Introduction to citizen science data

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Gfoe workshop,

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Outline

- diversity of citizen science data
- bias associated with each (site selection, reporting bias, detection issues …)
- simple trend models

Diversity of citizen science

Structured data

- Standardized sampling protocol
- Site-selection – sometimes stratified random, often not

Semi-structured data

- No standardized sampling protocol
- Site selection - free
- Metadata associated with data informs on survey methods

Unstructured data

- No standardized sampling protocol
- Site selection – free
- Little metadata

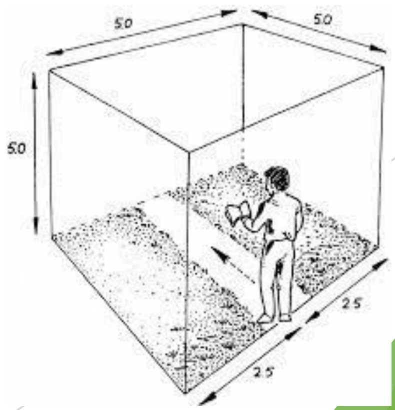
Structured citizen science

- Analysis is (relatively) easy!!
- Still can be site selection biases and missing data issues (see Bled et al. 2013; Sauer et al. 2020; bbBayes)

The North American Breeding Bird Survey

BBS

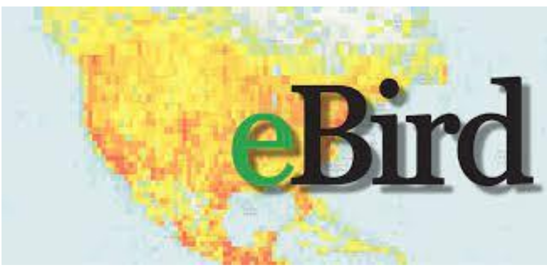
tagfalter-monitoring.de



Semi-structured and structured data

- Examples:

iNaturalist



FLORA incognita

naturgucker.de

GBIF
Global Biodiversity Information Facility

Observation.org

Semi-structured and structured data

- Analysis more difficult!
- People are not coordinated in their efforts
- Variation among people in how they collect data

How do people vary in data collection?

Table 1. Traits of recorders that could be influential in describing different recorder 'profiles' or 'syndromes'; a range of potential profiles have been identified

Trait	Relevance to information content
Complete lists?	An indication of the typical effort per survey
Coverage of 'rare' species	Predilection for reporting unusual sightings
Coverage of difficult species	Taxonomic expertise
Length of activity of reporting	Temporal footprint
Frequency of recording	Productivity and consistency
Spatial variation in recording	Spatial footprint of the data
Variation in recording across taxa	Consistency of recording across taxa (taxonomic specialist vers

Isaac and Pocock, 2015

Semi-structured and structured data

- Analysis more difficult!

- Need to consider observation/sampling processes:
  - People are not coordinated in their efforts
  - Variation among people in how they collect data

- Need to model these observation/sampling processes
  - Estimating detection probability
  - ‘Imperfect detection’

Concept of imperfect detection

- When we do a wildlife survey, we (almost) never see all individuals of a species present.

Is imperfect detection always a problem?

- No – we don’t need to worry about imperfect detection when:

  - We can assume detection probability don’t change over time or space

  and

  - we are only interested in species’ relative occurrences/abundances and not absolute values.

- We make this assumption most of the time when we analyze structured citizen science data

When can imperfect detection be a problem?

