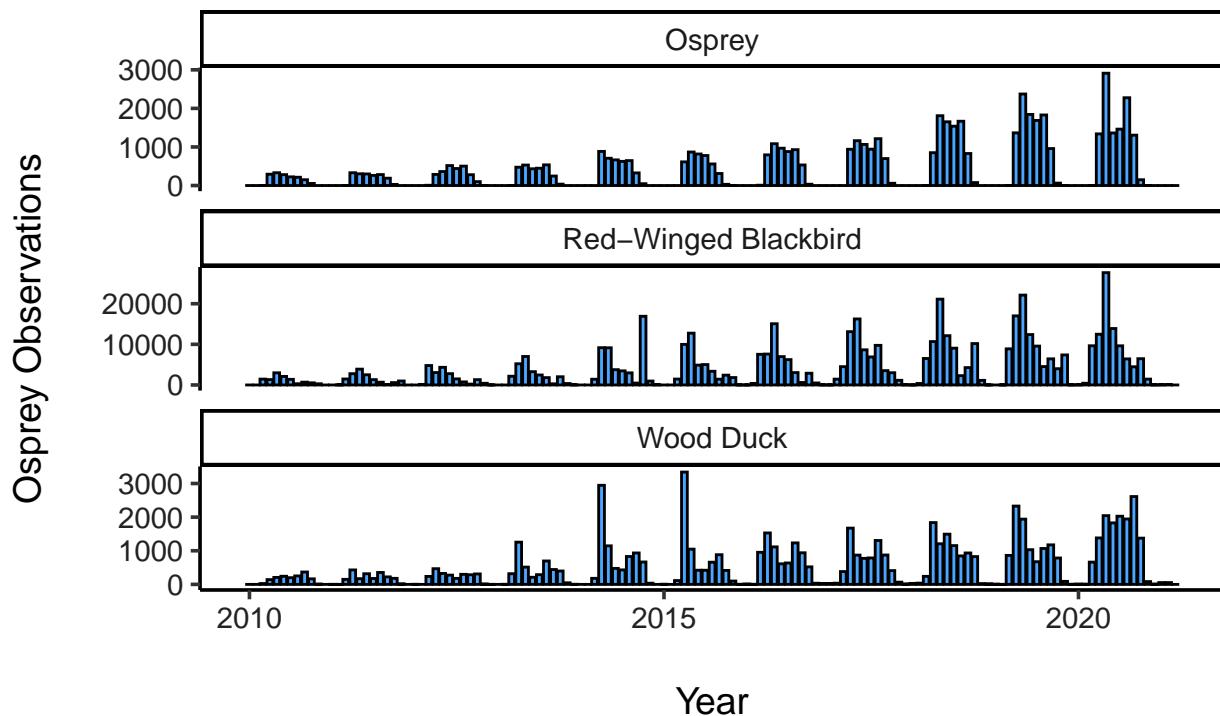
Bird Observation Density by Species

Maine: 2010:2020

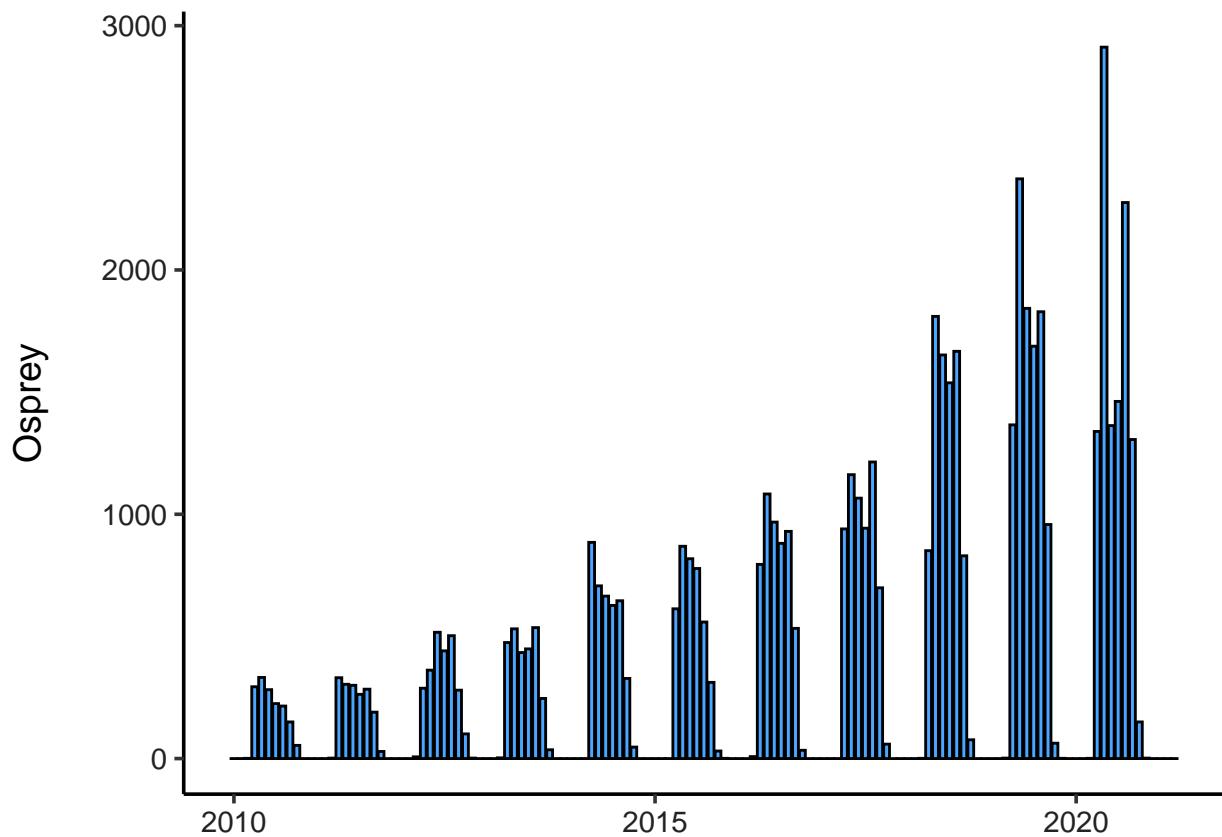


```
#another way of visualizing it
plot.crazy <- ggplot(ME_birds_temps, aes(x = Month_Year)) + geom_bar(aes(y = observation_count_sum), fill = "#f08080")
  labs(x = "Year", title = "Maine data, 2010-2021", subtitle = "with Average Temperatures", color = "M
  facet_wrap(~common_name, nrow = 3, scales = "free_y")
print(plot.crazy)
```

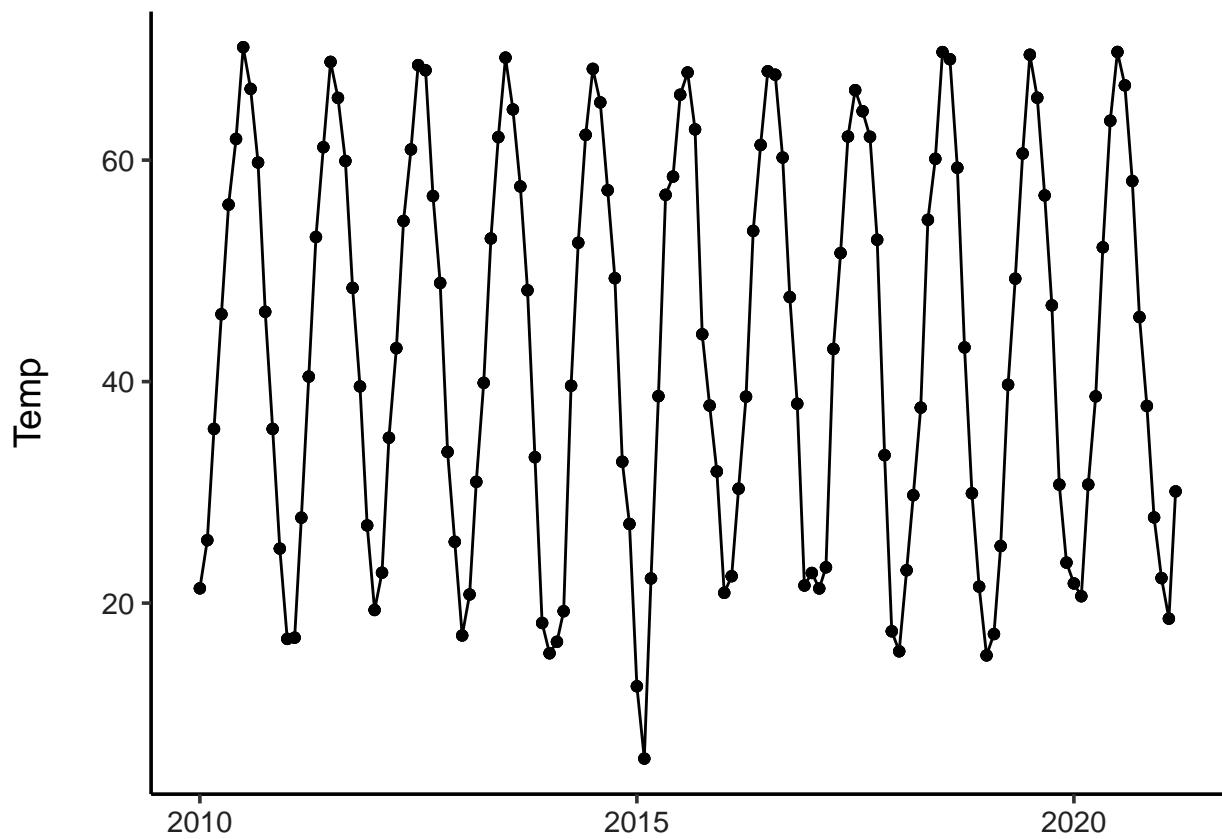
Maine data, 2010–2021 with Average Temperatures



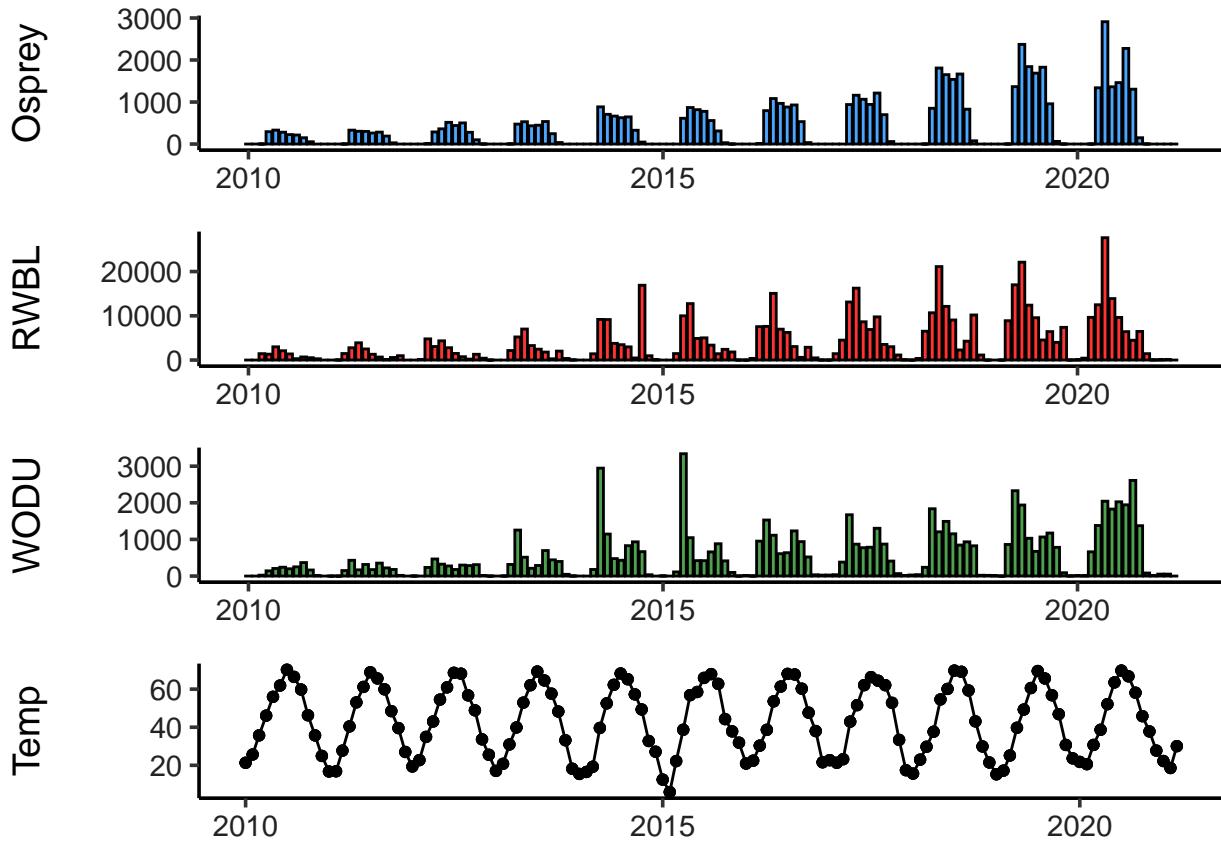
```
# plot_grid all species together
plot.ospr <- ggplot(OSPR_ME_month, aes(x = Month_Year, y = observation_count_sum)) + geom_bar(aes(y = o
