

# Package ‘ebirdst’

December 7, 2022

**Type** Package

**Title** Access and Analyze eBird Status and Trends Data

**Version** 1.2021.1

**Description** Tools to download, load, plot, and analyze eBird Status and Trends Data Products ([\(<https://science.ebird.org/en/status-and-trends>\)](https://science.ebird.org/en/status-and-trends)). eBird ([\(<https://ebird.org/home>\)](https://ebird.org/home)) is a global database of bird observations collected by member of the public. eBird Status and Trends uses these data to model global bird abundances, range boundaries, and habitat associations at a high spatial and temporal resolution.

**License** GPL-3

**URL** <https://github.com/CornellLabofOrnithology/ebirdst>

**BugReports** <https://github.com/CornellLabofOrnithology/ebirdst/issues>

**Depends** R (>= 4.0.0)

**Imports** DBI, dplyr (>= 1.0.0), gbm, ggplot2, grDevices, gridExtra, jsonlite, magrittr, mgcv, precrec, PresenceAbsence, raster (>= 3.1-5), rgdal, rlang, RSQLite, sf (>= 1.0-0), stats, stringr, tidyr (>= 1.0.0), tools, utils, viridisLite

**Suggests** exactextractr, fields, knitr, rmarkdown, rnaturalearth, testthat, withr

**VignetteBuilder** knitr

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.2.1

**NeedsCompilation** no

**Author** Matthew Strimas-Mackey [aut, cre]  
([\(<https://orcid.org/0000-0001-8929-7776>\)](https://orcid.org/0000-0001-8929-7776)),  
Shawn Ligocki [aut],  
Tom Auer [aut] ([\(<https://orcid.org/0000-0001-8619-7147>\)](https://orcid.org/0000-0001-8619-7147)),  
Daniel Fink [aut] ([\(<https://orcid.org/0000-0002-8368-1248>\)](https://orcid.org/0000-0002-8368-1248)),  
Cornell Lab of Ornithology [cph]

**Maintainer** Matthew Strimas-Mackey <mes335@cornell.edu>

**Repository** CRAN

**Date/Publication** 2022-12-07 15:50:02 UTC

## R topics documented:

abundance_palette . . . . .	3
bernoulli_dev . . . . .	3
binom_test_p . . . . .	4
date_to_st_week . . . . .	4
ebirdst . . . . .	5
ebirdst_data_dir . . . . .	5
ebirdst_download . . . . .	6
ebirdst_extent . . . . .	7
ebirdst_habitat . . . . .	9
ebirdst_ppms . . . . .	11
ebirdst_ppms_ts . . . . .	13
ebirdst_predictors . . . . .	14
ebirdst_runs . . . . .	15
ebirdst_subset . . . . .	16
ebirdst_version . . . . .	17
ebirdst_weeks . . . . .	18
get_species . . . . .	18
get_species_path . . . . .	19
label_raster_stack . . . . .	20
load_config . . . . .	21
load_fac_map_parameters . . . . .	22
load_pds . . . . .	23
load_pis . . . . .	24
load_predictions . . . . .	25
load_ranges . . . . .	26
load_raster . . . . .	27
load_stixels . . . . .	29
parse_raster_dates . . . . .	30
plot_pds . . . . .	31
plot_pis . . . . .	32
poisson_dev . . . . .	34
project_extent . . . . .	34
sample_grid . . . . .	35
set_ebirdst_access_key . . . . .	36
stixelize . . . . .	37

**Index**

**39**

---

abundance\_palette      *eBird Status and Trends color palettes for mapping*

---

**Description**

Generate the color palettes used for the eBird Status and Trends relative abundance maps.

**Usage**

```
abundance_palette(  
  n,  
  season = c("weekly", "breeding", "nonbreeding", "migration", "prebreeding_migration",  
            "postbreeding_migration", "year_round")  
)
```

**Arguments**

n                    integer; the number of colors to be in the palette.  
season                character; the season to generate colors for or "weekly" to get the color palette used in the weekly abundance animations.

**Value**

A character vector of hex color codes.

**Examples**

```
# breeding season color palette  
abundance_palette(10, season = "breeding")
```

---

bernoulli\_dev      *Bernoulli deviance*

---

**Description**

Bernoulli deviance

**Usage**

```
bernoulli_dev(obs, pred)
```

**Arguments**

obs                  numeric; observed values.  
pred                  numeric; predicted values.

**Value**

A named numeric vector with three elements: model deviance, mean deviance, and deviance explained.

**Examples**

```
obs <- c(1, 1, 1, 0, 0, 0)
pred <- c(0.9, 0.8, 0.7, 0.3, 0.1, 0.2)
ebirdst::bernoulli_dev(obs, pred)
```

---

binom_test_p	<i>Binomial test for ensemble support</i>
--------------	---

---

**Description**

Binomial test for ensemble support

**Usage**

```
binom_test_p(x)
```

**Arguments**

x numeric; named numeric vector with values for pat, pi\_es, and pat\_cutoff.

**Value**

A numeric p-value.

**Examples**

```
ebirdst::binom_test_p(c(pat = 0.1, pi_es = 75))
```

---

date_to_st_week	<i>Get the Status and Trends week that a date falls into</i>
-----------------	--

---

**Description**

Get the Status and Trends week that a date falls into

**Usage**

```
date_to_st_week(dates)
```

**Arguments**

dates a vector of dates.

**Value**

An integer vector of weeks numbers from 1-52.

**Examples**

```
d <- as.Date(c("2016-04-08", "2018-12-31", "2014-01-01", "2018-09-04"))
date_to_st_week(d)
```

---

ebirdst	<i>ebirdst: Tools to Load, Map, Plot, and Analyze eBird Status and Trends Data Products</i>
---------	---

---

**Description**

Tools to load, map, plot, and analyze **eBird Status and Trends** data products

---

ebirdst_data_dir	<i>Path to eBird Status and Trends data download directory</i>
------------------	--

---

**Description**

Identify and return the path to the default download directory for eBird Status and Trends data products. This directory can be defined by setting the environment variable EBIRDST\_DATA\_DIR, otherwise the directory returned by `tools::R_user_dir("ebirdst", which = "data")` will be used.

**Usage**

```
ebirdst_data_dir()
```

**Value**

The path to the data download directory.

**Examples**

```
ebirdst_data_dir()
```

---

 ebirdst\_download      *Download eBird Status and Trends Data Products*


---

## Description

Download an eBird Status and Trends data package for a single species, or for an example species. Accessing Status and Trends data requires an access key, consult [set\\_ebirdst\\_access\\_key\(\)](#) for instructions on how to obtain and store this key. The example data consist of the results for Yellow-bellied Sapsucker subset to Michigan and are much smaller than the full dataset, making these data quicker to download and process. Only the low resolution data are available for the example data. In addition, the example data are accessible without an access key.