- We are comparing among habitats

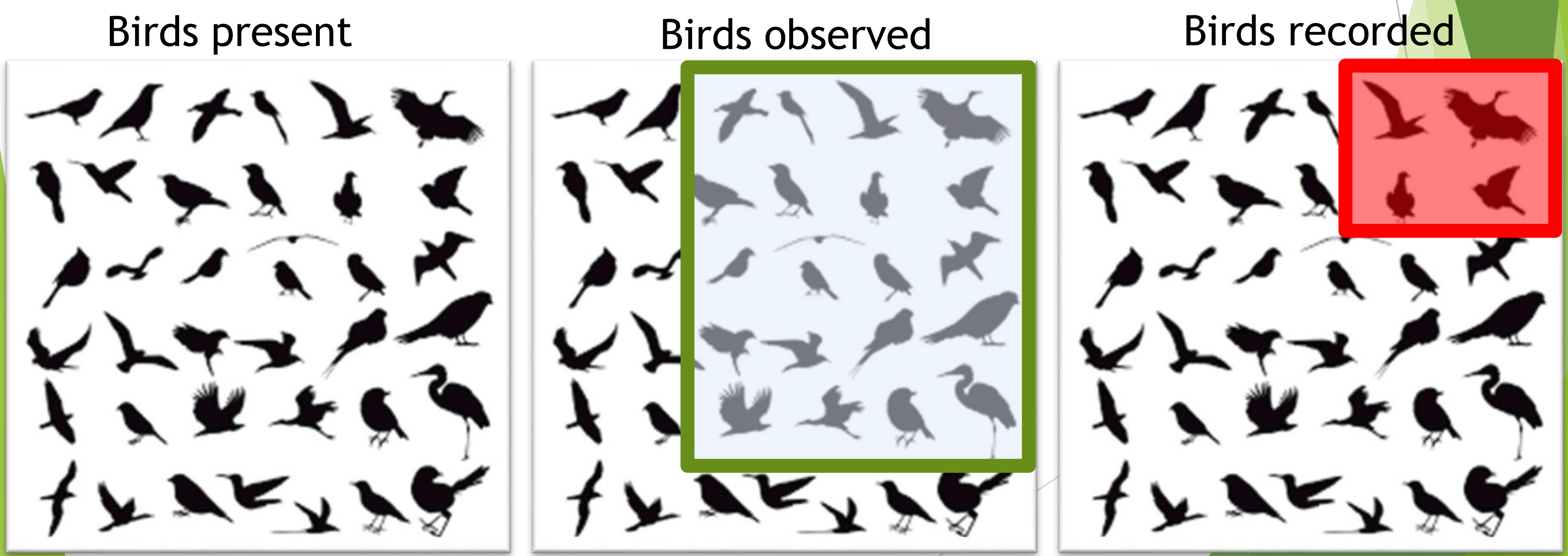
- We are comparing among species

- We are comparing among surveys collected with different methods or durations

Imperfect reporting too!!

- Most unstructured citizen science observations are just of one species … probably more species were seen!!!
  - Presence-only data

- For semi-structured citizen science, we might have metadata on whether an observation comes from a ‘complete checklist’
  - Presence-absence data



Hierarchical models for citizen science data

- Models to ask questions about:
- How large is the population or distribution of my species?
- What factors explain where my species lives?
- Is my species declining or increasing over time?

