

# Appendix S3 - Group Sites by Flyway

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This appendix describes how to extract flyway grouping variables for each BBS survey site. These variables can be accessed in the `BBS.occurrences` library using `data('Site.descriptors')`.

Load the cleaned BBS survey dataset that was prepared in **Appendix S1**

```
load("./BBS.Data.cleaned/BBS.2003-2009.filtered.Rdata")
```

Load the Landcover summary data for survey points that was prepared in **Appendix S2**

```
uniq.points.landcover <- read.csv("./LandCover/MODIS_Landcover_summary.csv")
```

Here we group sites into regions based on recognised North American migratory flyways. This is accomplished by loading the US Fish and Wildlife Service's `WaterfowlFlyways` shapefile. Note, this file can be manually downloaded here: <https://ecos.fws.gov/ServCat/Reference/Profile/42276> if the `tempfile` strategy below fails. We then use a simple function to ensure that the coordinate system of our latitudes and longitudes match that of the shapefile and then intersect each unique point with the flyway layer

```
# install.packages('sf')
library(sf)
library(dplyr)
temp <- tempfile()
download.file("https://ecos.fws.gov/ServCat/DownloadFile/113670",
             temp)
fly.shp <- sf::st_read(unzip(temp, "WaterfowlFlyways.shp"))
unlink(temp)

geo_inside <- function(lon, lat, map, variable) {
  # Escape the variable name
  variable <- dplyr::enquo(variable)

  # Convert each unique point into an sf object
  pt <- tibble::data_frame(x = lon, y = lat) %>%
    sf::st_as_sf(coords = c("x", "y"), crs = 4269) %>%
    sf::st_transform(crs = sf::st_crs(fly.shp))

  # Intersect the point with the map object
  pt %>% sf::st_join(map) %>% dplyr::pull(!variable)
}
```

Put landcover covariates and site descriptors into a single dataframe

```
library(dplyr)
Site.descriptors = sites.df %>% dplyr::left_join(uniq.points.landcover,
  by = c(Latitude = "lat", Longitude = "long", year = "year")) %>%
  dplyr::select(-modis.band, -richness, -simpsons.d,
    -simpsons.evenness, -no.data.fill)
```

Now that all of our site-level covariates are stored together, we can intersect each unique point with the shapefile above to group the sites into flyways and then join the grouping information back to the descriptors data

```
point_site.groups = Site.descriptors %>% dplyr::select(lat,  
  lon) %>% dplyr::distinct() %>% dplyr::mutate(site.group = geo_inside(lon = lon,  
  lat = lat, map = fly.shp, variable = NAME))  
  
Site.descriptors = Site.descriptors %>% left_join(point_site.groups,  
  by = c(Latitude = "lat", Longitude = "lon"))
```

Save the grouped descriptor data for downstream analysis. Note, the flyway variables can be directly accessed in the `BBS.occurrences` library using `data('Site.descriptors')`.

```
dir.create("./Analysis_data")  
save(Site.descriptors, file = "./Analysis_data/Site.descriptors.Rdata")
```