## Usage

```
ebirdst_download(
  species,
  path = ebirdst_data_dir(),
  tifs_only = TRUE,
  force = FALSE,
  show_progress = TRUE,
  pattern = NULL,
  dry_run = FALSE
)
```

## Arguments

species	character; a single species given as a scientific name, common name or six-letter species code (e.g. <code>woothr</code> ). The full list of valid species is can be viewed in the <a href="#">ebirdst_runs</a> data frame included in this package. To download the example dataset, use <code>"example_data"</code> .
path	character; directory to download the data to. All downloaded files will be placed in a sub-directory of this directory named for the data version year, e.g. <code>"2020"</code> for the 2020 Status Data Products. Each species' data package will then appear in a directory named with the eBird species code. Defaults to a persistent data directory, which can be found by calling <code>ebirdst_data_dir()</code> .
tifs_only	logical; whether to only download the GeoTIFFs for abundance and occurrence (the default), or download the entire data package, including data for predictor importance, partial dependence, and predictive performance metrics.
force	logical; if the data have already been downloaded, should a fresh copy be downloaded anyway.
show_progress	logical; whether to print download progress information.
pattern	character; regular expression pattern to supply to <a href="#">str_detect()</a> to filter files to download. Note that some files are mandatory and will always be downloaded.
dry_run	logical; whether to do a dry run, just listing files that will be downloaded. This can be useful when testing the use of <code>pattern</code> to filter the files to download.

**Value**

Path to the folder containing the downloaded data package for the given species. If `dry_run = TRUE` a list of files to download will be returned.

**Examples**

```
## Not run:
# download the example data
ebirdst_download("example_data")

# download the data package for wood thrush, geotiffs only
ebirdst_download("woothr")
# download the data package for wood thrush, all data
ebirdst_download("woothr", tifs_only = FALSE)

# use pattern to only download low resolution data
# dry_run can be used to see what files will be downloaded
ebirdst_download("lobcur", pattern = "_lr_", dry_run = TRUE)
# use pattern to only download the high res weekly abundance data
ebirdst_download("lobcur", pattern = "abundance_median_hr", dry_run = TRUE)

## End(Not run)
```

---

ebirdst_extent	<i>Construct a spatiotemporal extent object to subset Status and Trends data</i>
----------------	--

---

**Description**

`ebirdst_extent` objects are used to subset the eBird Status and Trends data spatially and temporally. This function constructs these objects.

**Usage**

```
ebirdst_extent(x, t, ...)

## S3 method for class 'bbox'
ebirdst_extent(x, t, ...)

## S3 method for class 'numeric'
ebirdst_extent(x, t, crs = 4326, ...)

## S3 method for class 'sfc'
ebirdst_extent(x, t, ...)

## S3 method for class 'sf'
ebirdst_extent(x, t, ...)
```

## Arguments

x	the spatial extent; either a rectangular bounding box (defined as a vector of numbers representing the coordinates of the boundaries or an <code>st_bbox()</code> object) or a polygon (an <code>sf</code> object). See Details for further explanation of the format of x.
t	the temporal extent; a 2-element vector of the start and end dates of the temporal extent, provided either as dates (Date objects or strings in ISO format "YYYY-MM-DD") or numbers between 0 and 1 representing the fraction of the year. Note that dates can wrap around the year, e.g. <code>c("2021-12-01", "2021-01-31")</code> is acceptable. See Details for further explanation of the format of t. <b>Leave the argument blank to include the full year of data.</b>
...	Additional arguments used by methods.
crs	coordinate reference system, provided as a crs object or argument to <code>st_crs()</code> . Defaults to unprojected, lat/long coordinates (crs = 4326). <b>Only required if x is given as a numeric vector defining the bounding box, ignored in all other cases.</b>

## Details

The spatial extent, x, can be either a rectangular bounding box or a set of spatial polygons. The bounding box can be defined either as an `st_bbox()` object or by providing the coordinates of the rectangle edges directly as a named vector with elements `xmin`, `xmax`, `ymin`, and `ymax` (note that latitude and longitude correspond to y and x, respectively). In this latter case, a coordinate reference system must be provided explicitly via the `crs` argument (`crs = 4326` is the default and is a short form for unprojected lat/long coordinates). For a polygon spatial extent, x should be either an `sf` or `sfc` object (with feature type POLYGON or MULTIPOLYGON) from the `sf` package. To import data from a Shapefile or GeoPackage into this format, use `read_sf()`.

The temporal extent defines the start and end dates of the time period. These are most easily provided as Date objects or date strings in ISO format ("YYYY-MM-DD"). If dates are defined as strings, the year can be omitted (i.e. "MM-DD"). Alternatively, dates can be defined in terms of fractions of the year, e.g. `t = c(0.25, 0.5)` would subset to data within the second quarter of the year. In all cases, dates can wrap around the year, e.g. `c("2021-12-01", "2021-01-31")` would subset to data in December or January.

## Value

An `ebirdst_extent` object consisting of a list with three elements: the spatial extent `extent`, the temporal extent `t`, and `type` (either "bbox" or "polygon").

## Methods (by class)

- `ebirdst_extent(bbox)`: bounding box created with `st_bbox()`
- `ebirdst_extent(numeric)`: bounding box given as edges
- `ebirdst_extent(sfc)`: polygons as `sfc` spatial feature column
- `ebirdst_extent(sf)`: polygons as `sf` object



## Examples

```
# bounding box of the north eastern united states as a numeric vector
bb_vec <- c(xmin = -80, xmax = -70, ymin = 40, ymax = 47)
ebirdst_extent(bb_vec)

# bbox object
bb <- sf::st_bbox(bb_vec, crs = 4326)
ebirdst_extent(bb)

# polygon imported from a shapefile
poly <- sf::read_sf(system.file("shape/nc.shp", package="sf"))
ebirdst_extent(poly)

# subset to january
ebirdst_extent(bb, t = c("2021-01-01", "2021-01-31"))

# dates can wrap around, e.g. to use dec-jan
ebirdst_extent(bb, t = c("2021-12-01", "2021-01-31"))

# dates can also be given without an associated year
ebirdst_extent(bb, t = c("12-01", "01-31"))
```

---

 ebirdst\_habitat

*eBird Status and Trends predictive habitat associations*


---

## Description

Combine the predictor importance (PI) and partial dependence (PD) data to provide an estimate of the importance and directionality of the land cover classes (i.e. habitat) used as covariates in the occurrence probability model. **Note:** This is one of, if not the most, computationally expensive operations in the package.

## Usage

```
ebirdst_habitat(path, ext, data = NULL, stationary_associations = FALSE)
```

```
## S3 method for class 'ebirdst_habitat'
plot(x, n_habitat_types = 15, ...)
```

## Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
ext	<a href="#">ebirdst_extent</a> object; the spatiotemporal extent over which to calculate the habitat associations. Note that <b>temporal component of ext is ignored in this function</b> , habitat associations are always calculated for the full year.

data	as an alternative to providing the path argument specifying the location of the data package, the data required to calculate habitat associations can be provided explicitly as a named list of three data frames: <code>pis</code> containing PI data from <code>load_pis()</code> , <code>pds</code> containing PD data from <code>load_pds()</code> , and <code>stixels</code> containing stixel weights in a <code>weight</code> column. All data should be provided at the stixel level, identified by the <code>stixel_id</code> column, and only those stixels appearing in the <code>stixels</code> data frame will be used. Typically stixel weights are the proportion of the focal region that the given stixel overlaps. Ignored if <code>path</code> is provided. <b>In most cases, users will want to avoid using these arguments and simply provide <code>path</code> instead.</b>
stationary_associations	logical; when the habitat association should be assumed to vary throughout the year and estimates should be made for each week of the year (the default) or habitat associations should be assumed constant throughout the year and a single set of estimates made for the full year. Annual estimates should only be made when you expect the associations to be constant throughout the year, e.g. for resident species.
x	<code>ebirdst_habitat</code> object; habitat relationships as calculated by <code>ebirdst_habitat()</code> .
n_habitat_types	number of habitat types to include in the cake plot. The most important set of predictors will be chosen based on the maximum weekly importance value across the whole year.
...	ignored.