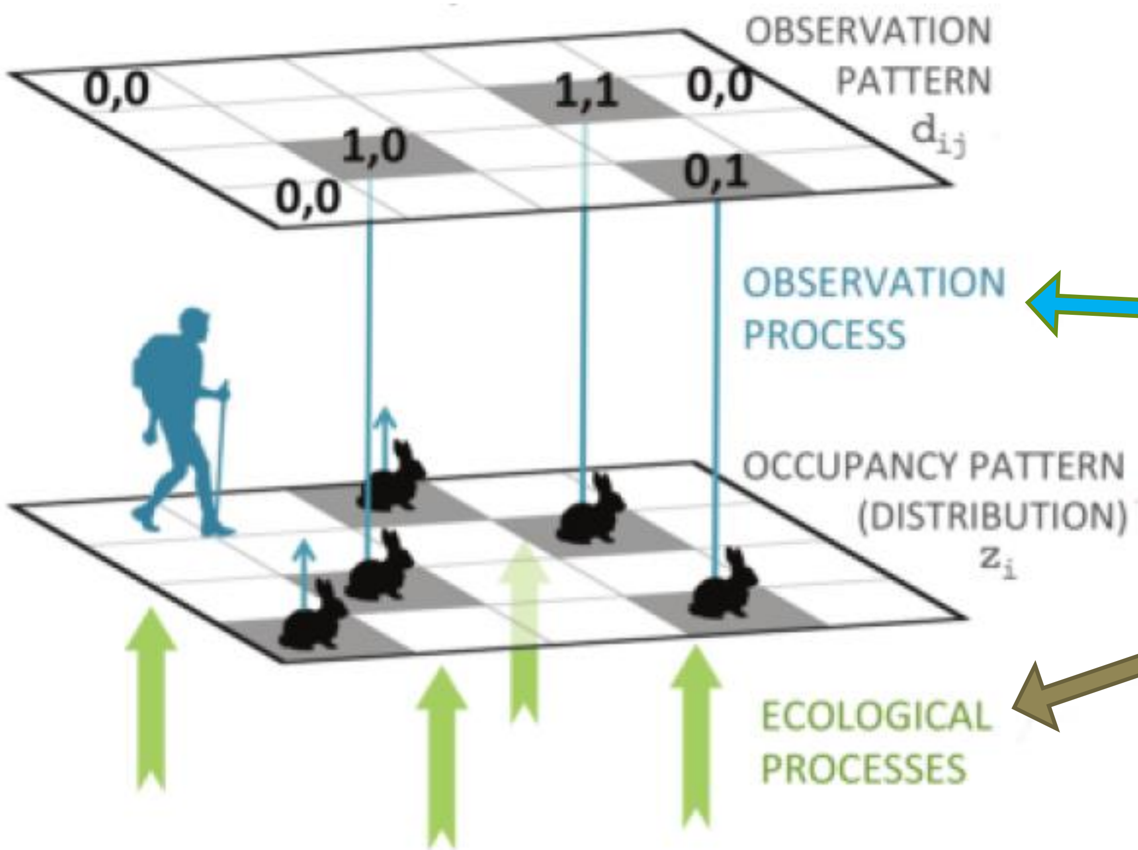
Different types of related models

- Occupancy Models
- N-Mixture Models
- Distance sampling Models

- All these models assume data is generated by:
  - ecological processes affecting where the species is
  - observation (or sampling) processes affecting where the species is detected by my survey method

- We have separate models for each process

Hierarchical models to account for observation/sampling processes



Usually modelled separately

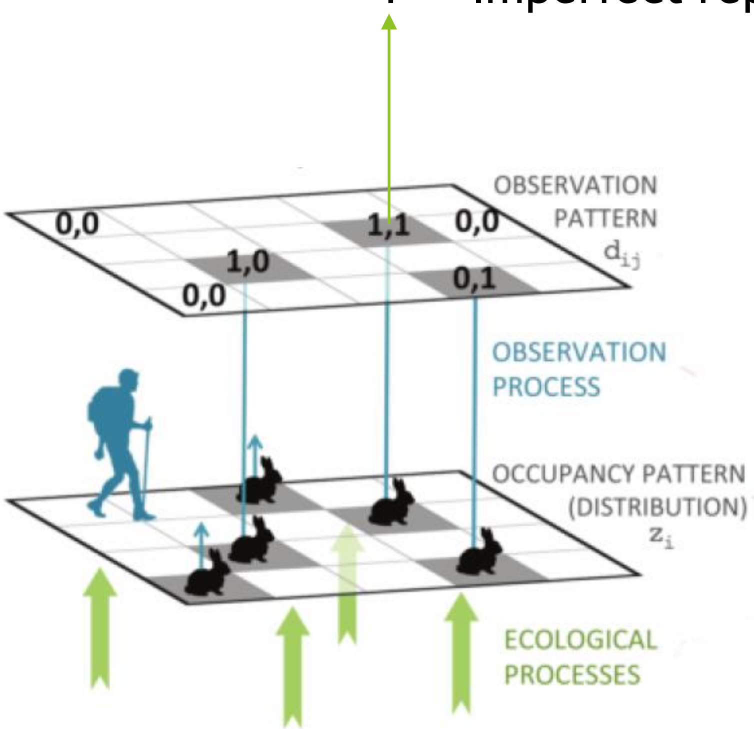
Image by: Res Altwegg

Imperfect detection in CS includes imperfect reporting

- In unstructured citizen science, people might see more species than they report

1 Imperfect reporting

Observation and reporting process usually modelled together



Common detection covariates

Type	Direction
Sampling effort	Species are more detectable with longer survey duration
Checklist length	Single list (opportunistic) or longer (complete checklist?)
Date of year	Dependent on species' phenology (e.g., flight period of butterflies)
Observer	More experienced observers might be able to detect species more often
Forest cover	Species harder to see in forest
Climate	Some species (e.g., many insects) are amore active on warm, sunny, rain-free days
……	

Depends on survey method: visual, acoustic, DNA-based etc..

Simple trend analysis

- Response: Count (Poisson or negative binomial) or Occurrence (binomial)
- Predictors: Site and Year (as fixed or random effects)