print(plot.ospr)
```



```
plot.rwbl <- ggplot(RWBL_ME_month, aes(x = Month_Year, y = observation_count_sum)) + geom_bar(aes(y = ob...  
plot.wodu <- ggplot(WODU_ME_month, aes(x = Month_Year, y = observation_count_sum)) + geom_bar(aes(y = ob...  
plot.temps <- ggplot(ME_birds_temps, aes(x = Month_Year, y = Mean_Temperature)) + geom_line(aes()) + ge...  
print(plot.temps)
```



```
plot_grid(plot.ospr, plot.rwbl, plot.wodu, plot.temps, ncol = 1, align = 'v')
```



```

WODU_ME_firstlast$FirstObs <- as.Date(WODU_ME_firstlast$FirstObs)
WODU_ME_firstlast$LastObs <- as.Date(WODU_ME_firstlast$LastObs)

gap1 <- WODU_ME_firstlast$FirstObs[2] - WODU_ME_firstlast$LastObs[1]
gap2 <- WODU_ME_firstlast$FirstObs[3] - WODU_ME_firstlast$LastObs[2]
gap3 <- WODU_ME_firstlast$FirstObs[4] - WODU_ME_firstlast$LastObs[3]
gap4 <- WODU_ME_firstlast$FirstObs[5] - WODU_ME_firstlast$LastObs[4]
gap5 <- WODU_ME_firstlast$FirstObs[6] - WODU_ME_firstlast$LastObs[5]
gap6 <- WODU_ME_firstlast$FirstObs[7] - WODU_ME_firstlast$LastObs[6]
gap7 <- WODU_ME_firstlast$FirstObs[8] - WODU_ME_firstlast$LastObs[7]
gap8 <- WODU_ME_firstlast$FirstObs[9] - WODU_ME_firstlast$LastObs[8]
gap9 <- WODU_ME_firstlast$FirstObs[10] - WODU_ME_firstlast$LastObs[9]
gap10 <- WODU_ME_firstlast$FirstObs[11] - WODU_ME_firstlast$LastObs[10]
