

Preliminary analysis of the available data for BC Butterflies and Dragonflies with a comparison of the data available online from collections and the data available from iNaturalist

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Intro

We're trying to figure out where we should do the Southern Interior of BC's Dragonfly Count and Butterfly Count.

I'm not uploading the data to GitHub because they're fairly big files... let me know if you want them and I'll share.

Candidate locations

There are 3 Christmas Bird count locations that seem like they would be the best fit for hosting the Ode and Butt Counts. Apex Mountain, Oliver-Osoyoos, and Vaseux Lake.

First we'll get those circles.

For the Oliver-Osoyoos, and Vaseux Lake CBC circles we can use Dave Bell's CBC circles which I downloaded from his "(My Google Maps)[<https://www.google.com/maps/d/viewer?mid=1D49EyLXIFoIBQYS5rE6Fi9YTenb6H46A&ll=49.715363640775124%2C-119.40967101463359&z=8>]" and edited in OkanaganCBCcircles.R in this .RProj directory.

```
OliverOsoyoosCBC <- sf::st_read("data/NathanCBCkmls/OliverOsoyoosCBC_Circle.kml",
                                    layer = "OliverOsoyoosCBC_Circle",
                                    quiet = TRUE)
VaseuxLakeCBC <- sf::st_read("data/NathanCBCkmls/VaseuxLakeCBC_Circle.kml",
                               layer = "VaseuxLakeCBC_Circle",
                               quiet = TRUE)

## Reproject to EPSG:4326
OliverOsoyoosCBC_wgs84 <- sf::st_transform(OliverOsoyoosCBC, 4326)
VaseuxLakeCBC_wgs84 <- sf::st_transform(VaseuxLakeCBC, 4326)
```

Dave does not have a circle for apex so I'm approximating the centroid of the circles on the Birds Canada CBC map and rolling with that.

```
## Set the centroid (Note: this is approximate)
ApexCentroid <- sf::st_sf(
  sf::st_point(c(-119.911581, 49.308790)), # lon, lat
  crs = 4326)

## Project to EPSG:3005 = BC Albers
ApexCentroid_proj <- sf::st_transform(ApexCentroid, 3005)
```

```

## Make the circle (12km radius)
ApexCBCcircle <- sf::st_buffer(ApexCentroid_proj, dist = 12000)

## Reproject to EPSG:4326
ApexCBCcircle_wgs84 <- sf::st_transform(ApexCBCcircle, 4326)

```

Data in Collections

Odonata data from Gibson et al (2024)

Now that we have the circles lets bring in the digitized Odonata holdings of the BC Entomology Collections from Gibson et al (2024; Can. Entomol. 156(e42): 1–16. doi:10.4039/tce.2024.38).

```

## Read in Gibson data
GibsonDF <- read.csv("data/GibsonData/Gibson2024CanEntSup002.csv")

## Remove rows with NA Lat Long data
GibsonDF <- GibsonDF %>%
  dplyr::filter(!is.na(Longitude), !is.na(Latitude))

## Restrict the dataset to just BC records
GibsonBC <- GibsonDF %>%
  dplyr::filter(Prov_State == "British Columbia")

## Finally we need to make sure that the Gibson data are in the right projection
GibsonBC_sf <- GibsonBC %>%
  sf::st_as_sf(coords = c("Longitude", "Latitude"),
               crs = 4326,
               remove = FALSE)

```

Now that we've got that sorted we can subset the data in the Gibson dataset to those records within these circles.

```

## Filter the data to the circles
ApexOdeRecords <- GibsonBC_sf %>%
  dplyr::filter(sf::st_intersects(., ApexCBCcircle_wgs84, sparse = FALSE)[, 1])
OliverOdeRecords <- GibsonBC_sf %>%
  dplyr::filter(sf::st_intersects(., OliverOsoyoosCBC_wgs84, sparse = FALSE)[, 1])
VaseuxOdeRecords <- GibsonBC_sf %>%
  dplyr::filter(sf::st_intersects(., VaseuxLakeCBC_wgs84, sparse = FALSE)[, 1])

```

Now we can do some quick summary stats to see how much data is in each dataset

```

## How many specimens in each circle
nrow(ApexOdeRecords)

## [1] 18
nrow(OliverOdeRecords)

## [1] 987
nrow(VaseuxOdeRecords)

## [1] 806
## How many species (ItemName) in each circle
length(unique(ApexOdeRecords$ItemName))

```

```

## [1] 4
length(unique(OliverOdeRecords$ItemName))

## [1] 50
length(unique(VaseuxOdeRecords$ItemName))

## [1] 49
## Now lets see how many of each species
ApexOdeRecSppCounts <- ApexOdeRecords %>%
  dplyr::group_by(ItemName) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
OliverOdeRecSppCounts <- OliverOdeRecords %>%
  dplyr::group_by(ItemName) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
VaseuxOdeRecSppCounts <- VaseuxOdeRecords %>%
  dplyr::group_by(ItemName) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))

## What are the top 5 spp and how many records do they have?
head(sf::st_drop_geometry(ApexOdeRecSppCounts))

## # A tibble: 4 x 2
##   ItemName           count
##   <chr>              <int>
## 1 Somatochlora semicircularis     6
## 2 Aeshna juncea                 5
## 3 Leucorrhinia hudsonica       5
## 4 Somatochlora albicincta       2

head(sf::st_drop_geometry(OliverOdeRecSppCounts))

## # A tibble: 6 x 2
##   ItemName           count
##   <chr>              <int>
## 1 Enallagma annexum      101
## 2 Enallagma ebrium        65
## 3 Sympetrum occidentale    63
## 4 Enallagma carunculatum    53
## 5 Ischnura cervula        51
## 6 Sympetrum costiferum      46

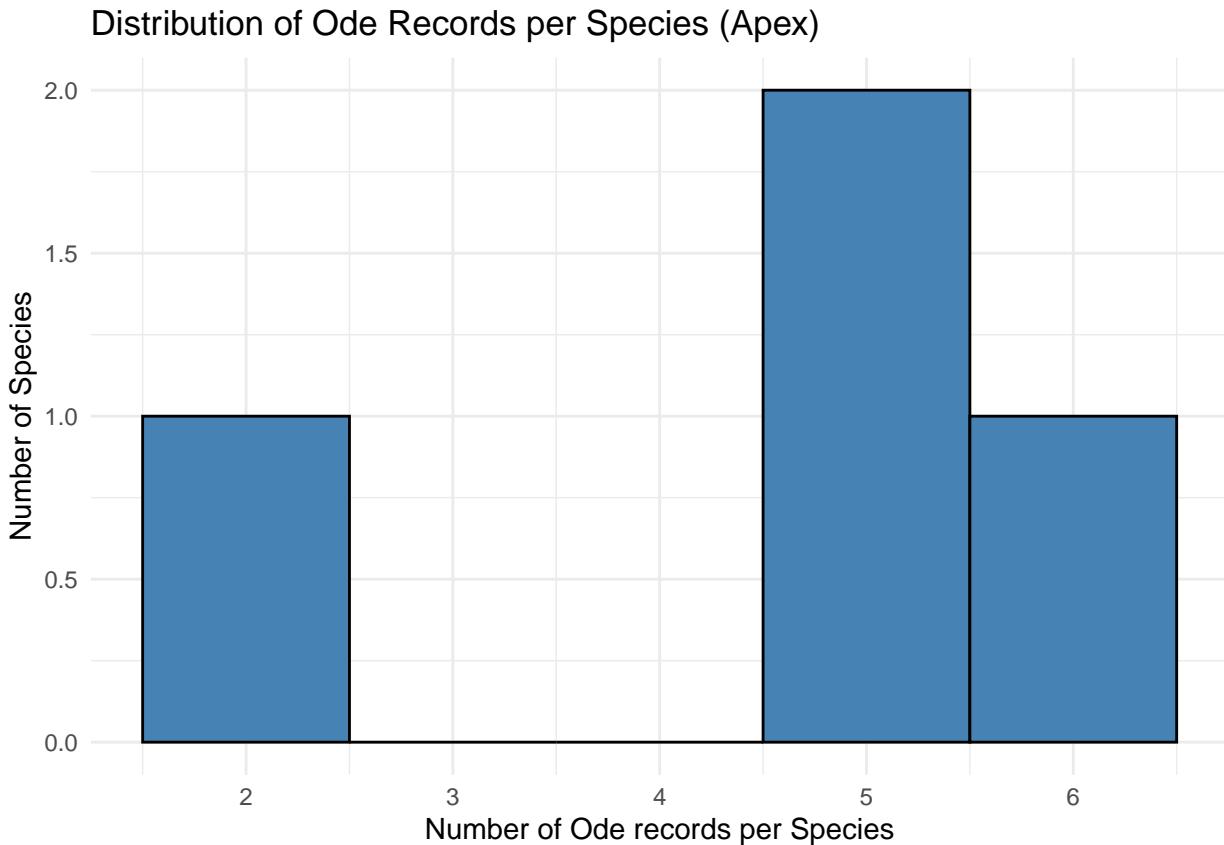
head(sf::st_drop_geometry(VaseuxOdeRecSppCounts))

## # A tibble: 6 x 2
##   ItemName           count
##   <chr>              <int>
## 1 Ischnura cervula      73
## 2 Amphiagrion abbreviatum    61
## 3 Enallagma boreale        49
## 4 Enallagma annexum        39
## 5 Lestes disjunctus         38
## 6 Sympetrum obtrusum        37