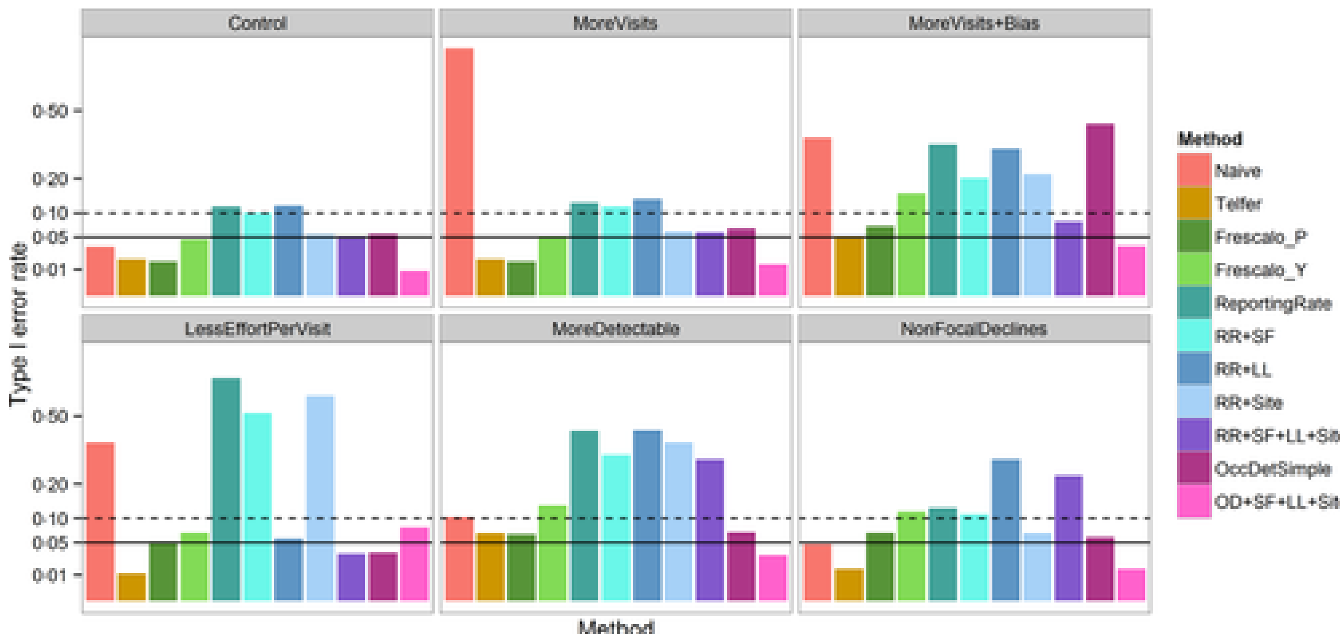
Useful resources

Methods in Ecology and Evolution
BRITISH ECOLOGICAL SOCIETY

Research Article | Open Access

Statistics for citizen science: extracting signals of change from noisy ecological data

Nick J. B. Isaac, Arco J. van Strien, Tom A. August, Marnix P. de Zeeuw, David B. Roy