## Details

The Status and Trends models use both effort (e.g. number of observers, length of checklist) and habitat (e.g. elevation, percent forest cover) covariates; for the full list consult `ebirdst_predictors`. This function calculates habitat associations only for the following covariates that most closely represent metrics of available habitat. In all cases these are calculated within a 1.5 km radius of each checklist:

- Land cover: percent of each landcover class
- Water cover: percent of each watercover class
- Intertidal: percent cover of intertidal mudflats
- Nighttime lights: total reflectance of nighttime lights
- Roads: road density. There are 5 covariates distinguishing between different road types; however, these are grouped together for the sake of the habitat associations.

The `plot()` method can be used to produce a cake plot, a stacked area chart showing habitat associations in which area indicates the importance of a given land cover class and the position above or below the x-axis indicates the direction of the relationship.

## Value

An `ebirdst_habitat` object, consisting of a data frame giving the predictor importance and directionality for each predictor for each week of the year. The columns are:

- predictor: the name of the predictor
- week: the date of the center of the week, expressed as "MM-DD". This column will be missing if stationary\_associations = TRUE.
- importance: the relative importance of the predictor, these values are scaled so they sum to 1 within each week.
- prob\_pos\_slope: the predicted probability that the slope of the PD
- direction: the direction of the relationship, either 1 for a positive relationship, -1 for a negative relationship, or NA when the direction of the relationship is not significant.

### Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# define a spatial extent to calculate ppms over
e <- ebirdst_extent(c(xmin = -90, xmax = -82, ymin = 41, ymax = 48))

# compute habitat associations
habitat <- ebirdst_habitat(path = path, ext = e)
print(habitat)
# produce a cake plot
plot(habitat)

## End(Not run)
```

---

 ebirdst\_ppms

*eBird Status and Trends predictive performance metrics (PPMs)*


---

### Description

Calculate a suite of predictive performance metrics (PPMs) for the eBird Status and Trends model of a given species within a spatiotemporal extent.

### Usage

```
ebirdst_ppms(path, ext, es_cutoff, pat_cutoff)

## S3 method for class 'ebirdst_ppms'
plot(x, ...)
```

## Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
ext	<a href="#">ebirdst_extent</a> object (optional); the spatiotemporal extent over which to calculate the PPMs.
es_cutoff	fraction between 0-1; the ensemble support cutoff to use in distinguishing zero and non-zero predictions. Optimal ensemble support cutoff values are calculated for each week during the modeling process and stored in the data package for each species. <b>In general, you should not specify a value for <code>es_cutoff</code> and instead allow the function to use the species-specific model-based values.</b>
pat_cutoff	numeric between 0-1; percent above threshold. Optimal PAT cutoff values are calculated for each week during the modeling process and stored in the data package for each species. <b>In general, you should not specify a value for <code>pat_cutoff</code> and instead allow the function to use the species-specific model-based values.</b>
x	<a href="#">ebirdst_ppms</a> object; PPMs as calculated by <code>ebirdst_ppms()</code> .
...	ignored.

## Details

During the eBird Status and Trends modeling process, a subset of observations (the "test data") are held out from model fitting to be used for evaluating model performance. Model predictions are made for each of these observations and this function calculates a suite of predictive performance metrics (PPMs) by comparing the predictions with the observed count on the eBird checklist.

Three types of PPMs are calculated: binary or range-based PPMs assess the ability of model to predict range boundaries, occurrence PPMs assess the occurrence probability predictions, and abundance PPMs assess the predicted abundance. Both the occurrence and count PPMs are within-range metrics, meaning the comparison between observations and predictions is only made within the range where the species occurs.

Prior to calculating PPMs, the test dataset is subsampled spatiotemporally using `ebirdst_subset()`. This process is performed for 25 monte carlo iterations resulting in 25 estimates of each PPM.

## Value

An `ebirdst_ppms` object containing a list of three data frames: `binary_ppms`, `occ_ppms`, and `abd_ppms`. These data frames have 25 rows corresponding to 25 Monte Carlo iterations each estimating the PPMs using a spatiotemporal subsample of the test data. Columns correspond to the different PPMs. `binary_ppms` contains binary or range-based PPMs, `occ_ppms` contains within-range occurrence probability PPMs, and `abd_ppms` contains within-range abundance PPMs. In some cases, PPMs may be missing, either because there isn't a large enough test set within the spatiotemporal extent or because average occurrence or abundance is too low. In these cases, try increasing the size of the [ebirdst\\_extent](#) object.

`plot()` can be called on the returned `ebirdst_ppms` object to produce a boxplot of PPMs in all three categories: Binary Occurrence, Occurrence Probability, and Abundance.

## Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# define a spatiotemporal extent to calculate ppms over
bb_vec <- c(xmin = -90, xmax = -82, ymin = 41, ymax = 48)
e <- ebirdst_extent(bb_vec, t = c("05-01", "07-31"))

# compute predictive performance metrics
ppms <- ebirdst_ppms(path = path, ext = e)
plot(ppms)

## End(Not run)
```

---

ebirdst_ppms_ts	<i>Time series of eBird Status and Trends PPMs summarized temporally</i>
-----------------	--

---

## Description

Calculate a time series of predictive performance metrics (PPMs) for the eBird Status and Trends model. For each week or month of the year, PPMs will be summarized independently to produce a time series. For further details on eBird Status and Trends PPMs consult the help for [ebirdst\\_ppms](#).

## Usage

```
ebirdst_ppms_ts(path, ext, summarize_by = c("weeks", "months"), ...)

## S3 method for class 'ebirdst_ppms_ts'
plot(x, type = c("binary", "occurrence", "abundance"), metric = "kappa", ...)
```

## Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
ext	<a href="#">ebirdst_extent</a> object (optional); the spatial extent over which to calculate the PPMs. Note that <a href="#">ebirdst_extent</a> objects typically specify both a spatial and temporal extent, however, <b>within this function only the spatial component of the extent is used.</b>
summarize_by	character; periods over which to summarize PPMs. PPMs can either be calculated for eBird Status and Trends weeks (as defined in <a href="#">ebirdst_weeks</a> ) or for the months of the year.
...	ignored.
x	<a href="#">ebirdst_ppms_ts</a> object; PPMs summarized by weeks or months as calculated by <code>ebirdst_ppms_ts()</code> .

type	character; the PPM type to plot, either a binary, occurrence, or abundance PPM can be plotted.
metric	character; the specific metric to plot, the list of possible metrics varies by PPM type: <ul style="list-style-type: none"> <li>• Binary or occurrence: auc, ppc, kappa, bernoulli_dev, sensitivity, specificity</li> <li>• Abundance: poisson_dev_abd, poisson_dev_occ, spearman_abd, spearman_occ</li> </ul>

### Value

An `ebirdst_ppms_ts` object containing a list of three data frames: `binary_ppms`, `occ_ppms`, and `abd_ppms`. Each row of these data frames corresponds to the PPMs from one Monte Carlo iteration for a given time period. Columns correspond to the different PPMs. `binary_ppms` contains binary or range-based PPMs, `occ_ppms` contains within-range occurrence probability PPMs, and `abd_ppms` contains within-range abundance PPMs. In some cases, PPMs may be missing, either because there isn't a large enough test set within the spatiotemporal extent or because average occurrence or abundance is too low. In these cases, try increasing the size of the `ebirdst_extent` object. `plot()` can be called on the returned `ebirdst_ppms_ts` object to plot a time series of a single PPM.

### Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# define a spatial extent to calculate ppms over
e <- ebirdst_extent(c(xmin = -90, xmax = -82, ymin = 41, ymax = 48))

# compute predictive performance metrics, summarized by months
ppms <- ebirdst_ppms_ts(path = path, ext = e, summarize_by = "months")

# plot time series
# binary, kappa
plot(ppms, type = "binary", metric = "kappa")
# occurrence, sensitivity
plot(ppms, type = "occurrence", metric = "sensitivity")
# # abundance, poisson deviance
plot(ppms, type = "abundance", metric = "poisson_dev_abd")

## End(Not run)
```

**Description**

A data frame of the predictors used in the eBird Status and Trends models. These include effort variables (e.g. distance traveled, number of observers, etc.) in addition to land and water cover variables. These landcover variables are derived from the MODIS MCD12Q1 500 m landcover product, and for each land cover class two FRAGSTATS metrics are calculated within a 1.5 km buffer around each checklist: % landcover (PLAND) and edge density (ED).

**Usage**

ebirdst\_predictors

**Format**

A data frame with 74 rows and 5 columns:

**predictor** Predictor variable name.

**predictor\_label** Descriptive labels for predictors for plotting and translating the cryptic variables names (e.g. umd\_fs\_c1 is Evergreen Needleleaf Forest).

**lc\_class** For the land and water cover FRAGSTATS variables, this gives the associated landcover class. It can be used for grouping and summarizing the four FRAGSTATS metrics to the level of the landcover class.

**lc\_class\_label** Similar to predictor\_label; however, this variable gives the FRAGSTATS metrics a single name for the landcover class.

---

ebirdst\_runs

*Data frame of available eBird Status and Trends species*

---

**Description**

A dataset containing the species for which eBird Status and Trends data are available. In addition, the dates defining the boundaries of the seasons are provided. These seasons are defined on a species-specific basis through expert review. For information on the details of defining seasons, please see the [seasons section of the FAQ](#). Note that missing dates imply that a season failed expert review for that species within that season.

**Usage**

ebirdst\_runs

**Format**

A data frame with 15 variables:

**species\_code** Six letter eBird code in eBird Taxonomy v2018

**scientific\_name** Scientific name from eBird Taxonomy v2018

**common\_name** English common name from eBird Taxonomy v2018

**resident** Classifies this species a resident or a migrant  
**breeding\_quality** Breeding season quality  
**breeding\_range\_modeled** Is the full range modeled?  
**breeding\_start** Breeding season start date  
**breeding\_end** Breeding season start date  
**nonbreeding\_quality** Non-breeding season quality  
**nonbreeding\_range\_modeled** Is the full range modeled?  
**nonbreeding\_start** Non-breeding season start date  
**nonbreeding\_end** Non-breeding season start date  
**postbreeding\_migration\_quality** Post-breeding season quality  
**postbreeding\_migration\_range\_modeled** Is the full range modeled?  
**postbreeding\_migration\_start** Post-breeding season start date  
**postbreeding\_migration\_end** Post-breeding season start date  
**prebreeding\_migration\_quality** Pre-breeding season quality  
**prebreeding\_migration\_range\_modeled** Is the full range modeled?  
**prebreeding\_migration\_start** Pre-breeding season start date  
**prebreeding\_migration\_end** Pre-breeding season start date  
**resident\_quality** Resident quality  
**resident\_start** For resident species, the year-round start date  
**resident\_end** For resident species, the year-round end date

---

 ebirdst\_subset

*Subset eBird Status and Trends data spatiotemporally*


---

## Description

Spatiotemporally subset the raster or tabular eBird Status and Trends data. The spatiotemporal extent should be defined using `ebirdst_extent()`.

## Usage

```

ebirdst_subset(x, ext)

## S3 method for class 'data.frame'
ebirdst_subset(x, ext)

## S3 method for class 'sf'
ebirdst_subset(x, ext)

## S3 method for class 'Raster'
ebirdst_subset(x, ext)
  
```



**Arguments**

- `x` eBird Status and Trends data to subset; either a RasterStack object with 52 layers (one for each week) or a data frame with PI or PD data.
- `ext` `ebirdst_extent` object; the spatiotemporal extent to filter the data to.

**Value**

eBird Status and Trends data in the same format as the input data, but subset in space and time.

**Methods (by class)**

- `ebirdst_subset(data.frame)`: PI or PD data
- `ebirdst_subset(sf)`: PI or PD data as an sf object
- `ebirdst_subset(Raster)`: Status and Trends rasters

**Examples**

```
## Not run:
# download example data
path <- ebirdst_download("example_data")
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# bbox for southern michigan in may
bb_vec <- c(xmin = -86, xmax = -83, ymin = 41.5, ymax = 43.5)
e <- ebirdst_extent(bb_vec, t = c("05-01", "05-31"))

# load and subset raster data
abd <- load_raster(path, product = "abundance", resolution = "1r")
abd_ss <- ebirdst_subset(abd, ext = e)

## End(Not run)
```

---

 ebirdst\_version

*eBird Status and Trends Data Products version*


---

**Description**

Identify the version of the eBird Status and Trends Data Products that this version of the R package works with. Versions are defined by the year that all model estimates are made for. In addition, the release data and end date for access of this version of the data are provided. Note that after the given access end data you will no longer be able to download this version of the data and will be required to update the R package and transition to using a newer data version.

**Usage**

```
ebirdst_version()
```

**Value**

A list with three components: `version_year` is the year the model estimates are made for in this version of the data, `release_year` is the year this version of the data were released, and `access_end_date` is the last date that users will be able to download this version of the data.

**Examples**

```
ebirdst_version()
```

---

<code>ebirdst_weeks</code>	<i>eBird Status and Trends weeks</i>
----------------------------	--------------------------------------

---

**Description**

eBird Status and Trends predictions are made for each of 52 weeks of the year. This data frame provides the boundaries of the weeks.

**Usage**

```
ebirdst_weeks
```

**Format**

A data frame with 52 rows and 5 columns:

**week\_number** Integer week number from 1-52.

**date** Date of the midpoint of the week.

**week\_midpoint** Date of the midpoint of the week expressed as a fraction of the year, i.e. a number from 0-1.

**week\_start** Date of the start of the week expressed as a fraction of the year, i.e. a number from 0-1.

**week\_end** Date of the end of the week expressed as a fraction of the year, i.e. a number from 0-1.

---

<code>get_species</code>	<i>Get eBird species code for a set of species</i>
--------------------------	--

---

**Description**

Give a vector of species codes, common names, and/or scientific names, return a vector of 6-letter eBird species codes. This function will only look up codes for species for which eBird Status and Trends results exist.

**Usage**

```
get_species(x)
```

**Arguments**

x character; vector of species codes, common names, and/or scientific names.

**Value**

A character vector of eBird species codes.

**Examples**