```

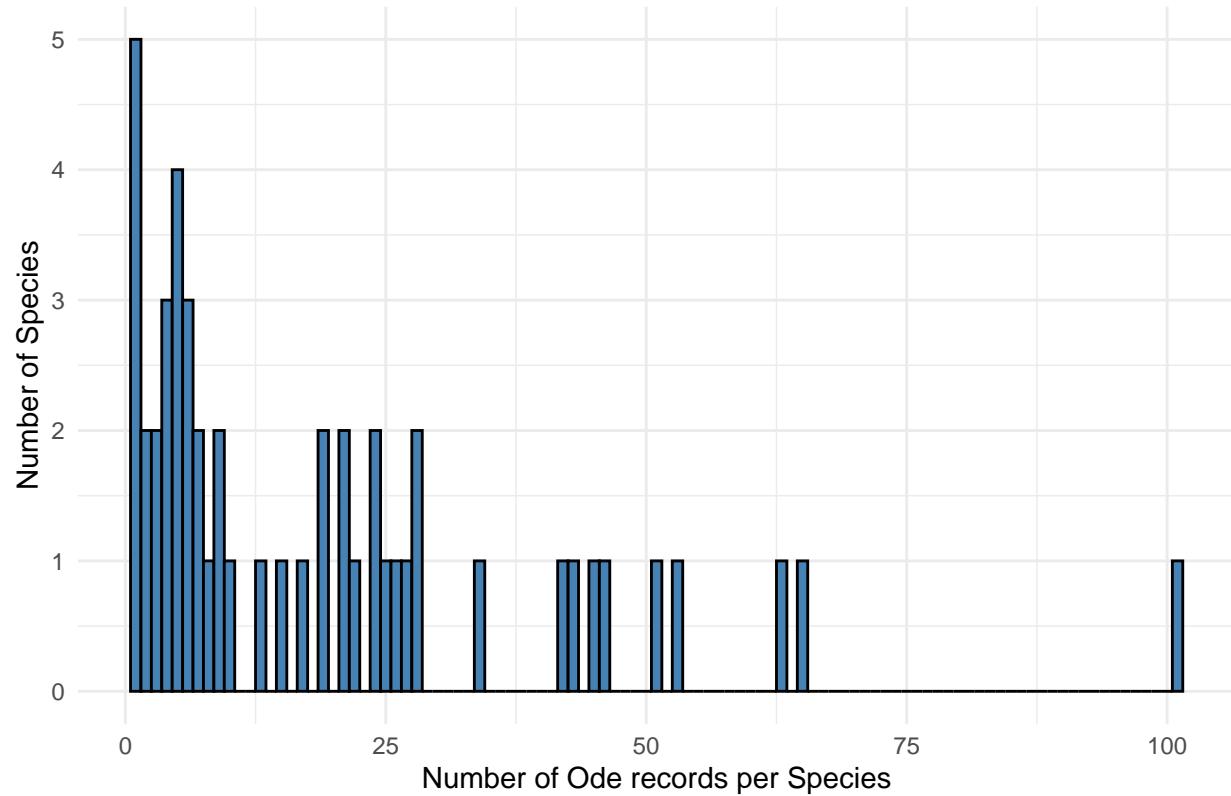
How many species have 1 specimen, 2 specimens, etc?

```
ggplot(ApexOdeRecSppCounts, aes(x = count)) +  
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +  
  labs(  
    x = "Number of Ode records per Species",  
    y = "Number of Species",  
    title = "Distribution of Ode Records per Species (Apex)"  
) +  
  theme_minimal()
```



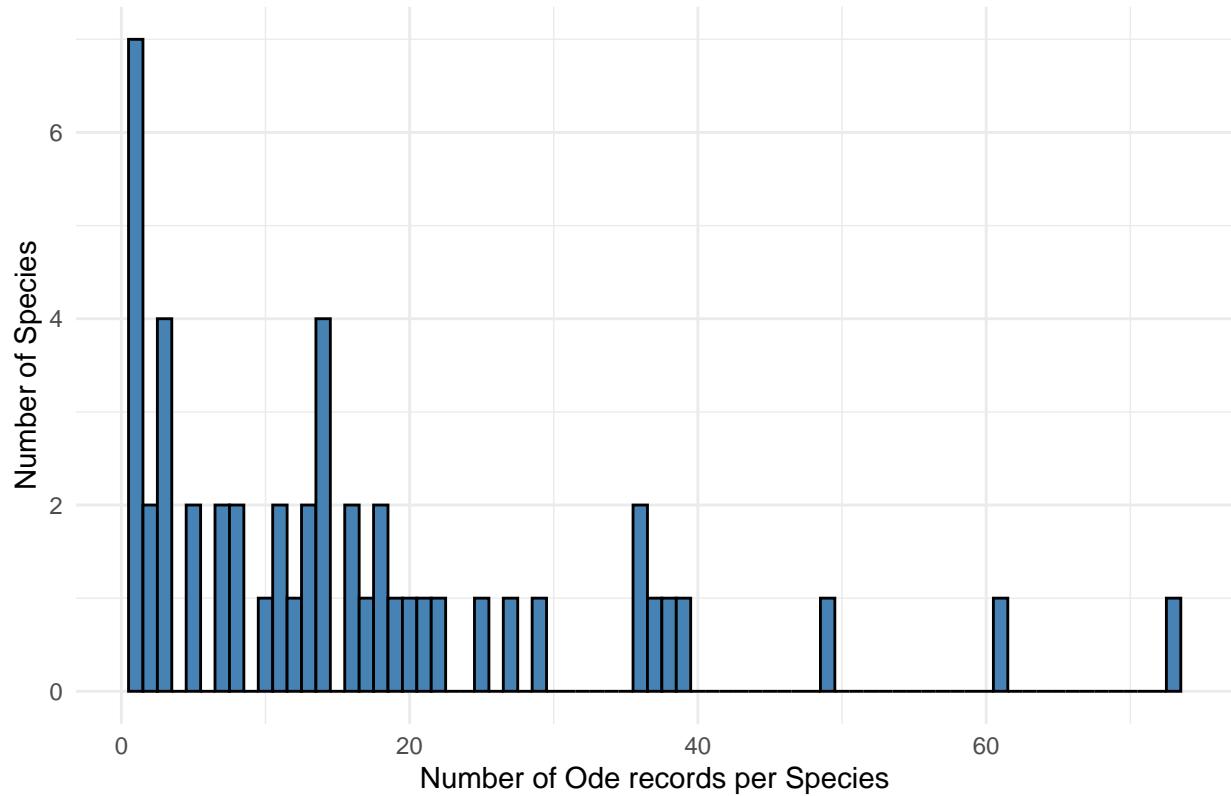
```
ggplot(OliverOdeRecSppCounts, aes(x = count)) +  
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +  
  labs(  
    x = "Number of Ode records per Species",  
    y = "Number of Species",  
    title = "Distribution of Ode Records per Species (Oliver)"  
) +  
  theme_minimal()
```

Distribution of Ode Records per Species (Oliver)



```
ggplot(VaseuxOdeRecSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Ode records per Species",
    y = "Number of Species",
    title = "Distribution of Ode Records per Species (Vaseux)"
  ) +
  theme_minimal()
```

Distribution of Ode Records per Species (Vaseux)



Now we know what's going on in the BC ode collections according to Gibson et al (2024) for these circles.

