Creel Survey - Stratified Random Sampling

Required Packages for this Vignette

Functions used in this chapter require loading the packages shown below.

```
library(dplyr)      ## for data manipulation
library(tidyr)      ## for data manipulation
library(lubridate)  ## for dates
library(magrittr)   ## for %<>%
library(suncalc)    ## for retrieving sunrise and sunset times
library(ggplot2)    ## for visualizations
```

Build Sampling Calendar

1. Create a vector of dates which should be sampled

```
## Define start and end dates
start_date <- "2023/03/01"
end_date <- "2023/10/31"
## Create vector based on start and end dates
date_vec <- seq.Date(as.Date(start_date), as.Date(end_date), "days")

## Load function to create a calendar data frame that can be merged with creel data files
source("scripts/calendar.R")

## Build calendar from start and end dates to assign DOW and holidays
cal <- create_calendar(start_date, end_date) %>%
  ## Assign week
  mutate(week = isoweek(date))
```

2. Find the sunrise and sunset times for a give location for each date in the vector defined above.

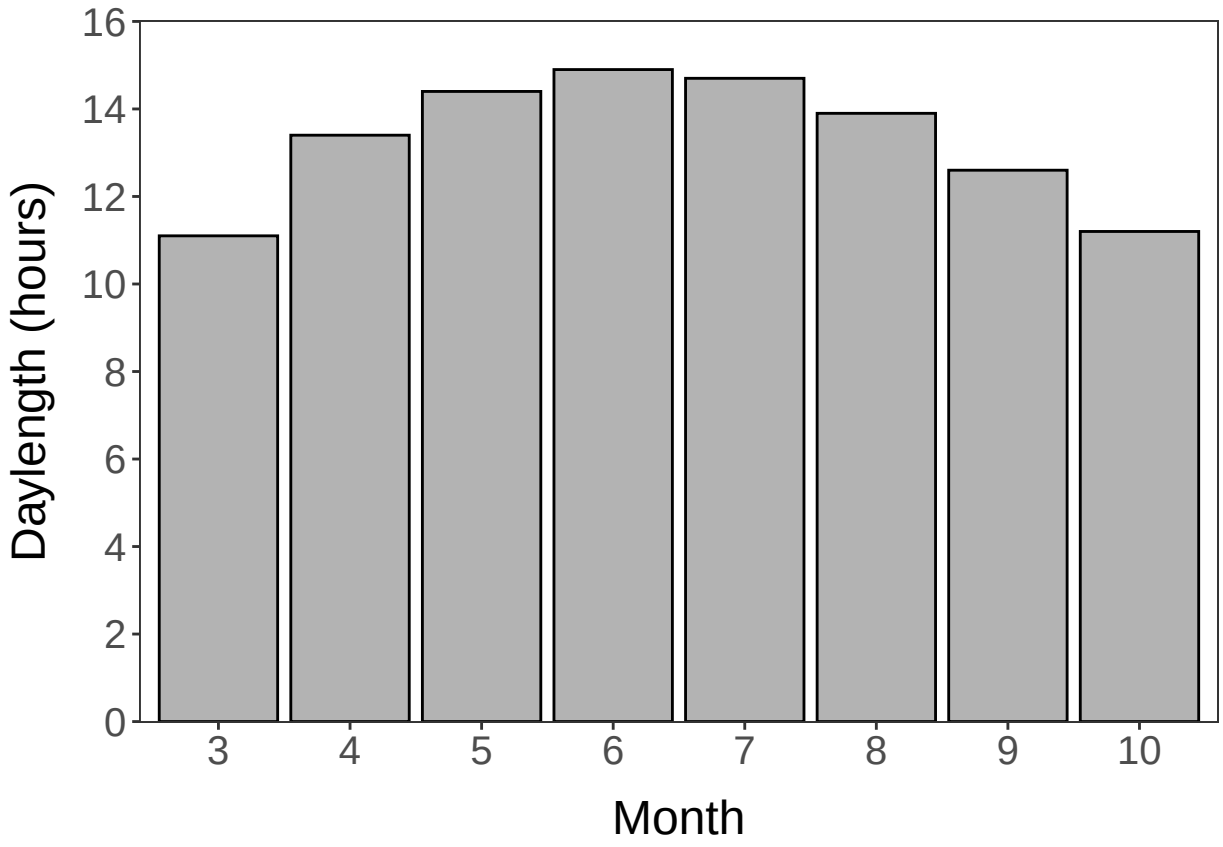
```
dat <- getSunlightTimes(date_vec, lat = 41.186126, lon = -111.381330,
                        keep = c("sunrise", "sunset"), tz = "America/Denver") %>%
  mutate(month = month(date))
## Display first six rows
head(dat)
```

```
##         date      lat       lon             sunrise              sunset month
## 1 2023-03-01 41.18613 -111.3813 2023-03-01 07:01:44 2023-03-01 18:17:01     3
## 2 2023-03-02 41.18613 -111.3813 2023-03-02 07:00:11 2023-03-02 18:18:11     3
## 3 2023-03-03 41.18613 -111.3813 2023-03-03 06:58:36 2023-03-03 18:19:20     3
## 4 2023-03-04 41.18613 -111.3813 2023-03-04 06:57:01 2023-03-04 18:20:28     3
## 5 2023-03-05 41.18613 -111.3813 2023-03-05 06:55:26 2023-03-05 18:21:36     3
## 6 2023-03-06 41.18613 -111.3813 2023-03-06 06:53:49 2023-03-06 18:22:44     3
```

