Now you see me, now you don't…
Why population trends should account for imperfect detection

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Introduction

The accurate monitoring of population trends is vital both in order to identify drivers of change and to prioritise species most in need of conservation.

Indices such as IUCN Red Lists frequently use occupancy data to assess population patterns. Such data is typically obtained by periodically revisiting a suite of sites and recording whether the species was observed.

This approach implicitly assumes that if the species is present we are certain to detect it, however this is almost never the case. Imperfect detection will therefore create biases in trend estimates.

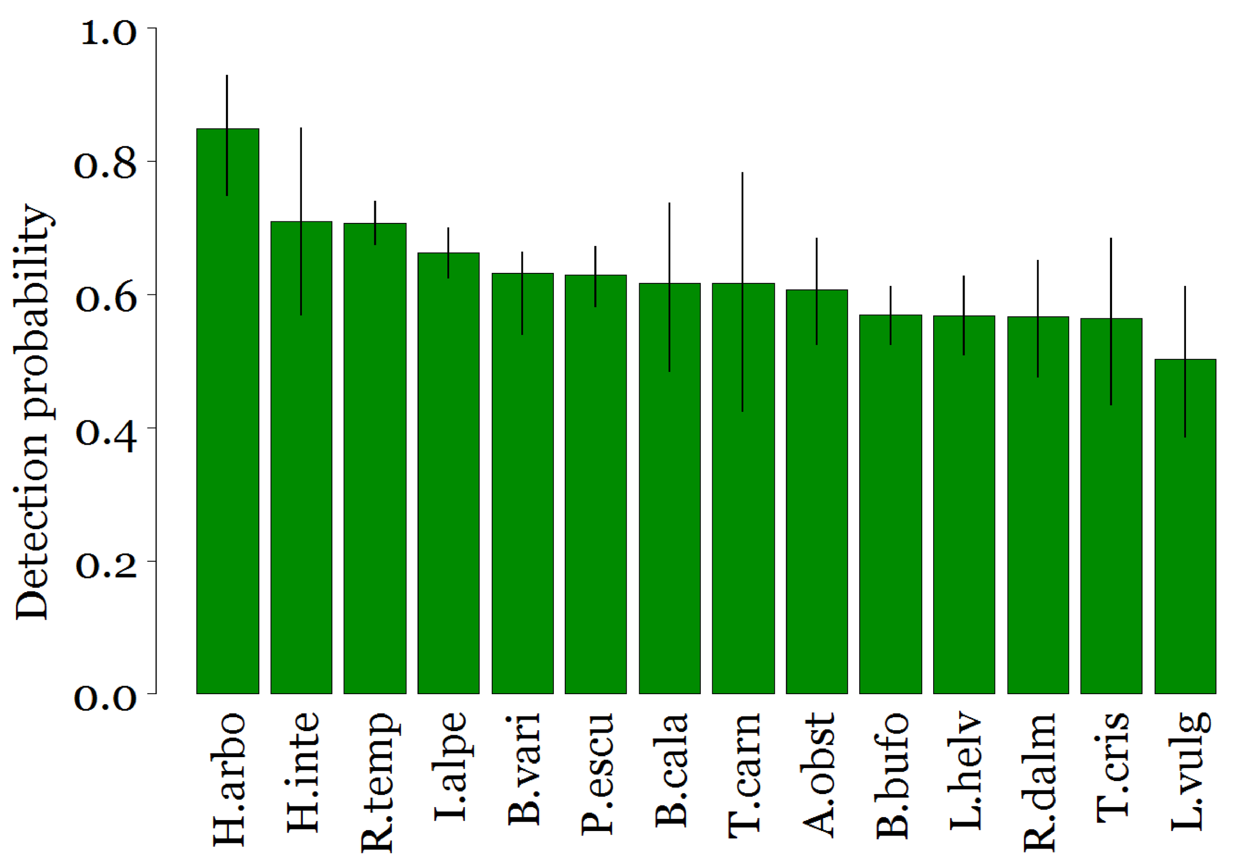
Here we estimate occupancy trends across Switzerland for 14 amphibian species, using both a method that controls for detection probability and a 'naïve' estimate which assumes detection is perfect.