```
get_species(c("Black-capped Chickadee", "Poecile gambeli", "carchi"))
```

---

get_species_path	<i>Get the path to the data package for a given species</i>
------------------	---

---

**Description**

This helper function can be used to get the path to a data package for a given species to be used by the various data loading functions.

**Usage**

```
get_species_path(species, path = ebirdst_data_dir())
```

**Arguments**

species character; a single species given as a scientific name, common name or six-letter species code (e.g. wothr). The full list of valid species is can be viewed in the [ebirdst\\_runs](#) data frame included in this package. To download the example dataset, use "example\_data".

path character; directory to download the data to. All downloaded files will be placed in a sub-directory of this directory named for the data version year, e.g. "2020" for the 2020 Status Data Products. Each species' data package will then appear in a directory named with the eBird species code. Defaults to a persistent data directory, which can be found by calling `ebirdst_data_dir()`.

**Value**

The path to the data package directory.

**Examples**

```
## Not run:  
# download the example data  
ebirdst_download("example_data")  
  
# get the path  
path <- get_species_path("example_data")
```

```
# use it to load data
abd <- load_raster(path, "abundance")

# get the path to the full data package for yellow-bellied sapsucker
# common name, scientific name, or species code can be used
path <- get_species_path("Yellow-bellied Sapsucker")
path <- get_species_path("Sphyrapicus varius")
path <- get_species_path("yepsap")

## End(Not run)
```

---

label\_raster\_stack      *Label data cubes with the week date for each band*

---

### Description

The data cubes are saved as GeoTIFFs, which don't allow for band labels. For convenience, this function labels the layers of a data cube once it has been loaded with the week dates for each band.

### Usage

```
label_raster_stack(x, weeks = NULL)
```

### Arguments

x	RasterStack or RasterBrick; eBird Status and Trends data cube, typically with 52 bands, one for each week.
weeks	vector of dates corresponding to the weeks of each layer in x. This argument should be used only rarely, when you're labelling a cube with fewer than the usual 52 weeks of predictions.

### Value

A RasterStack or RasterBrick with names assigned for the dates in the format of "wYYYY.MM.DD" per raster package constraints. The Raster\* objects do not allow the names to start with a number, nor are they allowed to contain "-", so it is not possible to store the date in an ISO compliant format. Use parse\_raster\_dates() to convert the layer names to dates.

### Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data")
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# weekly relative abundance
# note that only low resolution (1r) data are available for the example data
abd <- load_raster(path, "abundance", resolution = "1r")
```

```
# label
abd <- label_raster_stack(abd)
names(abd)

## End(Not run)
```

---

load\_config

*Load eBird Status and Trends configuration file*

---

## Description

Load the configuration file for an eBird Status and Trends runs. This configuration file is mostly for internal use and contains a variety of parameters used in the modeling process.

## Usage

```
load_config(path)
```

## Arguments

path                    character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by `ebirdst_download()` or `get_species_path()`.

## Value

A list with the run configuration parameters.

## Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data")
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# load configuration file
cfg <- load_config(path)

## End(Not run)
```

---

`load_fac_map_parameters`*Load full annual cycle map parameters*

---

### Description

Get the map parameters used on the eBird Status and Trends website to optimally display the full annual cycle data. This includes bins for the abundance data, a projection, and an extent to map. The extent is the spatial extent of non-zero data across the full annual cycle and the projection is optimized for this extent.

### Usage

```
load_fac_map_parameters(path)
```

### Arguments

`path` character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by `ebirdst_download()` or `get_species_path()`.

### Value

A list containing elements:

- `custom_projection`: a custom projection optimized for the given species' full annual cycle
- `fa_extent`: an Extent object storing the spatial extent of non-zero data for the given species in the custom projection
- `res`: a numeric vector with 2 elements giving the target resolution of raster in the custom projection.
- `fa_extent_sinu`: the extent in sinusoidal projection
- `weekly_bins/weekly_labels`: weekly abundance bins and labels for the full annual cycle
- `seasonal_bins/seasonal_labels`: seasonal abundance bins and labels for the full annual cycle

### Examples

```
## Not run:  
# download example data  
path <- ebirdst_download("example_data", tifs_only = FALSE)  
# or get the path if you already have the data downloaded  
path <- get_species_path("example_data")  
  
# get map parameters  
load_fac_map_parameters(path)  
  
## End(Not run)
```

---

load_pds	<i>Load eBird Status and Trends partial dependence data</i>
----------	---

---

### Description

Partial dependence (PD) plots depict the relationship between the modeled occurrence probability and each of the predictor variables used in the model. Status and Trends provides the data to generate these plots for every stixel.

### Usage

```
load_pds(path, ext, model = c("occurrence", "count"), return_sf = FALSE)
```

### Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
ext	<a href="#">ebirdst_extent</a> object; the spatiotemporal extent to filter the data to. The spatial component of the extent object must be provided in unprojected, latitude-longitude coordinates.
model	character; whether to make estimates for the occurrence or count model.
return_sf	logical; whether to return an <a href="#">sf</a> object of spatial points rather than the default data frame.

### Value

Data frame, or [sf](#) object if `return_sf = TRUE`, containing PD estimates for each stixel for either the occurrence or count model. The data frame will have the following columns:

- `stixel_id`: unique stixel identifier
- `latitude` and `longitude`: stixel centroid
- `day_of_year`: center day of year for stixel
- `predictor`: name of the predictor that the PD data correspond to, for a full list of predictors consult the [ebirdst\\_predictors](#) data frame
- `predictor_value`: value of the predictor variable at which PD is evaluated
- `response`: predicted response, occurrence or count, at the given value of the predictor averaged across all the values of the other predictors

### Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")
```

```
# load partial dependence data for occurrence model
pds <- load_pds(path)

# plot the top 15 predictor importances
# define a spatiotemporal extent to plot data from
bb_vec <- c(xmin = -86.6, xmax = -82.2, ymin = 41.5, ymax = 43.5)
e <- ebirdst_extent(bb_vec, t = c("05-01", "05-31"))
plot_pds(pds, "solar_noon_diff_mid", ext = e, n_bs = 5)

## End(Not run)
```

---

load\_pis

*Load eBird Status and Trends predictor importance data*


---

### Description

Loads the predictor importance (PI) data from the `stixel_summary.db` sqlite database. PI estimates are provided for each stixel over which a model was run and are identified by a unique stixel ID in addition to the coordinates of the stixel centroid.

### Usage

```
load_pis(path, ext, model = c("occurrence", "count"), return_sf = FALSE)
```

### Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
ext	<a href="#">ebirdst_extent</a> object; the spatiotemporal extent to filter the data to. The spatial component of the extent object must be provided in unprojected, latitude-longitude coordinates.
model	character; whether to make estimates for the occurrence or count model.
return_sf	logical; whether to return an <a href="#">sf</a> object of spatial points rather than the default data frame.

### Value

Data frame, or [sf](#) object if `return_sf = TRUE`, containing PI estimates for each stixel for either the occurrence or count models. The data are provided in a 'wide' format, with each row corresponding to the PI estimates for a give stixel for the occurrence count model, and the relative importance of each predictor in columns. Stixels are identified by a unique `stixel_id`, and the centroid of the stixel in space and time is specified by the `latitude`, `longitude`, and `day_of_year` columns. The column `predictor` provides a code specifying the predictor variable. These codes can be looked up in `ebirdst_predictors` for a brief description.



## Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# load predictor importance for the occurrence model
pis <- load_pis(path)

# plot the top 15 predictor importances
# define a spatiotemporal extent to plot data from
bb_vec <- c(xmin = -86.6, xmax = -82.2, ymin = 41.5, ymax = 43.5)
e <- ebirdst_extent(bb_vec, t = c("05-01", "05-31"))
plot_pis(pis, ext = e, n_top_pred = 15, by_cover_class = TRUE)

## End(Not run)
```

---

load\_predictions

*Load eBird Status and Trends test data predictions*

---

## Description

During eBird Status and Trends modeling, predictions are made for checklists in a test dataset that is not included in the model fitting process. This function loads these predictions in addition to the actual observed count on the associated checklist. These data are used by `ebirdst_ppms()` for calculating predictive performance metrics.

## Usage

```
load_predictions(path, return_sf = FALSE)
```

## Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
return_sf	logical; whether to return an <code>sf</code> object of spatial points rather than the default data frame.

## Value

Data frame, or `sf` object if `return_sf = TRUE`, containing observed counts and model predictions for the test data.

**Examples**

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# test data
test_predictions <- load_predictions(path)
dplyr::glimpse(test_predictions)

## End(Not run)
```

---

load\_ranges

*Load seasonal eBird Status and Trends range polygons*


---

**Description**

Range polygons are defined as the boundaries of non-zero seasonal relative abundance estimates, which are then (optionally) smoothed to produce more aesthetically pleasing polygons using the `smoothr` package.

**Usage**

```
load_ranges(path, resolution = c("mr", "lr"), smoothed = TRUE)
```

**Arguments**

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
resolution	character; the raster resolution from which the range polygons were derived.
smoothed	logical; whether smoothed or unsmoothed ranges should be loaded.

**Value**

An `sf` update containing the seasonal range boundaries, with each season provided as a different feature.

**Examples**

```
## Not run:
# download example data
path <- ebirdst_download("example_data")
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# load smoothed ranges
# note that only low res data are provided for the example data
```

```

ranges <- load_range(path, resolution = "1r")

## End(Not run)

```

---

load\_raster

*Load eBird Status and Trends raster data cubes*


---

## Description

Each of the eBird Status and Trends raster products is packaged as a GeoTIFF file representing predictions on a regular grid. The core products are occurrence, count, relative abundance, and percent of population. This function loads one of the available data products into R as a RasterStack object.

## Usage

```

load_raster(
  path,
  product = c("abundance", "count", "occurrence", "percent-population"),
  period = c("weekly", "seasonal", "full-year"),
  metric = NULL,
  resolution = c("hr", "mr", "1r")
)

```

## Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
product	character; Status and Trends product to load: occurrence, count, relative abundance, or percent of population. See Details for a detailed explanation of each of these products.
period	character; temporal period of the estimation. The Status and Trends models make predictions for each week of the year; however, as a convenience, data are also provided summarized at the seasonal or annual ("full-year") level.
metric	character; by default, the weekly products provide estimates of the median value ( <code>metric = "median"</code> ) and the summarized products are the cell-wise mean across the weeks within the season ( <code>metric = "mean"</code> ). However, additional variants exist for some of the products. For the weekly relative abundance, confidence intervals are provided: specify <code>metric = "lower"</code> to get the 10th quantile or <code>metric = "upper"</code> to get the 90th quantile. For the seasonal and annual products, the cell-wise maximum values across weeks can be obtained with <code>metric = "max"</code> .
resolution	character; the resolution of the raster data to load. The default is to load the native ~3 km resolution ("hr"); however, for some applications 9 km ("mr") or 27 km ("1r") data may be suitable.

## Details

The core Status and Trends data products provide weekly estimates across a regular spatial grid. They are packaged as rasters with 52 layers, each corresponding to estimates for a week of the year, and we refer to them as "cubes" (e.g. the "relative abundance cube"). All estimates are the median expected value for a standard 1km, 1 hour eBird Traveling Count by an expert eBird observer at the optimal time of day and for optimal weather conditions to observe the given species. These products are:

- occurrence: the expected probability (0-1) of occurrence a species.
- count: the expected count of a species, conditional on its occurrence at the given location.
- abundance: the expected relative abundance of a species, computed as the product of the probability of occurrence and the count conditional on occurrence.
- percent-population: the percent of the total relative abundance within each cell. This is a derived product calculated by dividing each cell value in the relative abundance raster with the total abundance summed across all cells.

In addition to these weekly data cubes, this function provides access to data summarized over different periods. Seasonal cubes are produced by taking the cell-wise mean or max across the weeks within each season. The boundary dates for each season are species specific and are available in `ebirdst_runs`, and if a season failed review no associated layer will be included in the cube. In addition, full-year summaries provide the mean or max across all weeks of the year that fall within a season that passed review. Note that this is not necessarily all 52 weeks of the year. For example, if the estimates for the non-breeding season failed expert review for a given species, the full-year summary for that species will not include the weeks that would fall within the non-breeding season.

## Value

For the weekly cubes, a `RasterStack` with 52 layers for the given product, labeled by week. Seasonal cubes will have up to four layers labeled according to the seasons. The full-year products will have a single layer.

## Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data")
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# weekly relative abundance
# note that only low resolution (1r) data are available for the example data
abd_weekly <- load_raster(path, "abundance", resolution = "1r")
# identify the weeks for each layer
parse_raster_dates(abd_weekly)

# max seasonal abundance
abd_seasonal <- load_raster(path, "abundance",
                           period = "seasonal", metric = "max",
                           resolution = "1r")

# available seasons in stack
```

```

names(abd_seasonal)
# subset to just breeding season abundance
abd_seasonal[["breeding"]]

## End(Not run)

```

---

load\_stixels

*Load summary data for eBird Status and Trends stixels*


---

## Description

eBird Status and Trends divides space and time into variably sized "stixels" within which individual base models are fit. The process of stixelization is performed many times and the prediction at any given point is the median of the predictions from all the stixels that that point falls in. This function loads summary statistics for each stixel, for example, the size of the stixels, the number of observations within each stixel, and a suite of predictive performance metrics (PPMs) for the model fit within that stixel.

## Usage

```
load_stixels(path, ext, return_sf = FALSE)
```

## Arguments

path	character; directory that the Status and Trends data for a given species was downloaded to. This path is returned by <code>ebirdst_download()</code> or <code>get_species_path()</code> .
ext	<a href="#">ebirdst_extent</a> object; the spatiotemporal extent to filter the data to. The spatial component of the extent object must be provided in unprojected, latitude-longitude coordinates.
return_sf	logical; whether to return an <a href="#">sf</a> object of spatial points rather than the default data frame.

## Value

Data frame, or [sf](#) object if `return_sf = TRUE`, containing stixel summary data. Data are organized with one stixel per row and each stixel identified by a unique `stixel_id`, the centroid of each stixel in space and time is specified by `lat`, `lon`, and `date`.

## Examples

```

## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# load stixel summary information
stixels <- load_stixels(path)

```

```
dplyr::glimpse(stixels)

## End(Not run)
```

---

parse\_raster\_dates      *Parse data cube layer names into dates*

---

### Description

`label_raster_stack()` labels the layers of a data cube with the associated week dates in the format of "wYYYY.MM.DD", because of constraints in the raster package. This function converts that character vector into an ISO compliant Date vector.

### Usage

```
parse_raster_dates(x)
```

### Arguments

x                      Raster object; labeled Status and Trends data cube.

### Value

Date vector.

### Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data")
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# weekly relative abundance
# note that only low resolution (1r) data are available for the example data
abd <- load_raster(path, "abundance", resolution = "1r")

# parse dates
parse_raster_dates(abd)

## End(Not run)
```

---

plot_pds	<i>Plot partial dependency (PD) line plots</i>
----------	--

---

### Description

For a given eBird Status and Trends species, produce a line plot showing the partial dependence (PD) relationship for a given predictor. Two options for smoothing are provided.