Examine Daylength During Sampling Period

```
## Summarize the calendar
dat_sum <- dat %>% group_by(month) %>%
  ## find latest sunrise and earliest sunset in each month
  summarize(max_sunrise = max(sunrise),
            min_sunset = min(sunset)) %>%
  ## build sunrise and sunset variables with common date to calculate length of day
  mutate(sunrise_hour = hour(max_sunrise),
         sunrise_minute = minute(max_sunrise),
         sunrise_time = as.POSIXct(paste0(Sys.Date(), " ", sunrise_hour, ":",
                                          sunrise_minute), format = "%Y-%m-%d %H:%M"),
         sunset_hour = hour(min_sunset),
         sunset_minute = minute(min_sunset),
         sunset_time = as.POSIXct(paste0(Sys.Date(), " ", sunset_hour, ":",
                                         sunset_minute), format = "%Y-%m-%d %H:%M")) %>%
  ## calculate length of day in each month
  mutate(lod = round(sunset_time-sunrise_time, 1))

## plot
ggplot(dat_sum, aes(x = month, y = lod)) +
  geom_bar(stat = "identity", fill = "gray70", color = "black") +
  scale_x_continuous(limits = c(2.5, 10.5), breaks = seq(1, 12, 1), expand = c(0, 0.1)) +
  scale_y_continuous(limits = c(0, 16), breaks = seq(0, 16, 2), expand = c(0, 0.02)) +
  labs(y = "Daylength (hours)", x = "Month") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 18, margin = margin(10, 0, 0, 0)),
        axis.title.y = element_text(size = 18, margin = margin(0, 10, 0, 0)),
        axis.text.x = element_text(size = 15),
        axis.text.y = element_text(size = 15),
        panel.grid = element_blank(),
        plot.margin = margin(10, 10, 5, 5))
```