Butterfly data from GBIF

Now that we have the circles lets bring in the digitized butterfly data available on GBIF.

```
## Make a download request for GBIF data... I'm using an occ_download
## instead of an occ_search because i) it lets me pull multiple families
## and ii) it lets me exclude iNat data explicitly.
# dl <- rgbif::occ_download(
#   pred_in("taxonKey", c(6951,      ## Hedyliidae
#           6953,      ## Hesperiidae
#           5473,      ## Lycaenidae
#           7017,      ## Nymphalidae
#           9417,      ## Papilionidae
#           5481,      ## Pieridae
#           1933999    ## Riodinidae
#   )),
#   pred("GADM_GID", "CAN.2_1"),
#   pred("hasCoordinate", TRUE),
#   pred_not(
#     pred("publishingOrg", "28eb1a3f-1c15-4a95-931a-4af90ecb574d")
#   ),
#   format = "SIMPLE_CSV",
#   user  = Sys.getenv("GBIF_USER"),
#   pwd   = Sys.getenv("GBIF_PWD"),
#   email = Sys.getenv("GBIF_EMAIL"))
```

```

#
# ## Check the status of that download with
# occ_download_wait(dl)
#
# ## get some metadata
# meta <- occ_download_meta(dl)
#
# ## get that download
# d <- occ_download_get(dl) %>%
#   occ_download_import()
#
# ## Finally we need to make sure that the Gibson data are in the right projection
# GbifButtData_sf <- d %>%
#   dplyr::rename(Longitude = decimalLongitude,
#                 Latitude = decimalLatitude) %>%
#   sf::st_as_sf(coords = c("Longitude", "Latitude"),
#               crs = 4326,
#               remove = FALSE)
#
# ## Write this into the data
# saveRDS(GbifButtData_sf, "data/GbifData/GbifButtData_sf.rds")

## Read the data back in
GbifButtData <- readRDS("data/GbifData/GbifButtData_sf.rds")

## Remove obs that aren't IDed to spp
GbifButtData <- GbifButtData %>%
  dplyr::filter(!is.na(species) & species != "")

```

The GBIF download DOI is `meta$doi`.

Now that we've got that sorted we can subset the data in the GBIF dataset to those records within these circles.

```

## Filter the data to the circles
ApexButtRecords <- GbifButtData %>%
  dplyr::filter(sf::st_intersects(., ApexCBCcircle_wgs84, sparse = FALSE)[, 1])
OliverButtRecords <- GbifButtData %>%
  dplyr::filter(sf::st_intersects(., OliverOsoyoosCBC_wgs84, sparse = FALSE)[, 1])
VaseuxButtRecords <- GbifButtData %>%
  dplyr::filter(sf::st_intersects(., VaseuxLakeCBC_wgs84, sparse = FALSE)[, 1])

```

Now we can do some quick summary stats to see how much data is in each dataset

```

## How many specimens in each circle
nrow(ApexButtRecords)

## [1] 1810
nrow(OliverButtRecords)

## [1] 5258
nrow(VaseuxButtRecords)

## [1] 1605

```

```

## How many species in each circle
length(unique(ApexButtRecords$species))

## [1] 104
length(unique(OliverButtRecords$species))

## [1] 132
length(unique(VaseuxButtRecords$species))

## [1] 101
## Now lets see how many of each species
ApexButtRecSppCounts <- ApexButtRecords %>%
  dplyr::group_by(species) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
OliverButtRecSppCounts <- OliverButtRecords %>%
  dplyr::group_by(species) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
VaseuxButtRecSppCounts <- VaseuxButtRecords %>%
  dplyr::group_by(species) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))

## What are the top 5 spp and how many records do they have?
head(sf::st_drop_geometry(ApexButtRecSppCounts))

## # A tibble: 6 x 2
##   species           count
##   <chr>              <int>
## 1 Parnassius smintheus    313
## 2 Erybia vidleri       151
## 3 Parnassius clodius     148
## 4 Occidryas anicia      136
## 5 Erybia epipsodea      115
## 6 Hesperia comma         63
head(sf::st_drop_geometry(OliverButtRecSppCounts))

## # A tibble: 6 x 2
##   species           count
##   <chr>              <int>
## 1 Pieris rapae        519
## 2 Coenonympha tullia    417
## 3 Colias philodice     314
## 4 Ochlodes sylvanoides   265
## 5 Strymon melinus       213
## 6 Icaricia icarioides    168
head(sf::st_drop_geometry(VaseuxButtRecSppCounts))

## # A tibble: 6 x 2
##   species           count
##   <chr>              <int>

```

```

## 1 Pieris rapae      205
## 2 Coenonympha tullia    170
## 3 Ochlodes sylvanoides   152
## 4 Colias philodice     103
## 5 Nymphalis antiopa      95
## 6 Erebia epipsodea       64

```

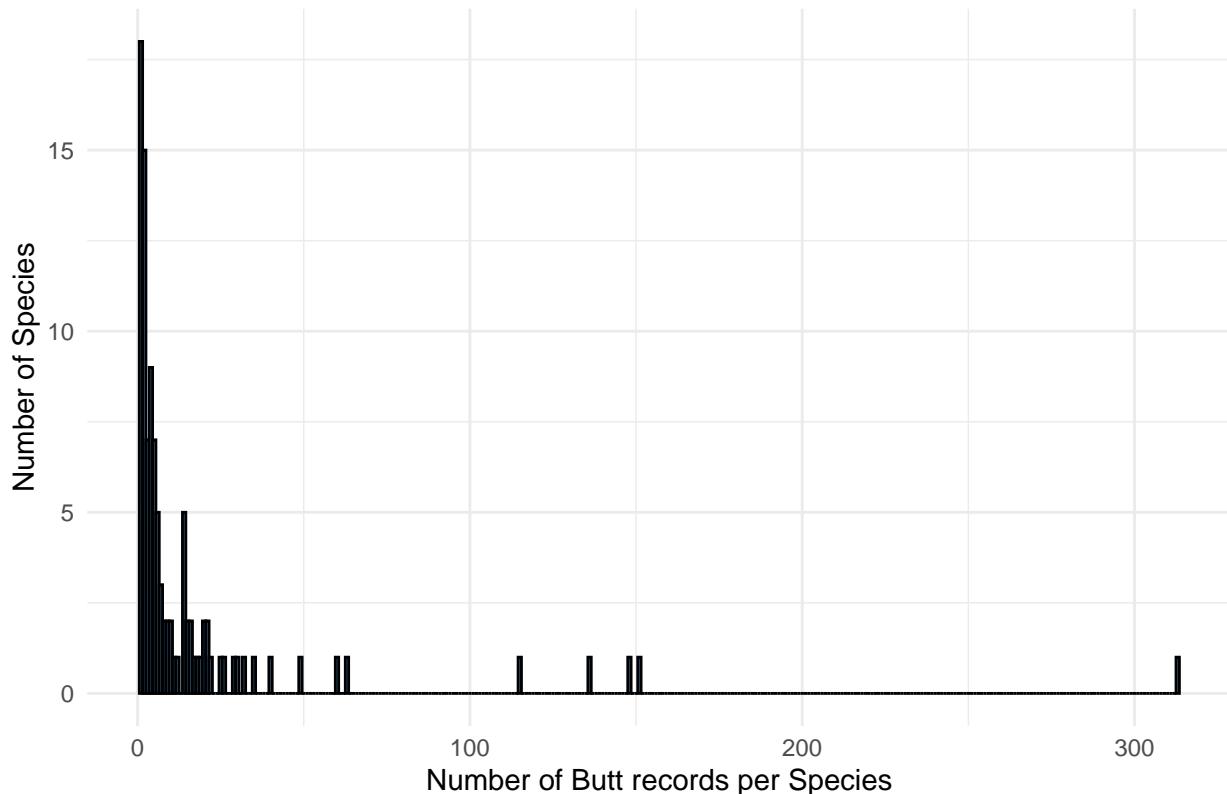
How many species have 1 specimen, 2 specimens, etc?

```

ggplot(ApexButtRecSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Butt records per Species",
    y = "Number of Species",
    title = "Distribution of Butt Records per Species (Apex)"
  ) +
  theme_minimal()