gap11 <- WODU_ME_firstlast$FirstObs[12] - WODU_ME_firstlast$LastObs[11]

WODU_ME_firstlast$GapFromLastYear <- c(NA, gap1, gap2, gap3, gap4, gap5, gap6, gap7, gap8,
                                         gap9, gap10, gap11)
  
```

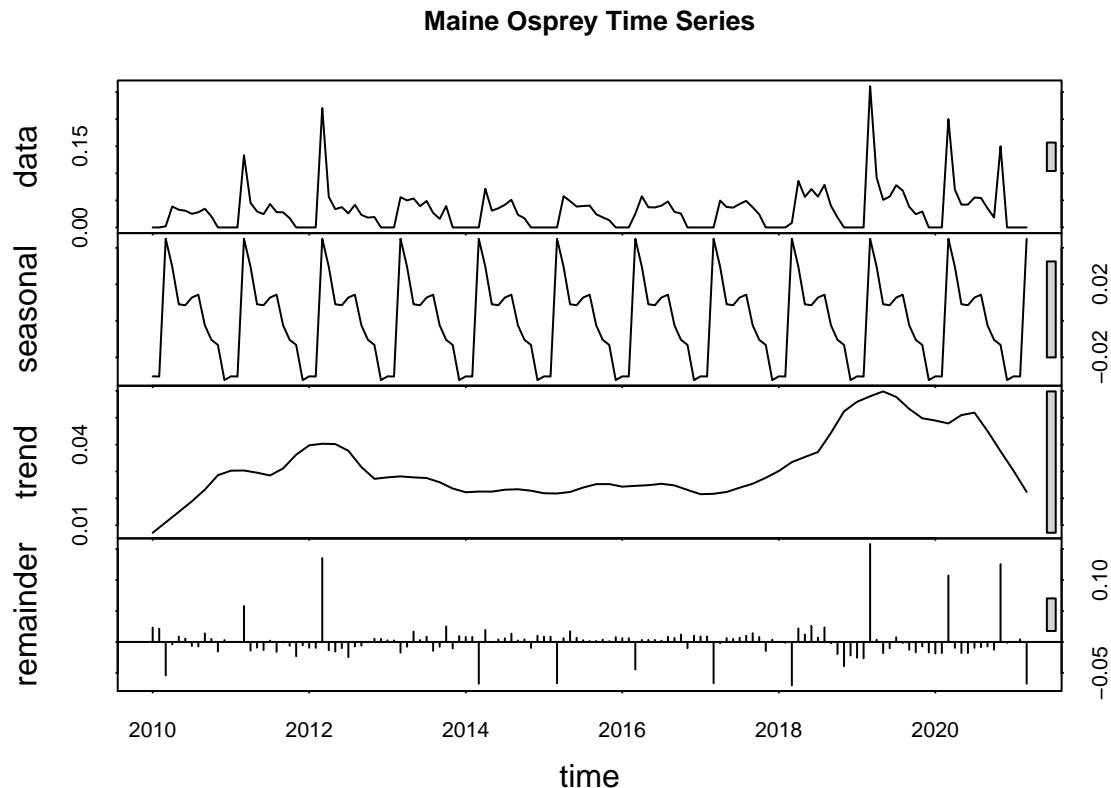
Time Series: The second approach is to construct a time series analysis for the observations. According to the time series analysis, each of the species showed both a strong seasonal component in observations, and a rising monotonic trend across the study period in Maine, according to the seasonal Mann-Kendall test (Osprey: $\tau = 0.389$, $p < 0.001$, Wood Duck: $\tau = 0.269$, $p < 0.001$, Red-Winged Blackbird: $\tau = 0.335$, $p < 0.001$). This rising trend may be due to increasing abundance of these species, but it may also be due to several confounding factors, including variability in observations by birders (e.g. location, time of day, or increasing expertise).

Each of the species had an influx of observations associated with spring migration (February-April). Wood

Ducks and Red-Winged Blackbird seasonal trends revealed two spikes, suggesting that most spring and fall observations are not from summer residents, but from migrating individuals from out-of-state. Osprey observations, on the other hand, had a relatively constant seasonal component for summer and fall.