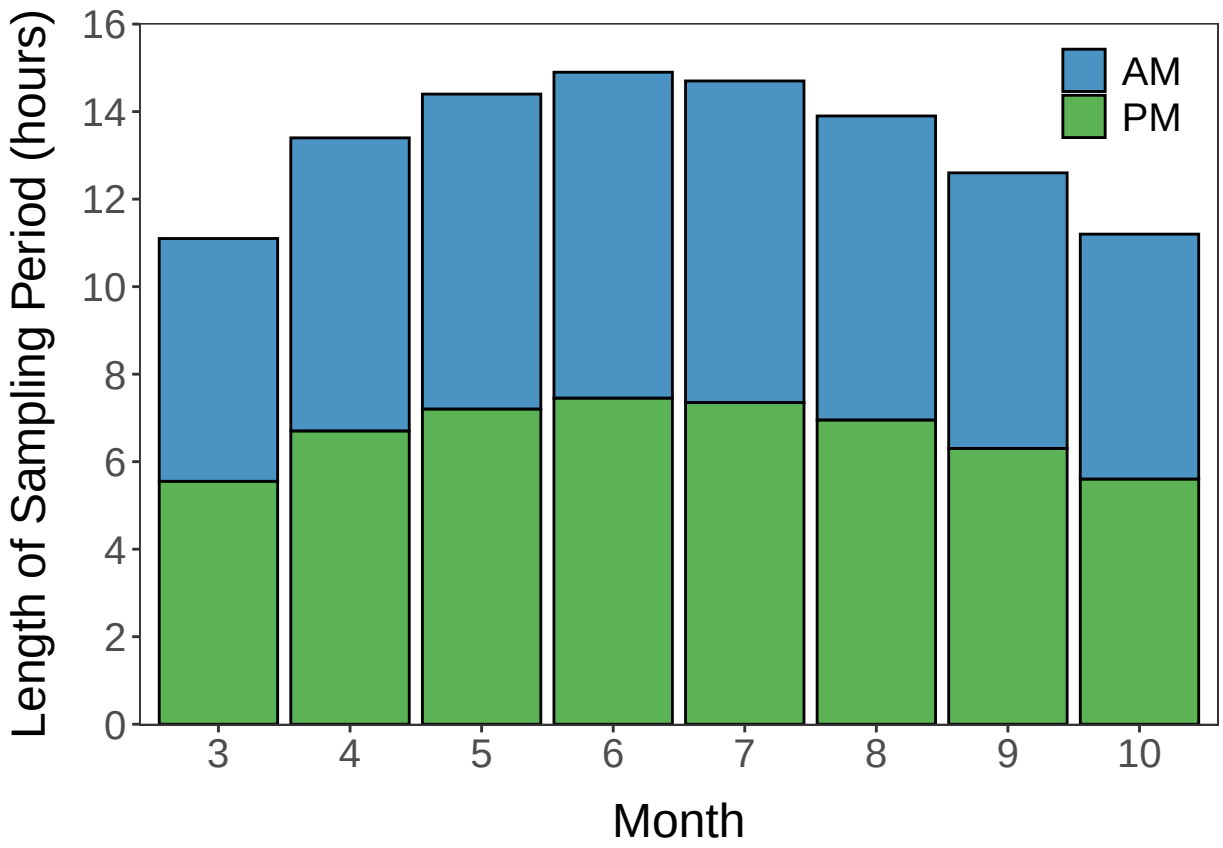


Add Time of Day Strata

```
dat_sum_strat <- dat_sum %>%
  mutate(losp = lod/2) %>%
  group_by_all() %>%
  expand(shift = c("AM", "PM")) %>%
  ungroup()

ggplot(dat_sum_strat, aes(x = month, y = losp, group = shift, fill = shift)) +
  geom_bar(stat = "identity", color = "black", alpha = 0.8) +
  scale_x_continuous(limits = c(2.5, 10.5), breaks = seq(1, 12, 1), expand = c(0, 0.1)) +
  scale_y_continuous(limits = c(0, 16), breaks = seq(0, 16, 2), expand = c(0, 0.02)) +
  scale_fill_manual(values = c("#1f78b4", "#33a02c")) +
  labs(y = "Length of Sampling Period (hours)", x = "Month") +
  theme_bw() +
  theme(axis.title.x = element_text(size = 18, margin = margin(10, 0, 0, 0)),
        axis.title.y = element_text(size = 18, margin = margin(0, 10, 0, 0)),
        axis.text.x = element_text(size = 15),
        axis.text.y = element_text(size = 15),
        legend.position = "inside",
        legend.position.inside = c(0.91, 0.9),
        legend.background = element_rect(fill = "transparent"),
        legend.title = element_blank(),
        legend.text = element_text(size = 15),
```

```
        panel.grid = element_blank(),
        plot.margin = margin(10, 10, 5, 5))
```



Create Randomized Sampling Calendar

```
## Restrict calendar to four weeks to simplify examples
cal <- cal %>%
  filter(week %in% 14:17)
```