```

Distribution of Butt Records per Species (Apex)

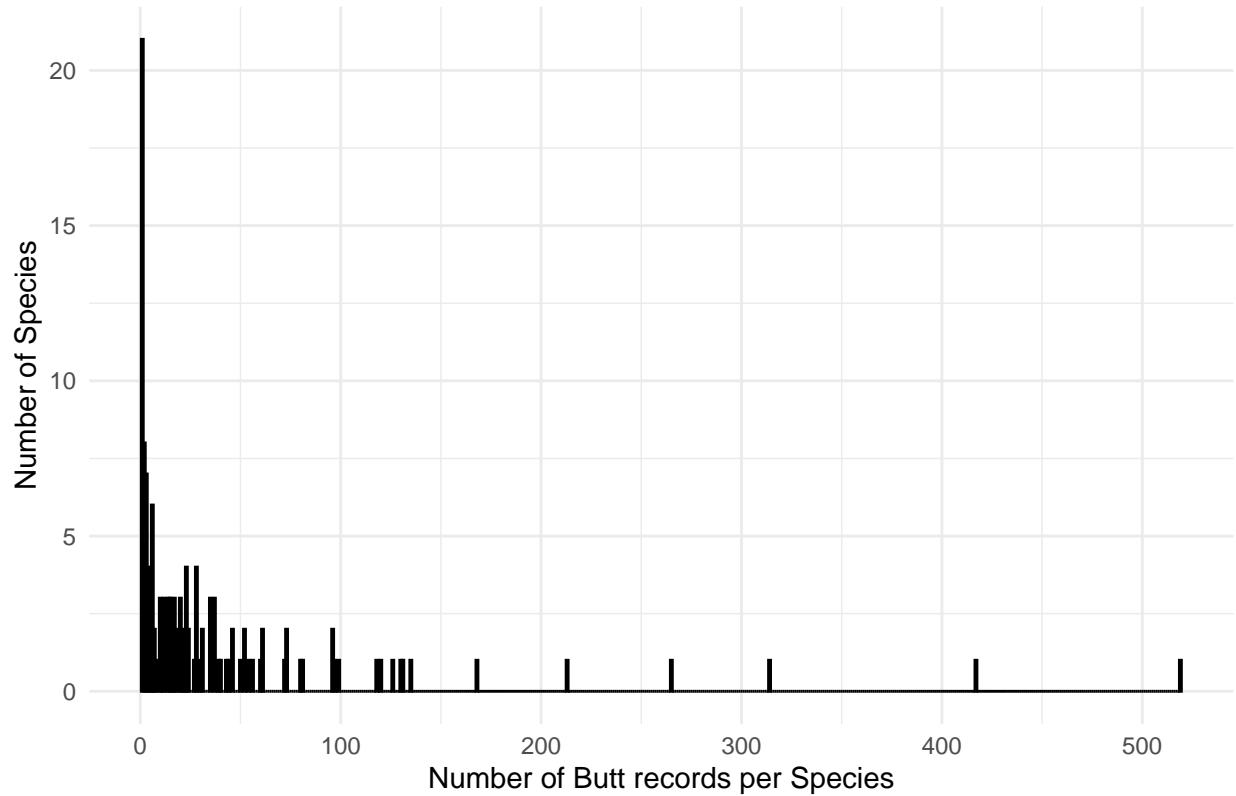


```

ggplot(OliverButtRecSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Butt records per Species",
    y = "Number of Species",
    title = "Distribution of Butt Records per Species (Oliver)"
  ) +
  theme_minimal()

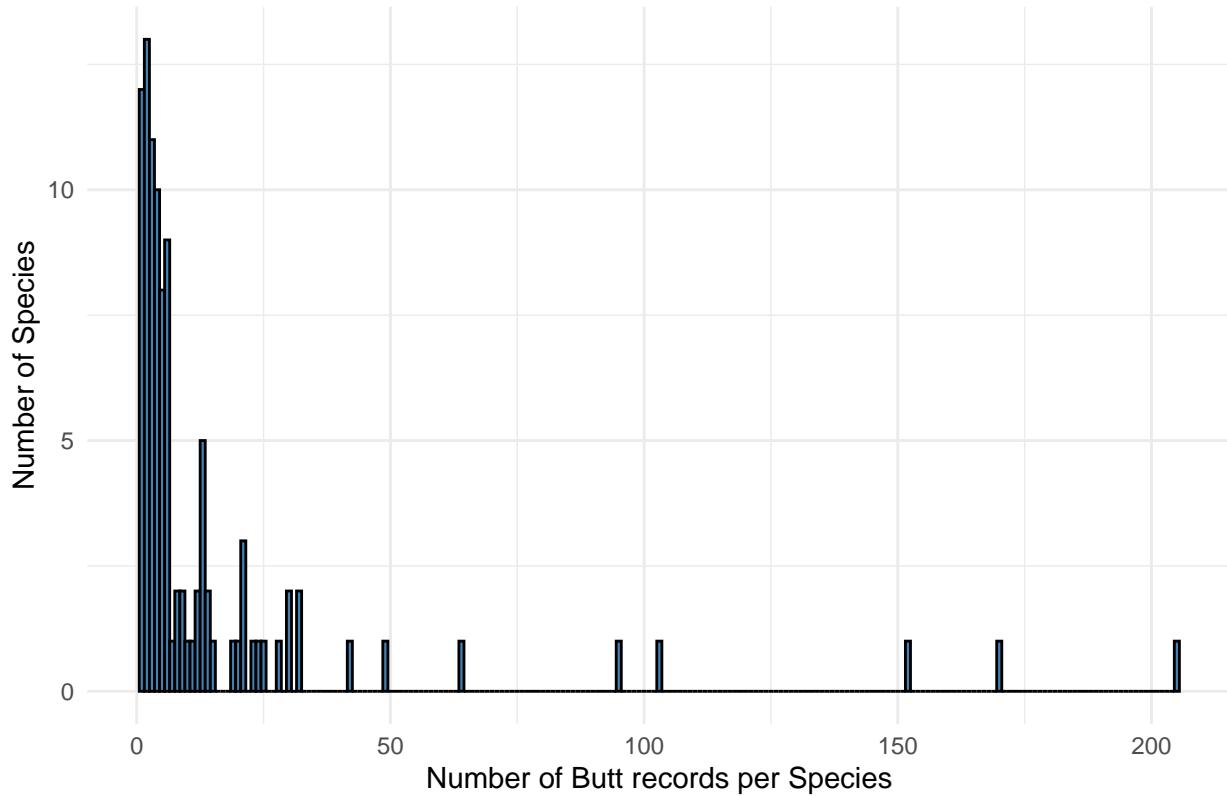
```

Distribution of Butt Records per Species (Oliver)



```
ggplot(VaseuxButtRecSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Butt records per Species",
    y = "Number of Species",
    title = "Distribution of Butt Records per Species (Vaseux)"
  ) +
  theme_minimal()
```

Distribution of Butt Records per Species (Vaseux)



Now we know what's going on in the BC Butt collections according to GBIF for these circles.

Data on iNaturalist

Lets look at iNat to see how many records there are in the iNat dataset for Odonata and Papilioidea. This dataset is much younger but will likely have more recent data. The data we'll use were downloaded from iNaturalist through the Export function on 2026-01-13. Note, some of these records are obscured... we'll start by not removing them but keep that in mind.