### Usage

```
plot_pds(
  pds,
  predictor,
  ext,
  bootstrap_smooth = TRUE,
  show_stixel_pds = FALSE,
  show_quantiles = FALSE,
  n_bs = 100,
  ss_equivalent = 10,
  k = 25,
  ci_alpha = 0.05,
  gbm_n_trees = 500,
  ylim = NULL,
  plot = TRUE
)
```

### Arguments

pds	data frame; partial dependence data from <a href="#">load_pds()</a> .
predictor	character; single predictor name to plot PD for. For a full list of predictors, and their associated definitions, see <a href="#">ebirdst_predictors</a> .
ext	<a href="#">ebirdst_extent</a> object; the spatiotemporal extent over which to calculate PDs. This is required, since results are less meaningful over large spatiotemporal extents.
bootstrap_smooth	logical; the ideal visualization of the PD data is a pointwise GAM smoothing of the individual stixel PD values. This argument specifies whether this should be done directly on the full PD dataset ( <code>bootstrap_smooth = FALSE</code> ) or by sub-sampling and bootstrapping. The latter approach deals with the randomness in the data and can be more efficient for large datasets.
show_stixel_pds	logical; whether to plot the individual stixel PD values as semi-transparent lines.
show_quantiles	logical; adds a band for the upper (90th) and lower (10th) quantiles of the individual stixel PD values. These are calculated using quantile regression.
n_bs	int; number of GAM bootstrap iterations when estimating PD confidence intervals. Ignored if <code>bootstrap_smooth = FALSE</code> .

ss_equivalent	int; when bootstrapping to estimate PD confidence intervals, this argument specifies the size of the subsample of the original data. In particular, <code>ss_equivalent</code> should be an integer representing the equivalent sampling size when averaging this number of PD estimates.
k	integer; number of knots to use in the GAM when smooth the PD relationship.
ci_alpha	numeric; alpha level of confidence intervals. Default is 0.05.
gbm_n_trees	integer; number of trees to fit in the GBM when estimating quantiles. Ignored if <code>show_quantiles = FALSE</code> . Default is 500.
ylim	numeric; 2-element vector to pre-define the y-limits of plotting. In the format <code>c(ymin, ymax)</code> .
plot	logical; whether to plot the PD relationships or just return data.

### Value

Plots the smoothed partial dependence relationship for the specified predictor and returns a data frame of the smoothed curve with confidence intervals.

### Examples

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# load predictor dependence data
pds <- load_pds(path)

# define a spatiotemporal extent to plot data from
bb_vec <- c(xmin = -90, xmax = -82, ymin = 41, ymax = 48)
e <- ebirdst_extent(bb_vec, t = c("05-01", "05-31"))

# for testing, run with 5 bootstrap iterations for speed
# in practice, best to run with the default number of iterations (100)
pd_smooth <- plot_pds(pds, "solar_noon_diff_mid", ext = e, n_bs = 5)
dplyr::glimpse(pd_smooth)

## End(Not run)
```

---

plot\_pis

*Plot predictor importance (PI) box plots*

---

### Description

For a given eBird Status and Trends species, produce a box plot showing the predictor importance (PI) for each of the predictors used in the occurrence model. Predictors are plotted in order from highest to lowest importance. Many function parameters allow for customized plots.



**Usage**

```
plot_pis(
  pis,
  ext,
  by_cover_class = TRUE,
  n_top_pred = 15,
  pretty_names = TRUE,
  plot = TRUE
)
```

**Arguments**

<code>pis</code>	data frame; predictor importance data from <code>load_pis()</code> .
<code>ext</code>	<code>ebirdst_extent</code> object; the spatiotemporal extent over which to calculate PIs. This is required, since results are less meaningful over large spatiotemporal extents.
<code>by_cover_class</code>	logical; whether to aggregate the FRAGSTATS metrics (PLAND and ED) for the land cover classes into single values for the land cover classes.
<code>n_top_pred</code>	integer; how many predictors to show.
<code>pretty_names</code>	logical; whether to convert cryptic land cover codes to readable land cover class names.
<code>plot</code>	logical; whether to plot predictor importance or just return top predictors.

**Value**

Plots a boxplot of predictor importance and invisibly returns the PI data subset to just the top predictors, grouped and renamed according to `by_cover_class` and `pretty_names`.

**Examples**

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# load predictor importance
pis <- load_pis(path)

# define a spatiotemporal extent to plot data from
bb_vec <- c(xmin = -86, xmax = -83, ymin = 41.5, ymax = 43.5)
e <- ebirdst_extent(bb_vec, t = c("05-01", "05-31"))

top_pred <- plot_pis(pis, ext = e, n_top_pred = 10)
top_pred

## End(Not run)
```

---

poisson_dev	<i>Poisson deviance</i>
-------------	-------------------------

---

**Description**

Poisson deviance

**Usage**

```
poisson_dev(obs, pred)
```

**Arguments**

obs	numeric; observed values.
pred	numeric; predicted values.

**Value**

A named numeric vector with three elements: model deviance, mean deviance, and deviance explained.

**Examples**

```
obs <- c(0, 0, 1, 3, 5, 2)
pred <- c(0.5, 0.1, 2.5, 3.3, 5.2, 2.5)
ebirdst:::poisson_dev(obs, pred)
```

---

project_extent	<i>Transform a spatiotemporal extent to a different CRS</i>
----------------	---

---

**Description**

Transform an eBird Status and Trends extent object to a different coordinate reference system. This is most commonly required to transform the extent to the sinusoidal CRS used by the eBird Status and Trends rasters.

**Usage**

```
project_extent(x, crs)
```

**Arguments**

x	<a href="#">ebirdst_extent</a> object; a spatiotemporal extent.
crs	coordinate references system, given either as a proj4string, an integer EPSG code, or a crs object generated with <a href="#">st_crs()</a> .

**Value**

An `ebirdst_extent` object in the new CRS.

**Examples**

```
# construct an ebirdst_extent object
bb_vec <- c(xmin = -80, xmax = -70, ymin = 40, ymax = 47)
bb <- sf::st_bbox(bb_vec, crs = 4326)
bb_ext <- ebirdst_extent(bb)

# transform to sinusoidal projection of rasters
sinu <- "+proj=sinu +lon_0=0 +x_0=0 +y_0=0 +a=6371007 +b=6371007 +units=m +no_defs"
project_extent(bb_ext, crs = sinu)

# also works on polygon extents
poly <- sf::read_sf(system.file("shape/nc.shp", package="sf"))
poly_ext <- ebirdst_extent(poly)
project_extent(poly_ext, crs = sinu)
```

---

sample\_grid

*Spatiotemporal sampling of points on a grid*


---

**Description**

Subsample points to deal with spatiotemporal bias in observations by defining a grid in space and time, then sampling the given number of points from each cell. `sample_case_control()` additionally samples presence and absence independently.

