# Group Project: Swiss Breeding Birds

Participants of the group project „Swiss breeding birds“ will work on a species distribution model (SDM) of breeding birds in Switzerland. The Swiss Ornithological Institute in Sempach kindly provides bird observation data and environmental variables for this project.

The provided bird observation data is a sample from the data set that was collected during field work (2013-2016) for the latest atlas of Swiss breeding birds (Knaus et al., 2018). Environmental data are official data from the Swiss federal statistical office, distributed by the Swiss Ornithological Institute.

Bird observation data was collected by hundreds of volunteers and also some professional birders, between 2013-2016, following an experimental design where a random sample of a total of about 2300 1 $km^2$ plots were re-visited 2-3 times throughout one breeding period within the project duration. These atlas squares are spread across Switzerland (see map). A detailed description of the methods can be found in the breeding bird atlas from page 50 onwards. A table of the environmental variables that were used in the atlas can be found on page 68. For data propriety reasons, only 15 of the official set of 16 variables can be provided here.

The sample provided for this project contains data from 131 different species and is in presence-only format. However, since during field work, any potential Swiss breeding bird had to be recorded, we can infer observed absence if a species is part of the entire data set, but not on the list of a particular atlas square. (It may be possible to later obtain count data if the group decides it be relevant for their project.) The last four columns in the bird data correspond to survey square IDs, based on the official Swiss grid classification; hence it corresponds to the grid of the environmental variables and enables you to link the two data sets.

SDMs consist of learning correlative relationships between species measures (eg. presence, counts, weights, etc.) and environmental variables in order to make predictions across a spatial region. SDMs are based on the concept of the ecological niche, that there are a set of environmental conditions that sustain the survival of a species. The relationship between a species and its environment can therefore be used to make predictions about the likely occurrence or measure of a species at unobserved locations given the environmental parameters.

In addition to environmental information, spatial correlations can also be used to predict the distribution of a species across the landscape. Spatial patterns in a species can be the result of a spatially structured missing covariate or due to biological spatial patterns resulting from processes such as movement, competition, or predation, etc.

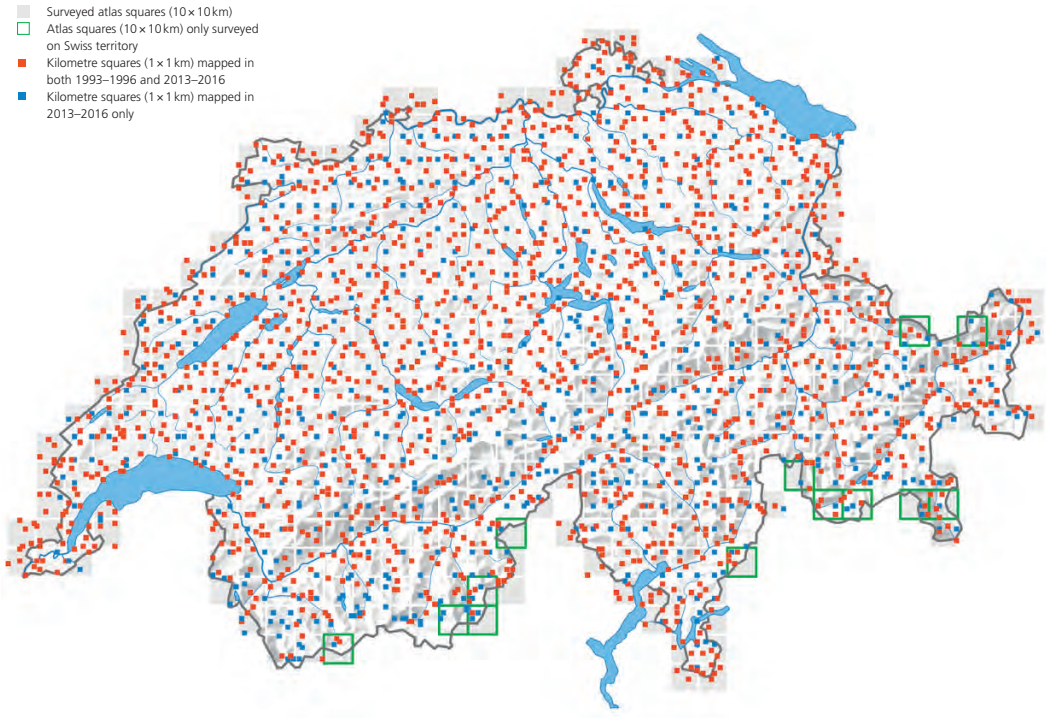
SDMs have a long history in ecology. Unsurprisingly, a diverse set of modeling tools are available for constructing SDMs and range from machine learning techniques to generalized linear regression and hierarchical modeling. Given the scope of this workshop, we will be using the Template Model Builder (TMB) to develop hierarchical SDMs based on both, environmental covariates and spatial random effects.