Odonate iNat data

Now we'll read in the iNat data.

```
## Read in the data
iNatOdeDF <- read.csv("data/iNatData/iNatOdesBC2026JAN13.csv")

## Keep only research grade obs
iNatOdeRG <- iNatOdeDF %>%
  dplyr::filter(quality_grade == "research")

## Keep only CCO, CC-BY, CC-BY-NC records so you don't go to jail for 1B years
iNatOdeRG_CC <- iNatOdeRG %>%
  dplyr::filter(license %in% c("CC0", "CC-BY", "CC-BY-NC"))

## Remove read.csv2()## Remove all data with big (>5km) or NA accuracy
iNatOdeRG_CC_acc <- iNatOdeRG_CC %>%
  dplyr::filter(positional_accuracy < 5000)
```

```

## Change the Lat and long columns to Lat and Long
iNatOdeRG_CC_acc <- iNatOdeRG_CC_acc %>%
  dplyr::rename("Longitude" = "longitude") %>%
  dplyr::rename("Latitude" = "latitude")

## Finally we need to make sure that the iNat data are in the right projection
iNatOde_sf <- iNatOdeRG_CC_acc %>%
  sf::st_as_sf(coords = c("Longitude", "Latitude"),
               crs = 4326,
               remove = FALSE)

```

Now that we have the iNat data read in and cleaned lets filter to the same circles as before.

```

## Filter the data to the circles
ApexOdeObs <- iNatOde_sf %>%
  dplyr::filter(sf::st_intersects(., ApexCBCcircle_wgs84, sparse = FALSE)[, 1])
OliverOdeObs <- iNatOde_sf %>%
  dplyr::filter(sf::st_intersects(., OliverOsoyoosCBC_wgs84, sparse = FALSE)[, 1])
VaseuxOdeObs <- iNatOde_sf %>%
  dplyr::filter(sf::st_intersects(., VaseuxLakeCBC_wgs84, sparse = FALSE)[, 1])

```

Now we can do some quick summary stats to see how much data is in each dataset

```

## How many specimens in each circle
nrow(ApexOdeObs)

## [1] 2
nrow(OliverOdeObs)

## [1] 358
nrow(VaseuxOdeObs)

## [1] 461
## How many species (scientific_name) in each circle
length(unique(ApexOdeObs$scientific_name))

## [1] 1
length(unique(OliverOdeObs$scientific_name))

## [1] 40
length(unique(VaseuxOdeObs$scientific_name))

## [1] 44
## Now lets see how many of each species
ApexOdeObsSppCounts <- ApexOdeObs %>%
  dplyr::group_by(scientific_name) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
OliverOdeObsSppCounts <- OliverOdeObs %>%
  dplyr::group_by(scientific_name) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
VaseuxOdeObsSppCounts <- VaseuxOdeObs %>%

```

```

dplyr::group_by(scientific_name) %>%
dplyr::summarise(count = n(), .groups = "drop") %>%
dplyr::arrange(dplyr::desc(count))

## What are the top 5 spp and how many records do they have?
head(sf::st_drop_geometry(ApexOdeObsSppCounts))

## # A tibble: 1 x 2
##   scientific_name     count
##   <chr>              <int>
## 1 Libellula forensis      2

head(sf::st_drop_geometry(OliverOdeObsSppCounts))

## # A tibble: 6 x 2
##   scientific_name     count
##   <chr>              <int>
## 1 Argia emma          56
## 2 Libellula forensis    41
## 3 Libellula pulchella    30
## 4 Sympetrum corruptum    23
## 5 Ischnura cervula      18
## 6 Pachydiplax longipennis    16

head(sf::st_drop_geometry(VaseuxOdeObsSppCounts))

## # A tibble: 6 x 2
##   scientific_name     count
##   <chr>              <int>
## 1 Libellula forensis      71
## 2 Rhionaeschna californica    42
## 3 Ischnura cervula        36
## 4 Libellula quadrimaculata    33
## 5 Argia emma            25
## 6 Aeshna palmata         24

```

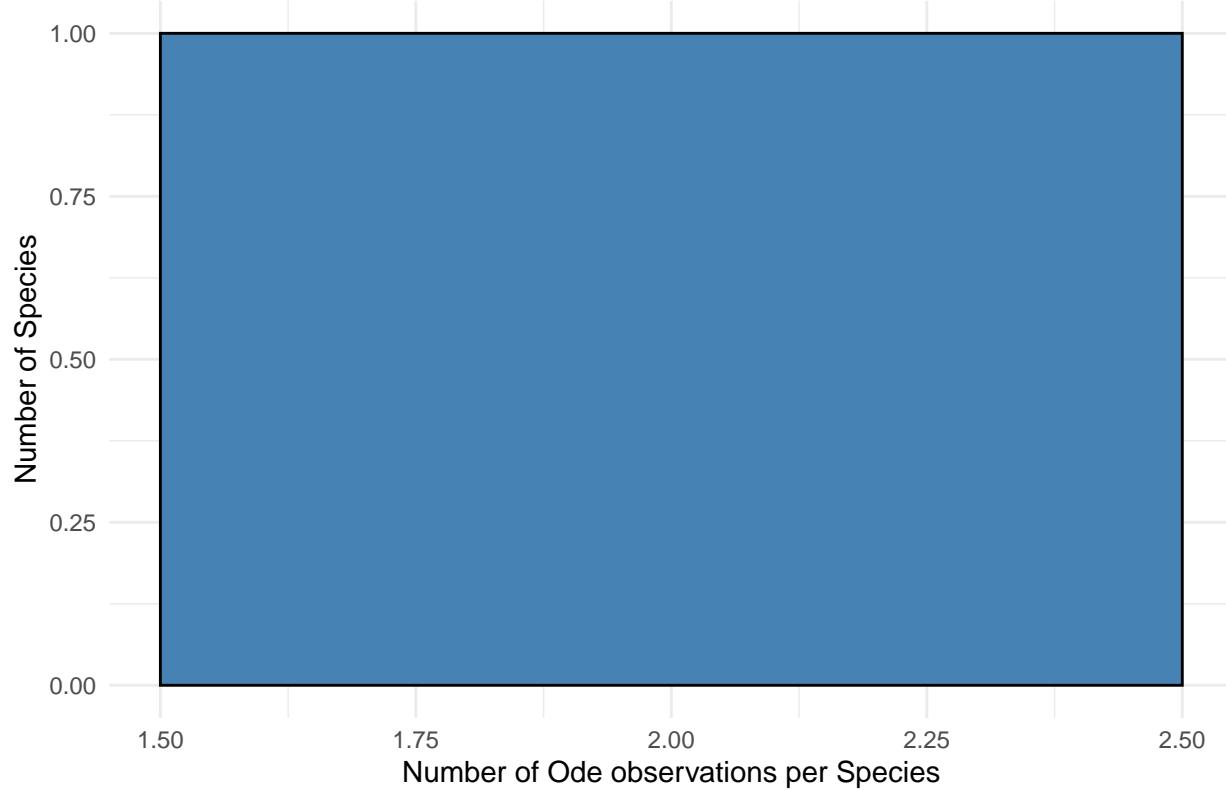
How many species have 1 specimen, 2 specimens, etc?

```

ggplot(ApexOdeObsSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Ode observations per Species",
    y = "Number of Species",
    title = "Distribution of Ode Observations per Species (Apex)"
  ) +
  theme_minimal()

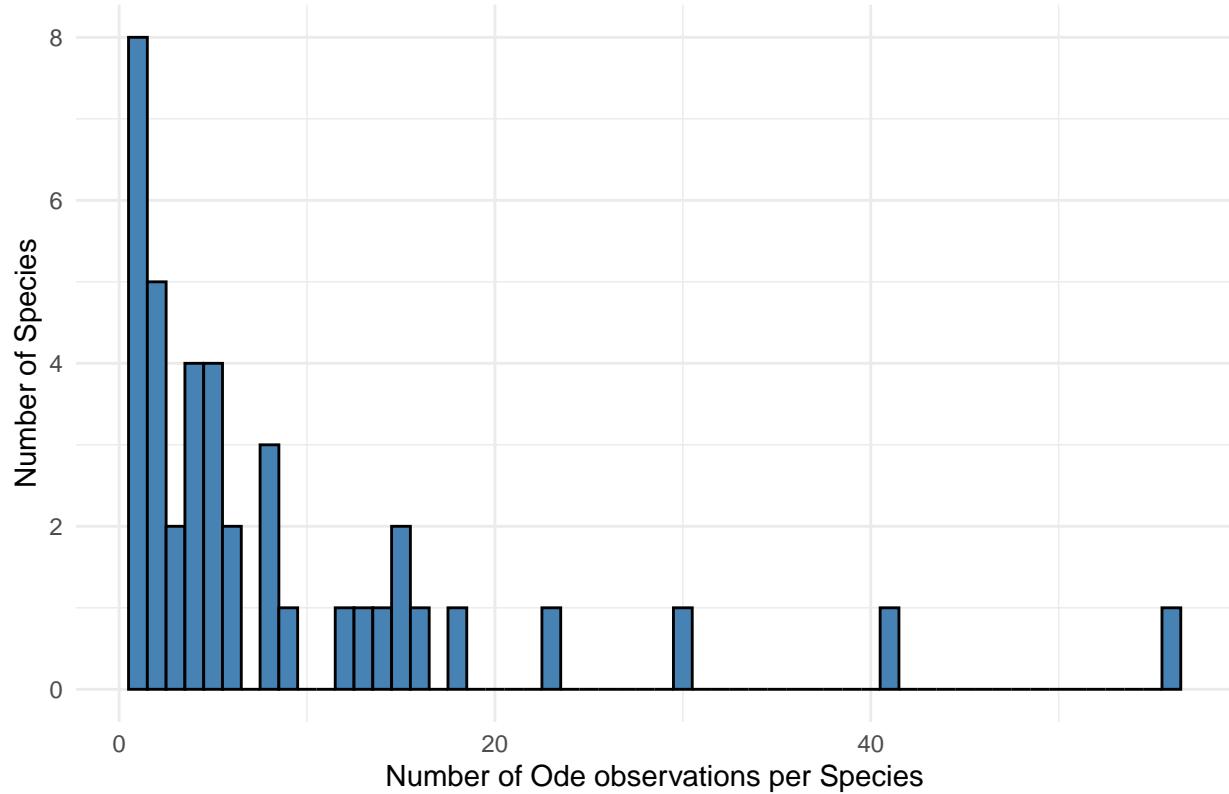
```