**Usage**

```
sample_grid(x, res, t_res, n = 1, replace = FALSE, jitter = TRUE)
```

```
sample_case_control(x, res, t_res, n = 1, replace = FALSE, jitter = TRUE)
```

**Arguments**

<code>x</code>	data frame or <code>sf</code> object; the points to subsample. If <code>x</code> is a data frame the coordinates should be provided as columns <code>latitude</code> and <code>longitude</code> . The day of year should be expressed as an integer from 1-366.
<code>res</code>	numeric; the size in meters of the grid to sample from. This can be a 2 element vector indicating the x and y dimensions of the cells.
<code>t_res</code>	numeric; the temporal resolution for sampling expressed as a proportion of the year. For example, <code>7 / 365</code> would result in sampling from each week.
<code>n</code>	integer; the number of points to sample from each grid cell.
<code>replace</code>	logical; whether to sample with replacement.
<code>jitter</code>	logical; to avoid always using the same grid for sampling, the grid can be jittered so that the origin is different each time this function is called.

**Value**

Logical vector indicating which rows are selected.

**Examples**

```
## Not run:
# download example data
path <- ebirdst_download("example_data", tifs_only = FALSE)
# or get the path if you already have the data downloaded
path <- get_species_path("example_data")

# test data to sample
preds <- load_predictions(path, return_sf = TRUE)

# sample on a 100, 4 month grid
s <- sample_grid(preds, res = 100000, t_res = 1 / 4)
preds_grid <- preds[s, ]

# case control sampling independently samples presence and absence
s <- sample_case_control(preds, res = 1000000, t_res = 1 / 12)
preds_cc <- preds[s, ]

# grid sampling preserves the presence/absence ratio
table(preds$obs > 0) / nrow(preds)
table(preds_grid$obs > 0) / nrow(preds_grid)
# while case control sampling increases the prevalence of presences
table(preds_cc$obs > 0) / nrow(preds_cc)

# plot
library(sf)
p <- par(mar = c(0, 0, 0, 0))
plot(st_geometry(preds), col = "black", pch = 19, cex = 0.2)
plot(st_geometry(preds_cc), col = "red", pch = 19, cex = 0.5, add = TRUE)

## End(Not run)
```

---

```
set_ebirdst_access_key
```

*Store the eBird Status and Trends access key*

---

**Description**

Accessing eBird Status and Trends data requires an access key, which can be obtained by visiting <https://ebird.org/st/request>. This key must be stored as the environment variable EBIRDST\_KEY in order for `ebirdst_download()` to use it. The easiest approach is to store the key in your `.Renvirom` file so it can always be accessed in your R sessions. Use this function to set EBIRDST\_KEY in your `.Renvirom` file provided that it is located in the standard location in your home directory. It is also possible to manually edit the `.Renvirom` file. **The access key is specific to you and should never be shared or made publicly accessible.**

**Usage**

```
set_ebirdst_access_key(key, overwrite = FALSE)
```

**Arguments**

key	character; API key obtained by filling out the form at <a href="https://ebird.org/st/request">https://ebird.org/st/request</a> .
overwrite	logical; should the existing EBIRDST_KEY be overwritten if it has already been set in .Renviron.

**Value**

Edits .Renviron, then returns the path to this file invisibly.

**Examples**

```
## Not run:
# save the api key, replace XXXXXX with your actual key
set_ebirdst_access_key("XXXXXX")

## End(Not run)
```

---

stixelize

*Generate polygons for eBird Status and Trends stixels*


---

**Description**

eBird Status and Trends divides space and time into variably sized "stixels" within which individual base models are fit. The process of stixelization is performed many times and the prediction at any given point is the median of the predictions from all the stixels that that point falls in. [load\\_stixels\(\)](#) loads information on all the stixels that compromise a species' Status and Trends model, with stixels identified by the location of their centroid. This function uses this information to define polygons for each stixel and attaches them to the original data in the form of an [sf](#) object.

**Usage**

```
stixelize(x)
```

**Arguments**

x	data frame; stixel summary data loaded with <a href="#">load_stixels()</a> , or any other data frame with fields lonitude_min, lontidue_max, latitude_min, and latitude_max.
---	--

**Value**

[sf](#) object with geometry column storing polygons representing the stixels boundaries.

**Examples**

```
## Not run:  
# download example data  
path <- ebirdst_download("example_data", tifs_only = FALSE)  
# or get the path if you already have the data downloaded  
path <- get_species_path("example_data")  
  
# load stixel summary information  
stixels <- load_stixels(path)  
  
# build stixel polygons  
stixelize(stixels)  
  
## End(Not run)
```

# Index

- \* **datasets**
  - ebirdst\_predictors, 14
  - ebirdst\_runs, 15
  - ebirdst\_weeks, 18
- abundance\_palette, 3
- bernoulli\_dev, 3
- binom\_test\_p, 4
- date\_to\_st\_week, 4
- ebirdst, 5
- ebirdst\_data\_dir, 5
- ebirdst\_download, 6
- ebirdst\_download(), 36
- ebirdst\_extent, 7, 9, 12–14, 17, 23, 24, 29, 31, 33–35
- ebirdst\_extent(), 16
- ebirdst\_habitat, 9, 10
- ebirdst\_habitat(), 10
- ebirdst\_ppms, 11, 12, 13
- ebirdst\_ppms(), 12, 25
- ebirdst\_ppms\_ts, 13, 13
- ebirdst\_ppms\_ts(), 13
- ebirdst\_predictors, 10, 14, 23, 31
- ebirdst\_runs, 6, 15, 19
- ebirdst\_subset, 16
- ebirdst\_subset(), 12
- ebirdst\_version, 17
- ebirdst\_weeks, 13, 18
- get\_species, 18
- get\_species\_path, 19
- label\_raster\_stack, 20
- label\_raster\_stack(), 30
- load\_config, 21
- load\_fac\_map\_parameters, 22
- load\_pds, 23
- load\_pds(), 10, 31
- load\_pis, 24
- load\_pis(), 10, 33
- load\_predictions, 25
- load\_ranges, 26
- load\_raster, 27
- load\_stixels, 29
- load\_stixels(), 37
- parse\_raster\_dates, 30
- plot.ebirdst\_habitat (ebirdst\_habitat), 9
- plot.ebirdst\_ppms (ebirdst\_ppms), 11
- plot.ebirdst\_ppms\_ts (ebirdst\_ppms\_ts), 13
- plot\_pds, 31
- plot\_pis, 32
- poisson\_dev, 34
- project\_extent, 34
- read\_sf(), 8
- sample\_case\_control (sample\_grid), 35
- sample\_case\_control(), 35
- sample\_grid, 35
- set\_ebirdst\_access\_key, 36
- set\_ebirdst\_access\_key(), 6
- sf, 8, 23–25, 29, 35, 37
- sfc, 8
- st\_bbox(), 8
- st\_crs(), 8, 34
- stixelize, 37
- str\_detect(), 6