```
#Osprey Time Series
OSPR.ts <- ts(OSPR_ME_month$observation_per_min_avg,
               start = c(2010,1), frequency = 12)

OSPR.ts.decomposed <- stl(OSPR.ts, s.window = "periodic")
# Visualize the decomposed series.
plot(OSPR.ts.decomposed, main = "Maine Osprey Time Series")
```



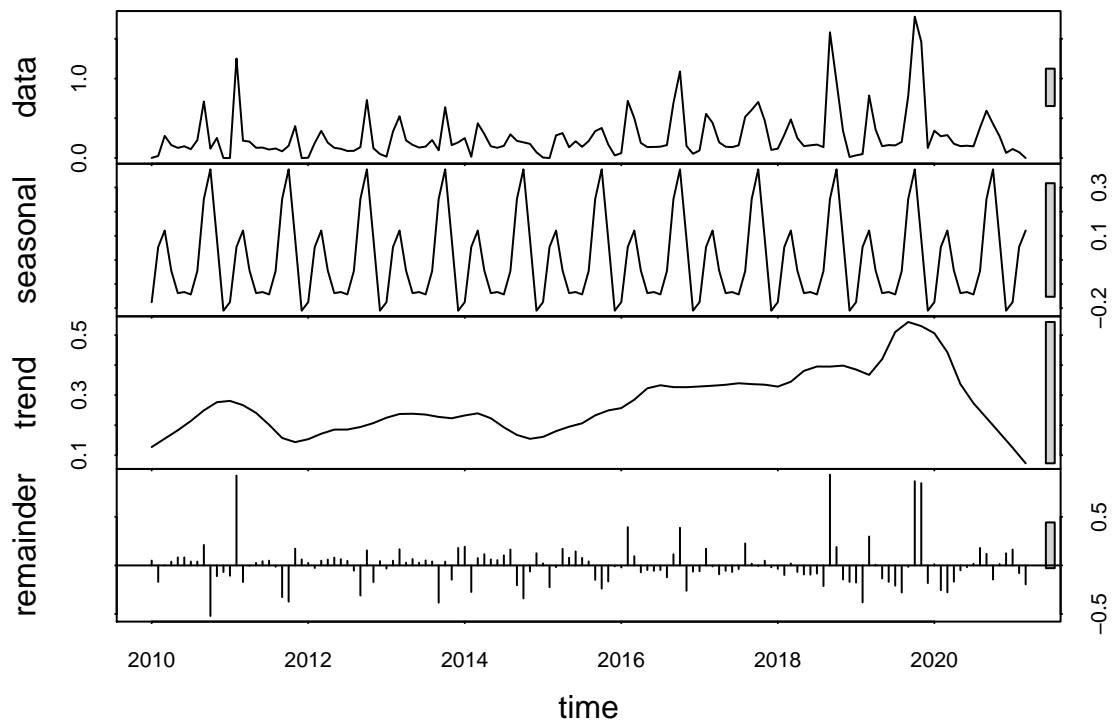
```
#Red-winged Blackbird Time Series
#remove outlier, interpolate
RWBL_ME_month$observation_per_min_avg[RWBL_ME_month$observation_per_min_avg > 3] <- NA

RWBL_ME_month <-
  RWBL_ME_month %>%
  mutate(observation_per_min_avg = zoo::na.approx(observation_per_min_avg))

RWBL.ts <- ts(RWBL_ME_month$observation_per_min_avg,
               start = c(2010,1), frequency = 12)

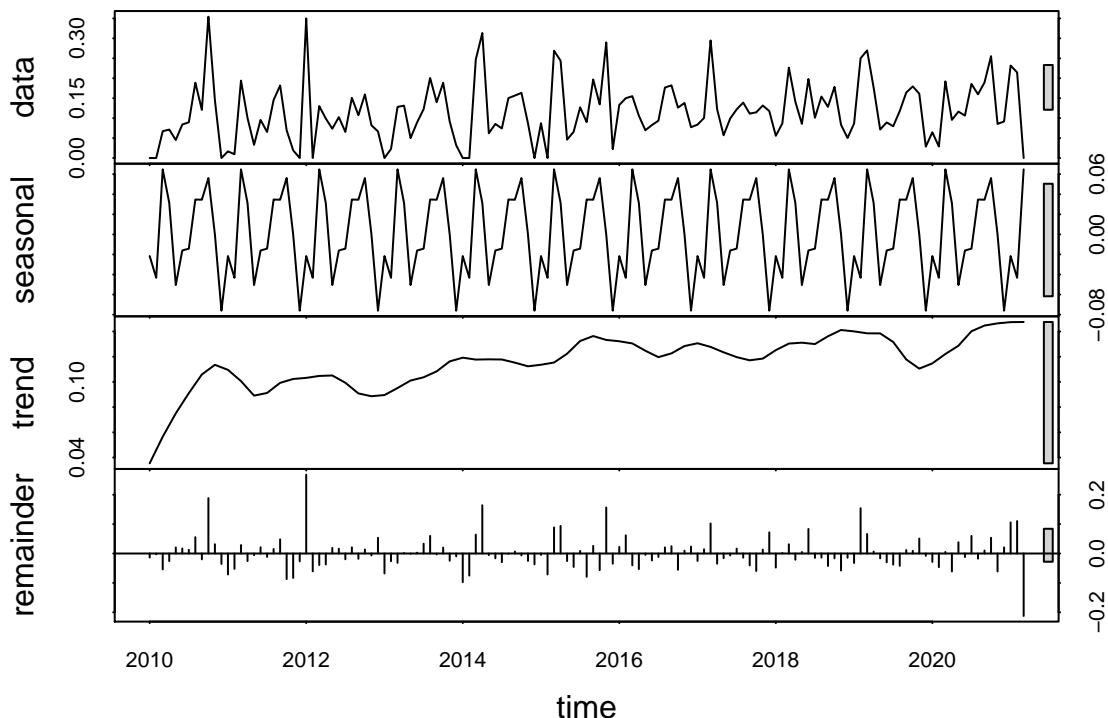
RWBL.ts.decomposed <- stl(RWBL.ts, s.window = "periodic")
# Visualize the decomposed series.
plot(RWBL.ts.decomposed, main = "Maine Red-Winged Blackbird Time Series")
```

Maine Red-Winged Blackbird Time Series



```
## Wood Duck
WODU.ts <- ts(WODU_ME_month$observation_per_min_avg,
                  start = c(2010,1), frequency = 12)
WODU.ts.decomposed <- stl(WODU.ts, s.window = "periodic")