Distribution of Ode Observations per Species (Apex)



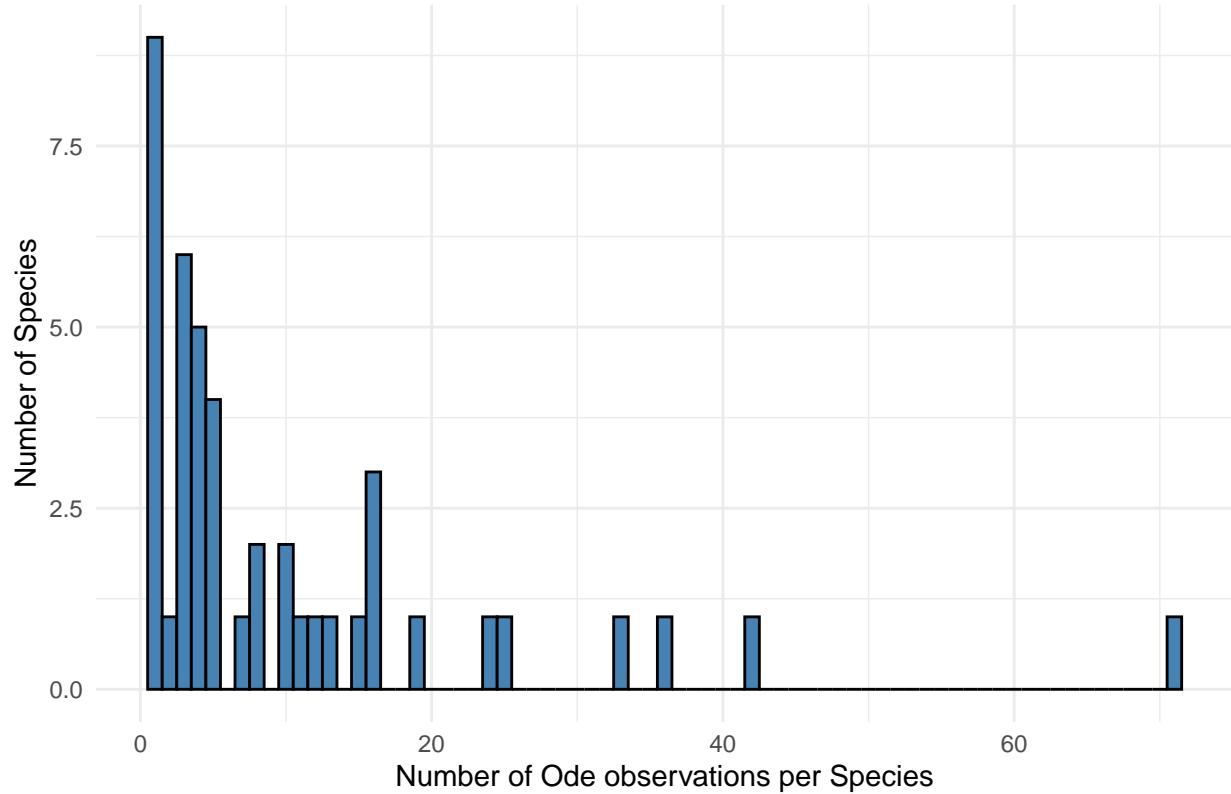
```
ggplot(OliverOdeObsSppCounts, aes(x = count)) +  
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +  
  labs(  
    x = "Number of Ode observations per Species",  
    y = "Number of Species",  
    title = "Distribution of Ode Observations per Species (Oliver)"  
) +  
  theme_minimal()
```

Distribution of Ode Observations per Species (Oliver)



```
ggplot(VaseuxOdeObsSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Ode observations per Species",
    y = "Number of Species",
    title = "Distribution of Ode Observations per Species (Vaseux)"
  ) +
  theme_minimal()
```

Distribution of Ode Observations per Species (Vaseux)



```
iNatButt_sf <- iNatButtRG_CC_acc %>%
  sf::st_as_sf(coords = c("Longitude", "Latitude"),
               crs = 4326,
               remove = FALSE)
```

Now that we have the iNat data read in and cleaned lets filter to the same circles as before.

```
## Filter the data to the circles
ApexButtObs <- iNatButt_sf %>%
  dplyr::filter(sf::st_intersects(., ApexCBCcircle_wgs84, sparse = FALSE)[, 1])
OliverButtObs <- iNatButt_sf %>%
  dplyr::filter(sf::st_intersects(., OliverOsoyoosCBC_wgs84, sparse = FALSE)[, 1])
VaseuxButtObs <- iNatButt_sf %>%
  dplyr::filter(sf::st_intersects(., VaseuxLakeCBC_wgs84, sparse = FALSE)[, 1])
```

Now we can do some quick summary stats to see how much data is in each dataset

```
## How many specimens in each circle
nrow(ApexButtObs)
```

```
## [1] 433
```

```
nrow(OliverButtObs)
```

```
## [1] 2864
```

```
nrow(VaseuxButtObs)
```

```
## [1] 2642
```

```
## How many species (scientific_name) in each circle
length(unique(ApexButtObs$scientific_name))
```

```
## [1] 83
```

```
length(unique(OliverButtObs$scientific_name))
```

```
## [1] 102
```

```
length(unique(VaseuxButtObs$scientific_name))
```

```
## [1] 90
```

```
## Now lets see how many of each species
```

```
ApexButtObsSppCounts <- ApexButtObs %>%
  dplyr::group_by(scientific_name) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
OliverButtObsSppCounts <- OliverButtObs %>%
  dplyr::group_by(scientific_name) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
VaseuxButtObsSppCounts <- VaseuxButtObs %>%
  dplyr::group_by(scientific_name) %>%
  dplyr::summarise(count = n(), .groups = "drop") %>%
  dplyr::arrange(dplyr::desc(count))
```

```
## What are the top 5 spp and how many records do they have?
head(sf::st_drop_geometry(ApexButtObsSppCounts))
```

```

## # A tibble: 6 x 2
##   scientific_name     count
##   <chr>             <int>
## 1 Icaricia icarioides     34
## 2 Ochlodes sylvanoides    24
## 3 Tharsalea helluooides   21
## 4 Polygonia gracilis      20
## 5 Limenitis lorquini      13
## 6 Papilio rutulus         13

head(sf::st_drop_geometry(OliverButtObsSppCounts))

## # A tibble: 6 x 2
##   scientific_name     count
##   <chr>             <int>
## 1 Icaricia icarioides    381
## 2 Euphilotes heracleoides 177
## 3 Glaucopsyche lygdamus   176
## 4 Coenonympha californica 116
## 5 Satyrium behrii        111
## 6 Strymon melinus        94

head(sf::st_drop_geometry(VaseuxButtObsSppCounts))

## # A tibble: 6 x 2
##   scientific_name     count
##   <chr>             <int>
## 1 Strymon melinus     418
## 2 Satyrium behrii      295
## 3 Icaricia icarioides   162
## 4 Ochlodes sylvanoides   141
## 5 Papilio rutulus       127
## 6 Pieris rapae          111