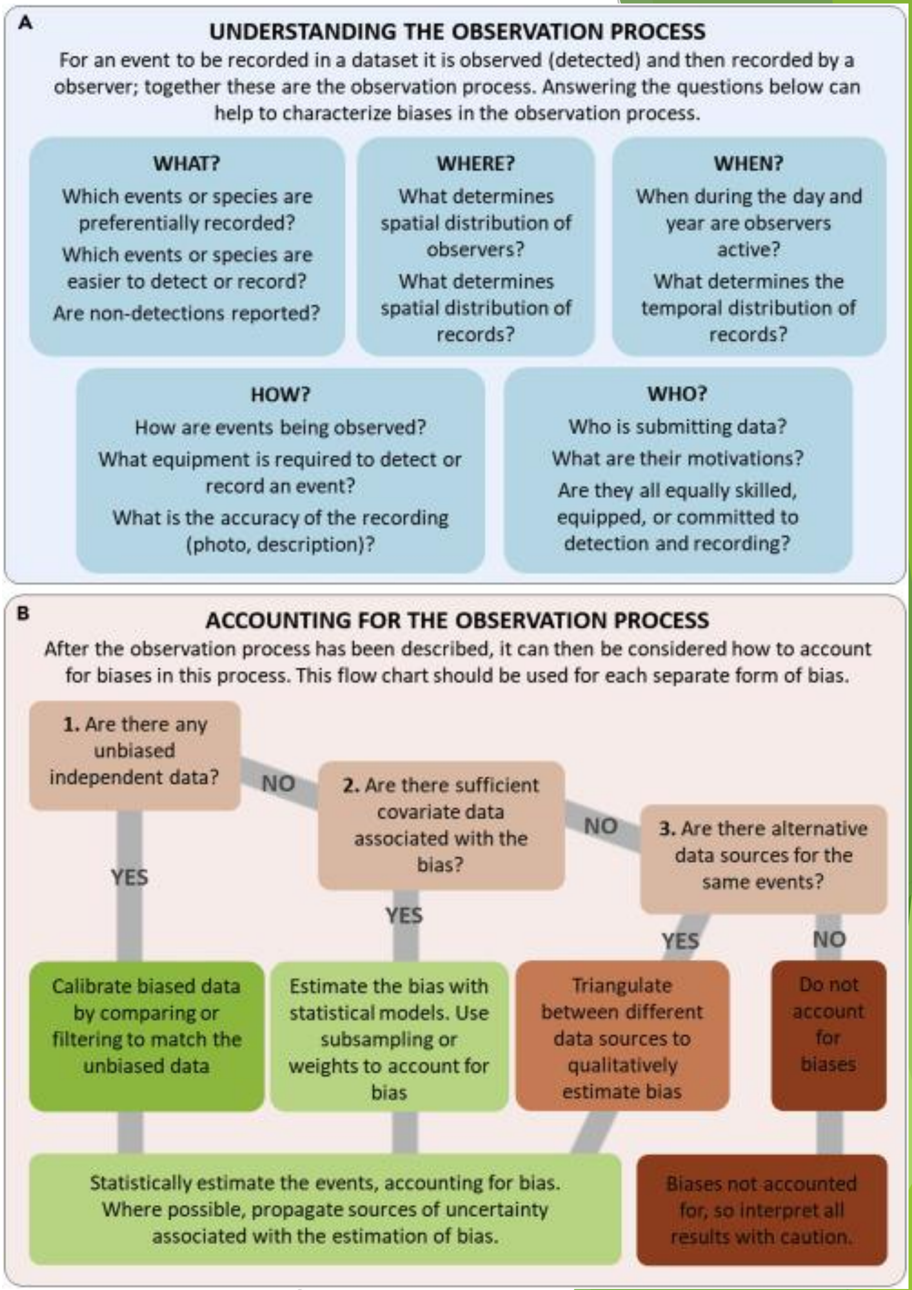
Useful resources

One Earth
Volume 2, Issue 5, 22 May 2020, Pages 455-465

Perspective

Making Messy Data Work for Conservation

A.D.M. Dobson [1], E.J. Milner-Gulland [2], Nicholas J. Aebischer [3], Colin M. Beale [4], Robert Brozovic [5], Peter Coals [6], Rob Critchlow [4], Anthony Dancer [7], Michelle Greve [8], Amy Hinsley [6], Harriet Ibbett [9], Alison Johnston [10], Timothy Kuiper [2], Steven Le Comber [11, 20], Simon P. Mahood [12, 13], Jennifer F. Moore [14], Erlend B. Nilsen [15], Michael J.O. Pocock [16] ... Aidan Keane [1]



Useful resources

Methods in Ecology and Evolution | BRITISH ECOLOGICAL SOCIETY

ADVANCES IN MODELLING DEMOGRAPHIC PROCESSES | Free Access

Occupancy models for citizen-science data

Res Altwegg, James D. Nichols

Table 1. Summary of points to consider when designing an atlas project to be analysed using occupancy models

	Feature	Design	Analysis
1	Size of spatial unit	Design choice: (a) > home range size, (b) ~ home range size, (c) < home range size	Interpretation of results as occupancy vs. use
2	Spatial sampling	Design choice: (a) each grid cell has known probability of being visited, (b) ensure that sampling is well distributed over relevant spatial covariates	(a) Covariate modelling that describes spatial occupancy patterns well, (b) direct modelling of spatial sampling process (Conn et al., 2017)
3	Unmodelled heterogeneity	Reduce heterogeneity: (a) ask volunteers to visit all habitats, (b) train observers to reduce variability in skills, (c) collect data on relevant covariates	(a) Model informative detection covariates, (b) model heterogeneity using random effects, (c) abundance models for abundance-induced heterogeneity
4	Independent detections	(a) Encourage different observers to visit same grid cell, (b) enforce time gap between observations from the same observer	(a) Model dependence in detection probabilities (e.g., as removal process), (b) model spatial dependence
5	False detections	(a) Tell observers to only record unambiguous identifications, (b) vet incoming data, (c) collect extra data required for false detection modelling	a) Model false detection probability
6	Closure	(a) Repeated checklists close together in time, (b) grid cells large enough to contain several	(a) Entry-only and exit-only models, (b) single entry–exit models, (c)

Useful resources

OIKOS
ADVANCING ECOLOGY

Forum | Full Access

Deriving indicators of biodiversity change from unstructured community-contributed data

Giovanni Rapacciuolo, Alison Young, Rebecca Johnson

First published: 04 June 2021 | https://doi.org/10.1111/oik.08215 | Citations: 1