# Visualize the decomposed series.
plot(WODU.ts.decomposed, main = "Maine Wood Duck Time Series")
```

Maine Wood Duck Time Series



```

## Create a table of the time-series data
monthly_OSPR_trend <- Kendall::SeasonalMannKendall(OSPR.ts)

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## WARNING: Error exit, tauk2. IFAULT = 12

#summary(monthly_OSPR_trend)
OSPR.ts.components <- as.data.frame(OSPR.ts.decomposed$time.series[,1:3])

monthly_WODU_trend <- Kendall::SeasonalMannKendall(WODU.ts)
#summary(monthly_WODU_trend)
WODU.ts.components <- as.data.frame(WODU.ts.decomposed$time.series[,1:3])

monthly_RWBL_trend <- Kendall::SeasonalMannKendall(RWBL.ts)
#summary(monthly_RWBL_trend)
RWBL.ts.components <- as.data.frame(RWBL.ts.decomposed$time.series[,1:3])

OSPR.ts.components$Species <- "Osprey"
OSPR.ts.components>Date <- OSPR_ME_month$Month_Year
WODU.ts.components$Species <- "Wood Duck"
WODU.ts.components>Date <- WODU.ts.components$Month_Year
RWBL.ts.components$Species <- "Red-Winged Blackbird"
RWBL.ts.components>Date <- RWBL.ts.components$Month_Year

OSPR_seasonal <- unique(OSPR.ts.components$seasonal)
WODU_seasonal <- unique(WODU.ts.components$seasonal)

```