We also map these measures onto Red List criteria to illustrate how ignoring detection probabilities can overestimate extinction threat.

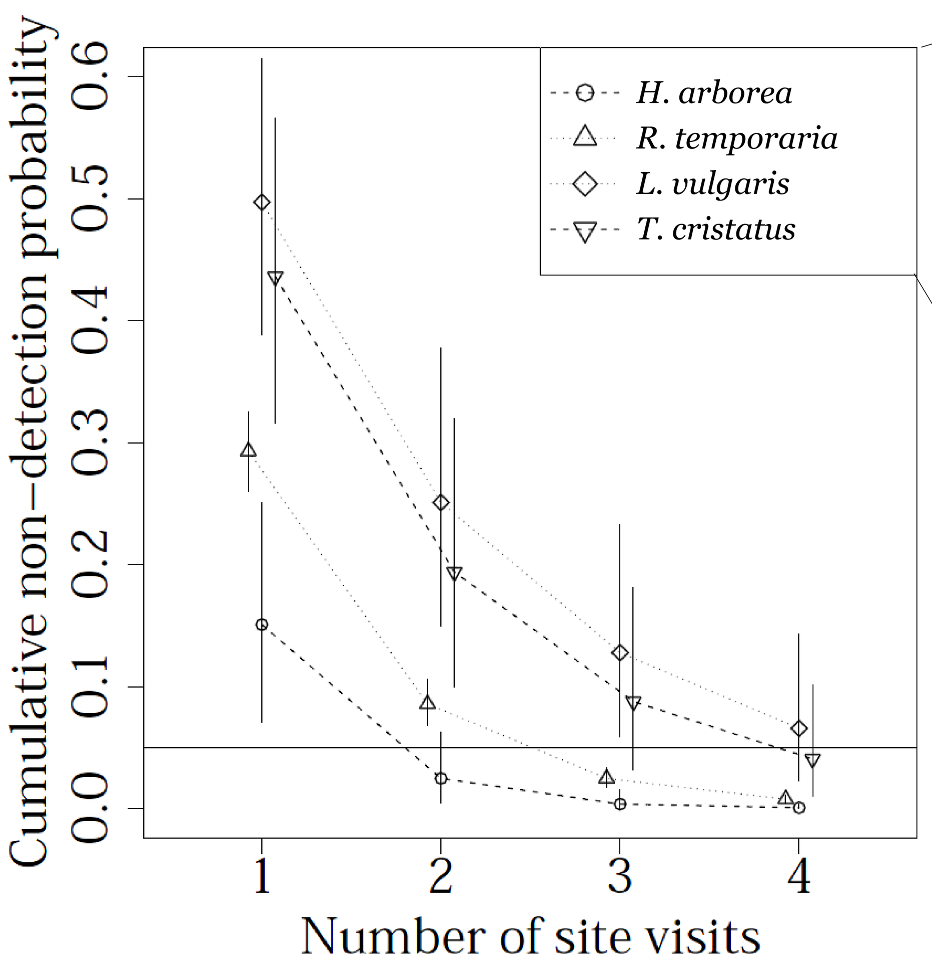
Conclusions

- Imperfect detection is the norm and detection probabilities vary considerably among species.
- Failing to account for imperfect detection biases population trends to an unknown extent and overinflates extinction risks.
- Repeated visits within a season allow us to estimate detection probabilities, establish true occupancy status and so identify unbiased population trends.
- Hierarchical models are a useful tool that can easily account for variation in detection probabilities and the effects of other environmental covariates to produce more accurate occupancy estimates.

Estimates of detection probability for 14 amphibian species



Cumulative non-detection probabilities and 95% credible intervals for the species with the highest and lowest detection probabilities



For most species, four visits without detecting presence were required to be 95% confident that the species was not occupying the site (horizontal line).