Example 1: Stratified by Time of Day (TOD) and Day of Week (DOW)

```
## set seed to reproduce randomized results
set.seed(254929024)

tod_levels <- c("AM", "PM")

## randomly select two weekdays per week and randomly assign a stratification
## (e.g., AM vs PM) with equal probability
cal_wd_one <- cal %>% filter(dow == "wd") %>%
  # group by a variable to ensure equal distribution within the levels of
```

```
  # selected variable
  group_by(week) %>%
  # number of days
  slice_sample(n = 2) %>%
  ungroup() %>%
  # randomly assign strata
  mutate(shift = sample(rep(tod_levels, each = ceiling(n()/length(tod_levels))),
                        size = n(), replace = FALSE))

## randomly select six weekend days per month and randomly assign a stratification
## (e.g., AM vs PM) with equal probability
cal_we_one <- cal %>% filter(dow == "we") %>%
  # number of days
  slice_sample(n = 6) %>%
  ungroup() %>%
  # randomly assign strata
  mutate(shift = sample(rep(tod_levels, each = ceiling(n()/length(tod_levels))),
                        size = n(), replace = FALSE))

## Combine randomized calendar
cal_rand_one <- bind_rows(cal_wd_one, cal_we_one) %>%
  arrange(month, day)
```

date	year	month	day	wday	dow	week	shift
2023-04-03	2023	4	3	Monday	wd	14	PM
2023-04-05	2023	4	5	Wednesday	wd	14	AM
2023-04-08	2023	4	8	Saturday	we	14	AM
2023-04-09	2023	4	9	Sunday	we	14	PM
2023-04-11	2023	4	11	Tuesday	wd	15	AM
2023-04-13	2023	4	13	Thursday	wd	15	AM
2023-04-15	2023	4	15	Saturday	we	15	AM
2023-04-18	2023	4	18	Tuesday	wd	16	PM
2023-04-20	2023	4	20	Thursday	wd	16	PM
2023-04-22	2023	4	22	Saturday	we	16	PM
2023-04-23	2023	4	23	Sunday	we	16	AM
2023-04-24	2023	4	24	Monday	wd	17	AM
2023-04-28	2023	4	28	Friday	wd	17	PM
2023-04-30	2023	4	30	Sunday	we	17	PM

Example 3: Stratified by Time of Day (TOD), Day of Week (DOW), and Access Site

```
## set seed to reproduce randomized results
set.seed(32104934)

site_levels <- c("A", "B", "C")

## randomly select two weekdays per week and randomly assign both strata with
## equal probability
cal_wd_mult <- cal %>% filter(dow == "wd") %>%
```

```r
  # group by a variable to ensure equal distribution within the levels of
  # selected variable
  group_by(week) %>%
  # number of days
  slice_sample(n = 2) %>%
  ungroup() %>%
  # randomly assign strata (e.g., time of day and access point)
  mutate(shift = sample(rep(tod_levels, each = ceiling(n()/length(tod_levels))),
                        size = n(), replace = FALSE),
         site = sample(rep(site_levels, each = ceiling(n()/length(site_levels))),
                       size = n(), replace = FALSE))

## randomly select six weekend days per month and randomly assign both strata with
## equal probability
cal_we_mult <- cal %>% filter(dow == "we") %>%
  # number of days
  slice_sample(n = 6) %>%
  ungroup() %>%
  # randomly assign strata (e.g., time of day and access point)
  mutate(shift = sample(rep(tod_levels, each = ceiling(n()/length(tod_levels))),
                        size = n(), replace = FALSE),
         site = sample(rep(site_levels, each = ceiling(n()/length(site_levels))),
                       size = n(), replace = FALSE))

## Combine randomized calendar
cal_rand_mult <- bind_rows(cal_wd_mult, cal_we_mult) %>%
  arrange(month, day)
```

date	year	month	day	wday	dow	week	shift	site
2023-04-03	2023	4	3	Monday	wd	14	AM	C
2023-04-07	2023	4	7	Friday	wd	14	PM	B
2023-04-11	2023	4	11	Tuesday	wd	15	PM	B
2023-04-14	2023	4	14	Friday	wd	15	AM	A
2023-04-15	2023	4	15	Saturday	we	15	AM	A
2023-04-16	2023	4	16	Sunday	we	15	PM	C
2023-04-17	2023	4	17	Monday	wd	16	PM	A
2023-04-20	2023	4	20	Thursday	wd	16	AM	A
2023-04-22	2023	4	22	Saturday	we	16	AM	C
2023-04-23	2023	4	23	Sunday	we	16	PM	A
2023-04-24	2023	4	24	Monday	wd	17	AM	B
2023-04-27	2023	4	27	Thursday	wd	17	PM	C
2023-04-29	2023	4	29	Saturday	we	17	AM	B
2023-04-30	2023	4	30	Sunday	we	17	PM	B