```

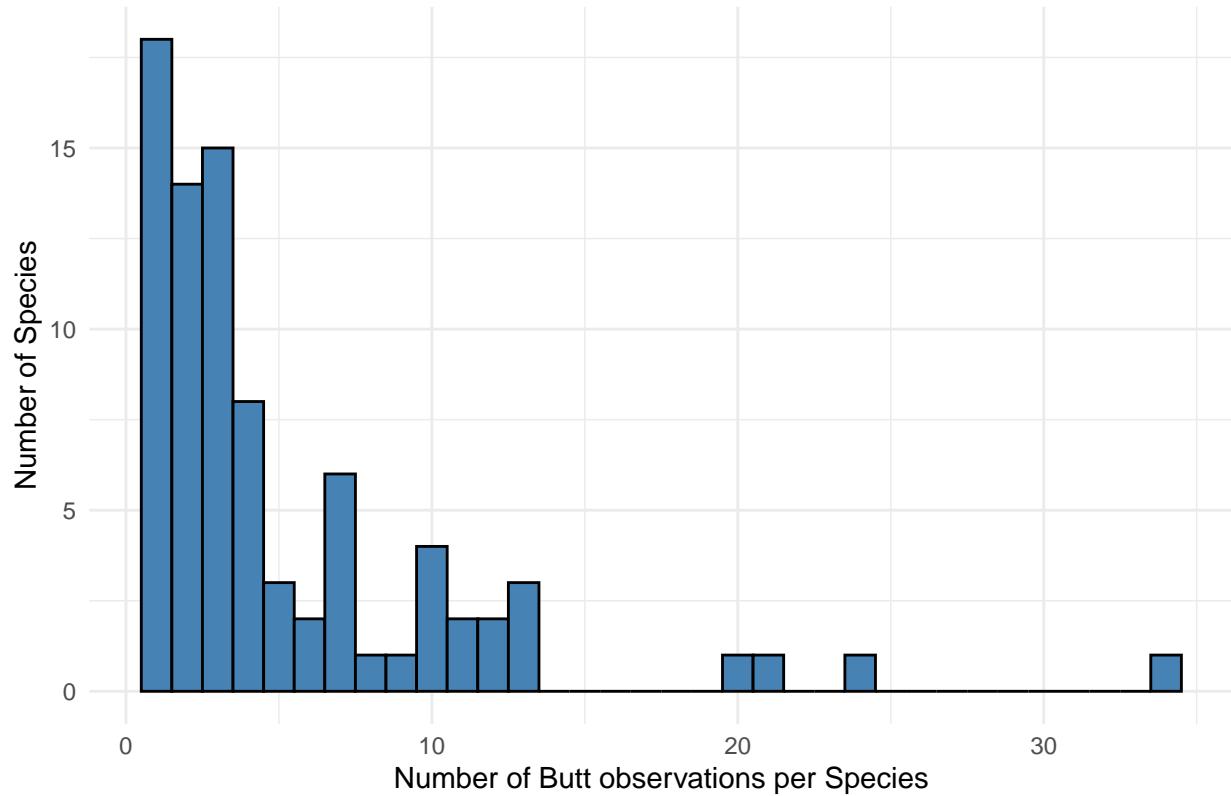
How many species have 1 specimen, 2 specimens, etc?

```

ggplot(ApexButtObsSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Butt observations per Species",
    y = "Number of Species",
    title = "Distribution of Butt Observations per Species (Apex)"
  ) +
  theme_minimal()

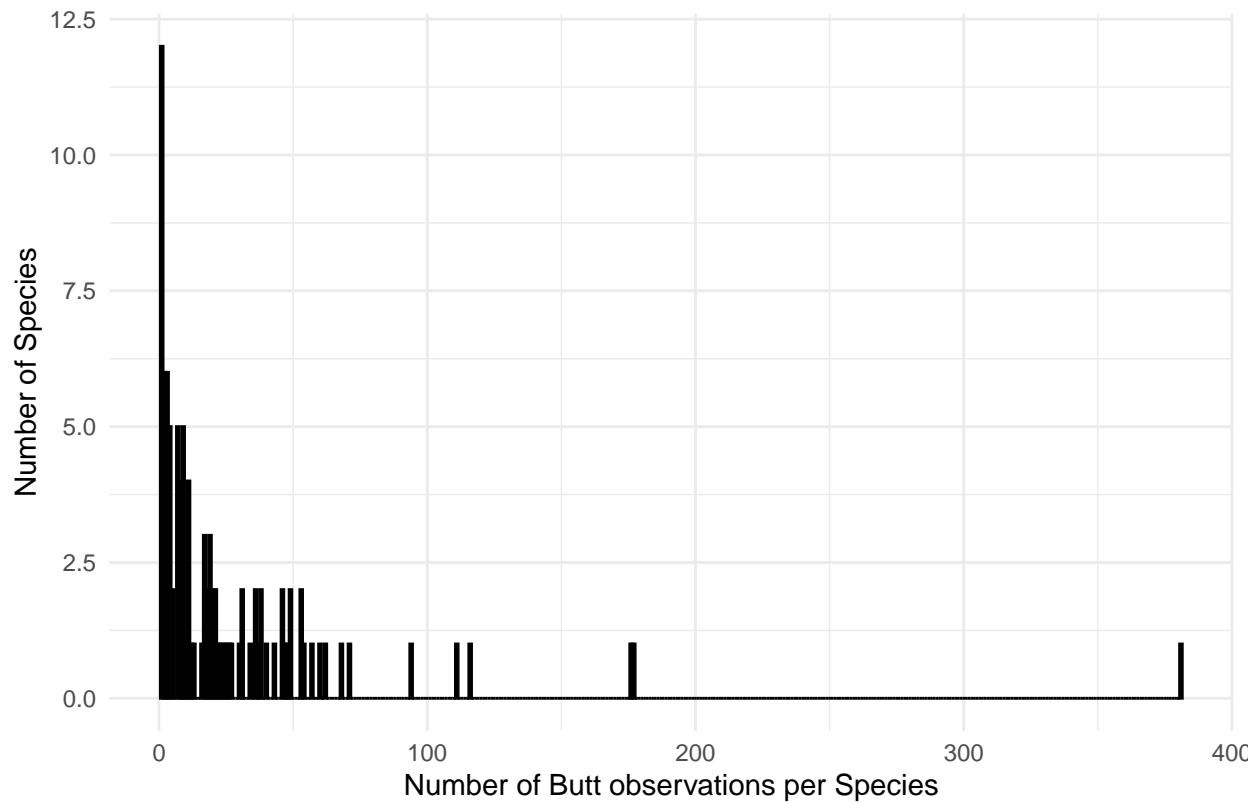
```

Distribution of Butt Observations per Species (Apex)