Data and Model

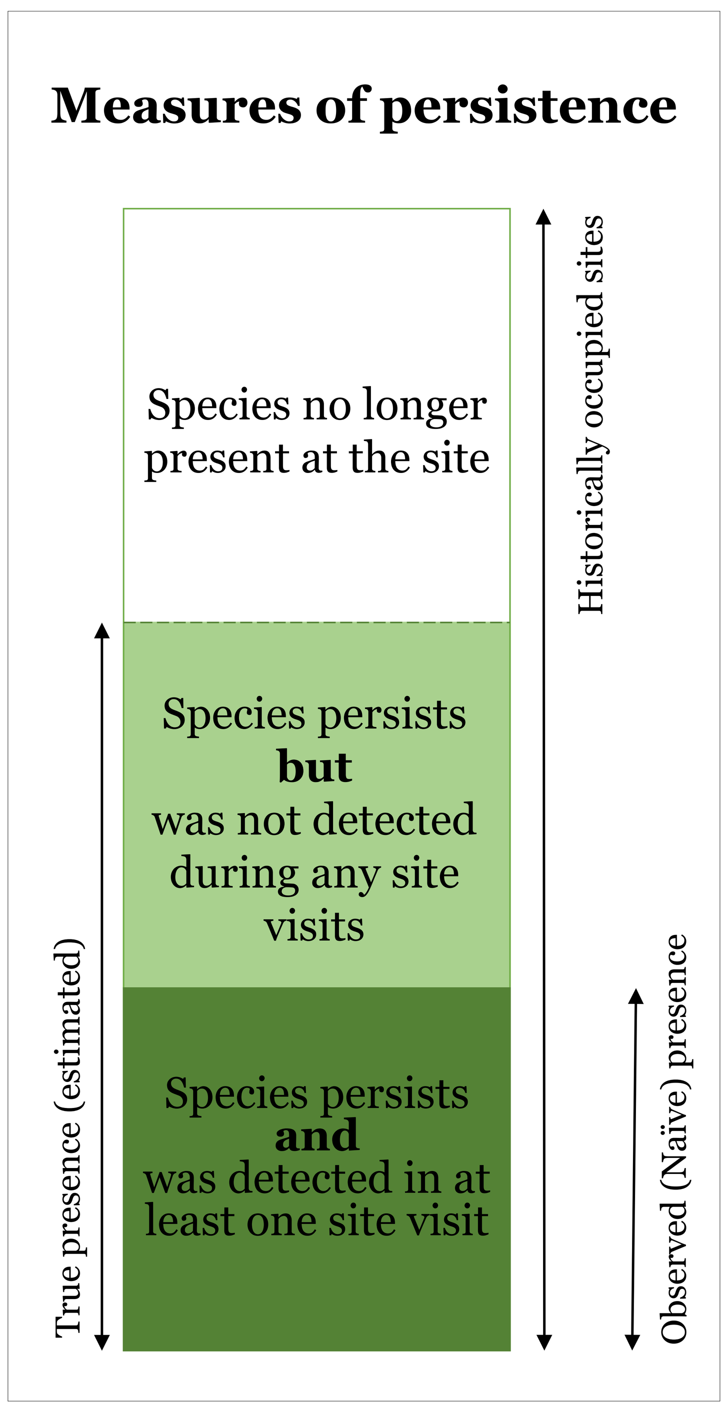
In 2002 and 2003 surveys were carried out across Switzerland to update the National Red List. Sites with historic species records were visited four times through a single breeding season to identify the presence or absence of each species.

We used a Bayesian hierarchical model[1,2] to estimate site occupancy for each species. The hierarchical structure of the model allows separation of the biological state (true species presence/absence) from observation error (the probability of seeing a species that is present).