**Links:**

Swiss Ornithological Institute: https://www.vogelwarte.ch/en/home/
Swiss breeding bird atlas 2013-2016 (Knaus et al., 2018):
https://www.dropbox.com/s/46s6x2tg16be3k1/SwissBreedingBirdAtlas_2013_2016.pdf?dl=0

SDM
https://damariszurell.github.io/SDM-Intro/

TMB
https://www.youtube.com/watch?v=A5CLrhzNzVU
https://www.youtube.com/watch?v=M8dR3mvZ5vc
https://sites.google.com/site/tmbisec2018/home
GlmmTMB
https://cran.r-project.org/web/packages/glmmTMB/vignettes/covstruct.html




*467 atlas squares (10 × 10 km) were surveyed in 2013–2016 (light grey). In 13 atlas squares, most of them along the southern border, only the Swiss side was surveyed (squares outlined in green). Red dots represent kilometre squares (1 × 1 km) where territory mapping was carried out in both 1993–1996 and 2013–2016, blue dots those surveyed in 2013–2016 only.*

# Environmental variables

| No. | Environmental variable | Description | Data set 1993–1996 | Data set 2013–2016 |
|---|---|---|---|---|
| 1 | Lakes (% of area) | Lakes, ponds, oxbow lakes etc. | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 2 | Agricultural grassland (% of area) | Farm pastures, Alpine pastures, meadows etc. | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 3 | Forest (% of area) | Forest, afforestations, open woodland etc. | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 4 | Structured grassland (% of area) | Brush forest, bushes & shrubby vegetation, clusters of trees, hedges, golf courses, parks etc. | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 5 | Arable land (% of area) | Arable land | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 6 | Screes & rocks (% of area) | Screes, rocks | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 7 | Glaciers (% of area) | Glaciers | Land-use statistics 1992–1997 | Land-use statistics 2004–2009 |
| 8 | Lake shores (m) | Length of lake shores | VECTOR25 (Version 2008) | VECTOR25 (Version 2008) |
| 9 | Buildings ($m^2$) | Ground area of buildings | VECTOR25 (Version 2004) | Topographic Landscape Model |
| 10 | Watercourses (km) | Length of all watercourses (incl. ditches) | VECTOR25 (Version 2008) | Topographic Landscape Model |
| 11 | Rivers and streams (m) | Length of large watercourses (stream order ≥3) | VECTOR25 (Version 2008) | VECTOR25 (Version 2008) |
| 12 | Wetlands ($m^2$) | Area of wetlands | VECTOR25 (Version 2007) | Topographic Landscape Model |
| 13 | Nitrogen deposition (kg N/ha/year) | Average nitrogen deposition per hectare and year | Meteotest 1990 | Meteotest 2010 |
| 14 | Exposure (–) | Average north-south index, slope exposure (e.g. north-facing, …) | Digital height model | Digital height model |
| 15 | Altitude (m a.s.l.) | Average altitude | Digital height model | Digital height model |
| 16 | Slope gradient (°) | Average slope gradient | Digital height model | Digital height model |

*The 16 environmental variables used for modelling, including a description and the data set for 1993–1996 and 2013–2016.*

See page 68 in the swiss breeding bird atlas for more information.
Variable 13 (nitrogen deposition) will not be provided due to data sensitivity.