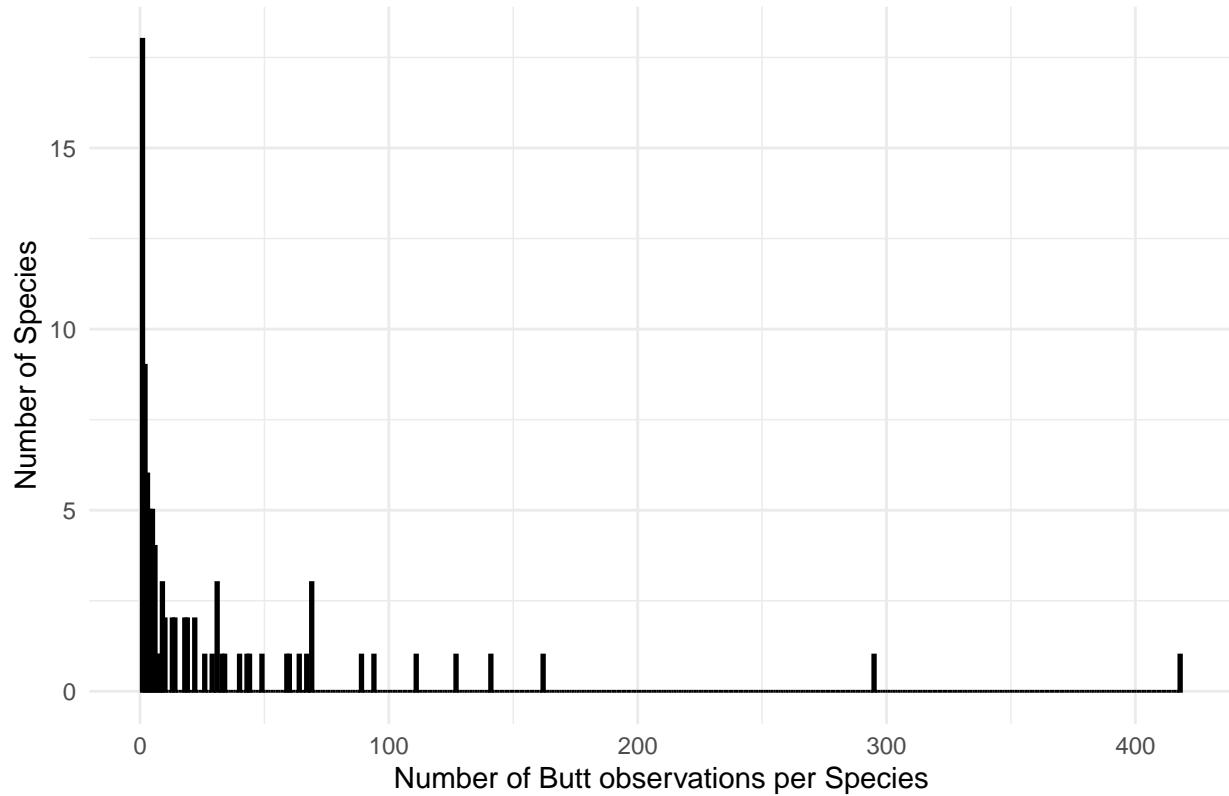
```
ggplot(OliverButtObsSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Butt observations per Species",
    y = "Number of Species",
    title = "Distribution of Butt Observations per Species (Oliver)"
  ) +
  theme_minimal()
```

Distribution of Butt Observations per Species (Oliver)



```
ggplot(VaseuxButtObsSppCounts, aes(x = count)) +
  geom_histogram(binwidth = 1, fill = "steelblue", color = "black") +
  labs(
    x = "Number of Butt observations per Species",
    y = "Number of Species",
    title = "Distribution of Butt Observations per Species (Vaseux)"
  ) +
  theme_minimal()
```

Distribution of Butt Observations per Species (Vaseux)



Now that we've done that we can see that the two datasets are (at least) superficially similar for Butterflies.

Comparative analyses

How does this all look between datasets and taxa?

```
## Odonata Museum N Specimens
nrow(ApexOdeRecords)

## [1] 18
nrow(OliverOdeRecords)

## [1] 987
nrow(VaseuxOdeRecords)

## [1] 806
## Papilionoidea Museum N Specimens
nrow(ApexButtRecords)

## [1] 1810
nrow(OliverButtRecords)

## [1] 5258
nrow(VaseuxButtRecords)

## [1] 1605
```

```

## Odonata iNat N Observations
nrow(ApexOdeObs)

## [1] 2
nrow(OliverOdeObs)

## [1] 358
nrow(VaseuxOdeObs)

## [1] 461
## Papilioidea iNat N Observations
nrow(ApexButtObs)

## [1] 433
nrow(OliverButtObs)

## [1] 2864
nrow(VaseuxButtObs)

## [1] 2642
## Odonata iNat N Species
length(unique(ApexOdeObs$scientific_name))

## [1] 1
length(unique(OliverOdeObs$scientific_name))

## [1] 40
length(unique(VaseuxOdeObs$scientific_name))

## [1] 44
## Papilioidea iNat N Species
length(unique(ApexButtObs$scientific_name))

## [1] 83
length(unique(OliverButtObs$scientific_name))

## [1] 102
length(unique(VaseuxButtObs$scientific_name))

## [1] 90
## Odonata Museum N Species
length(unique(ApexOdeRecords$ItemName))

## [1] 4
length(unique(OliverOdeRecords$ItemName))

## [1] 50
length(unique(VaseuxOdeRecords$ItemName))

## [1] 49

```

```

## Papilioidea Museum N Species
length(unique(ApexButtRecords$species))

## [1] 104
length(unique(OliverButtRecords$species))

## [1] 132
length(unique(VaseuxButtRecords$species))

## [1] 101
summary_df <- data.frame(
  Site = c("Apex", "Oliver", "Vaseux"),

  ## Odonata - Museum
  Odonata_Museum_Specimens = c(
    nrow(ApexOdeRecords),
    nrow(OliverOdeRecords),
    nrow(VaseuxOdeRecords)
  ),
  Odonata_Museum_Species = c(
    length(unique(ApexOdeRecords$ItemName)),
    length(unique(OliverOdeRecords$ItemName)),
    length(unique(VaseuxOdeRecords$ItemName))
  ),

  ## Odonata - iNaturalist
  Odonata_iNat_Observations = c(
    nrow(ApexOdeObs),
    nrow(OliverOdeObs),
    nrow(VaseuxOdeObs)
  ),
  Odonata_iNat_Species = c(
    length(unique(ApexOdeObs$scientific_name)),
    length(unique(OliverOdeObs$scientific_name)),
    length(unique(VaseuxOdeObs$scientific_name))
  ),

  ## Papilioidea - Museum
  Papilioidea_Museum_Specimens = c(
    nrow(ApexButtRecords),
    nrow(OliverButtRecords),
    nrow(VaseuxButtRecords)
  ),
  Papilioidea_Museum_Species = c(
    length(unique(ApexButtRecords$species)),
    length(unique(OliverButtRecords$species)),
    length(unique(VaseuxButtRecords$species))
  ),

  ## Papilioidea - iNaturalist
  Papilioidea_iNat_Observations = c(
    nrow(ApexButtObs),
    nrow(OliverButtObs),

```

```

    nrow(VaseuxButtObs)
),
Papilioidea_iNat_Species = c(
  length(unique(ApexButtObs$scientific_name)),
  length(unique(OliverButtObs$scientific_name)),
  length(unique(VaseuxButtObs$scientific_name))
),
  stringsAsFactors = FALSE
)

## Flip the table so it's more readable
summary_df_t <- summary_df |>
  tibble::column_to_rownames("Site") |>
  t() |>
  as.data.frame()

knitr::kable(
  summary_df_t,
  caption = "Summary of Odonata and Papilioidea records and observations by site",
  booktabs = TRUE,
  longtable = FALSE
)

```

Table 1: Summary of Odonata and Papilioidea records and observations by site

	Apex	Oliver	Vaseux
Odonata_Museum_Specimens	18	987	806
Odonata_Museum_Species	4	50	49
Odonata_iNat_Observations	2	358	461
Odonata_iNat_Species	1	40	44
Papilioidea_Museum_Specimens	1810	5258	1605
Papilioidea_Museum_Species	104	132	101
Papilioidea_iNat_Observations	433	2864	2642
Papilioidea_iNat_Species	83	102	90