This model provided estimates of **detection probabilities** for each species, and consequently the proportion of sites with true presence. From this estimate we were able to calculate **the proportion of historically occupied sites where the species persists.**

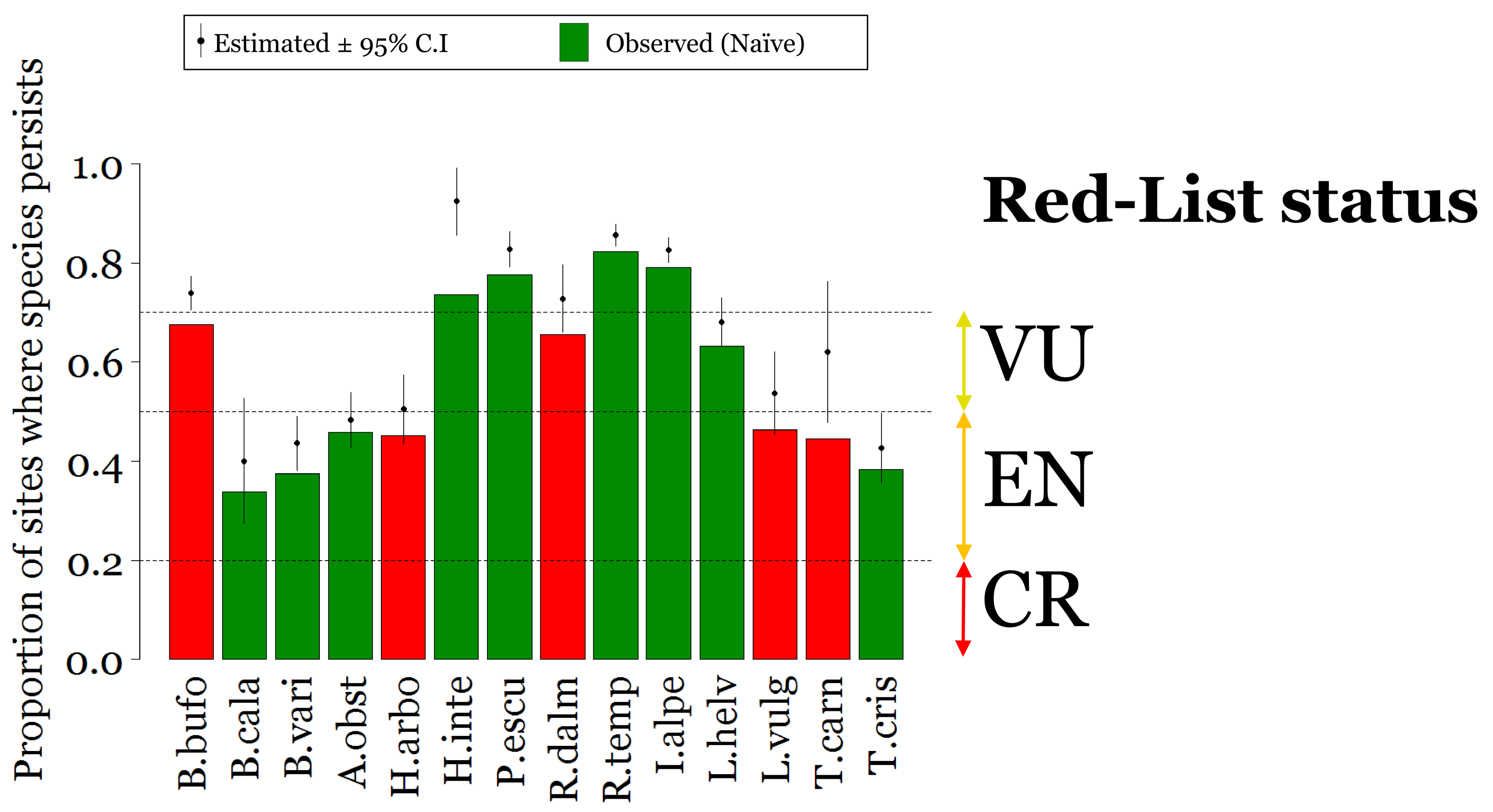
Naïve persistence at historically occupied sites was calculated as:

$$\text{Naïve persistence} = \frac{\textit{Observed presence}}{\textit{Historically occupied sites}}$$



[1] Mackenzie et al. 2002, Ecology
[2] Mackenzie et al. 2003, Ecology

Persistence rates for each species with (points) and without (bars) incorporating detection probability



- For all species, persistence rates were higher when imperfect detection was accounted for.
- **For those species shaded in red the different measures would result in different classifications under IUCN Red-Listing criteria.**