
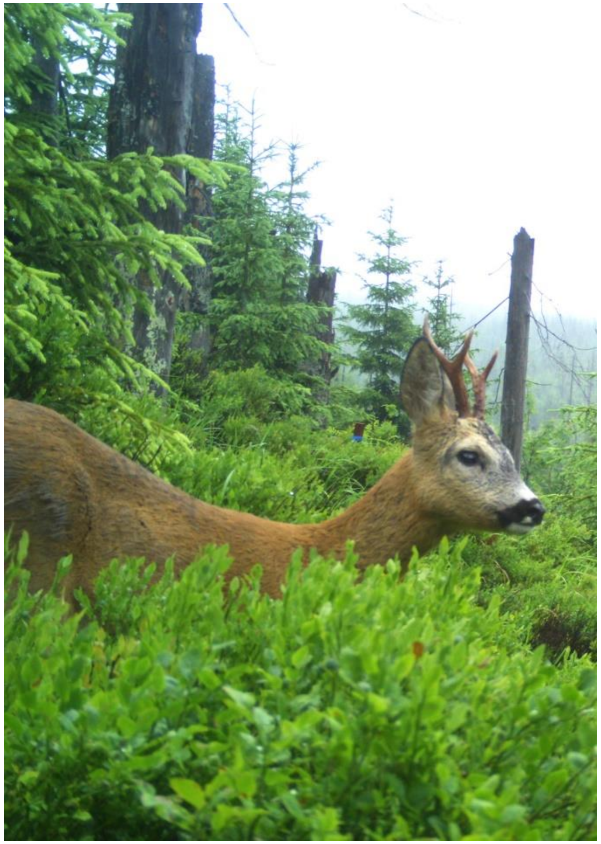
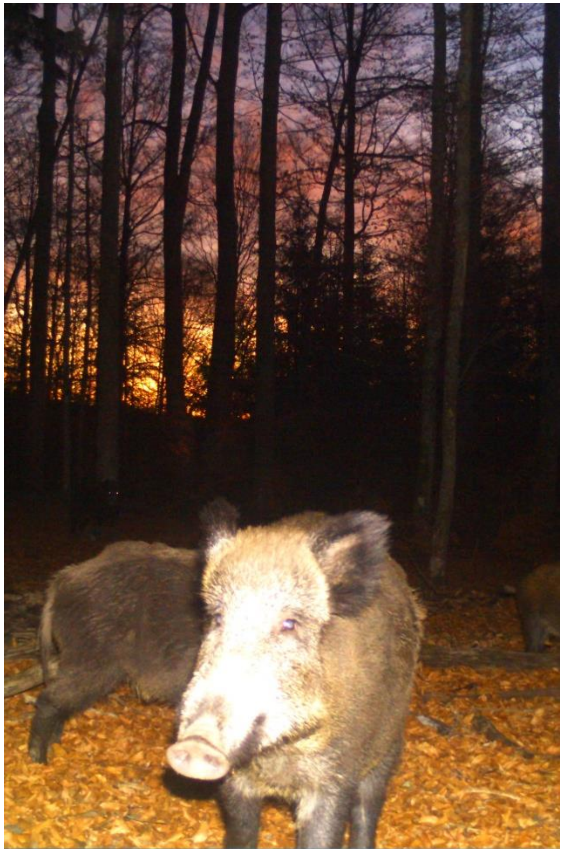

Estimating animal abundance using automatically derived observation distances

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Hjalmar Kühl, Timm Haucke, Volker Steinhage & Marco Heurich

NATIONALPARK Bayerischer Wald

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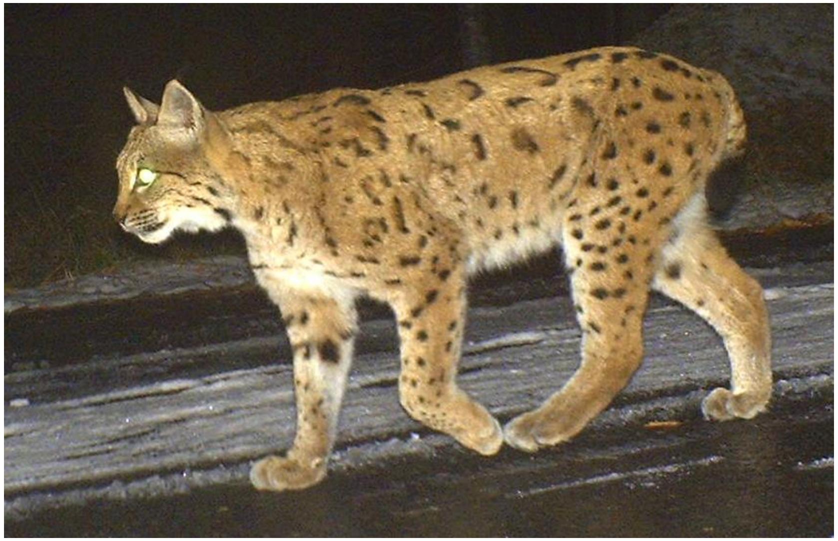
1. Why do we need observation distances?

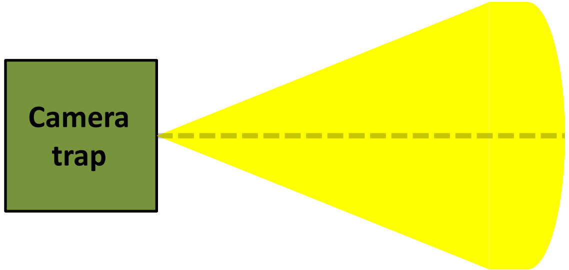
- Counting animals is difficult for most species, because we cannot identify individuals
- Observations at random locations → representative sample
- Camera trapping has become an increasingly popular approach

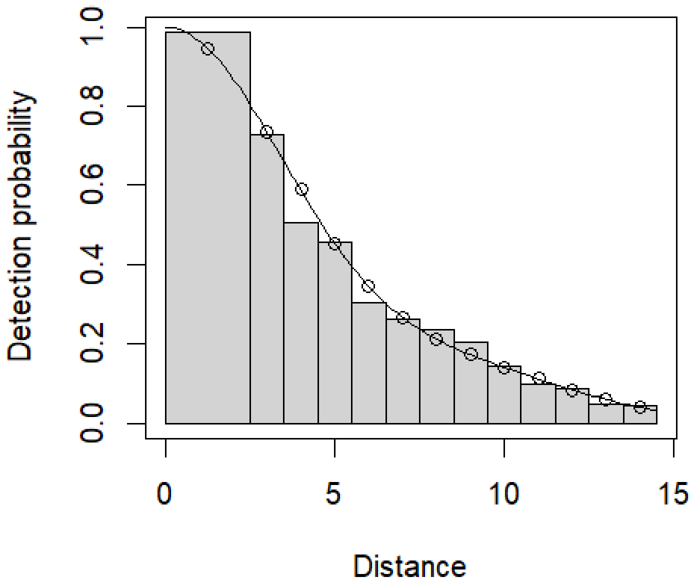


The lynx is rather an exception…

1. Why do we need observation distances?

- The probability to observe an animal decreases with its distance from a camera trap
- The form of this decrease depends on the properties of the animals, the vegetation and terrain, as well as the weather



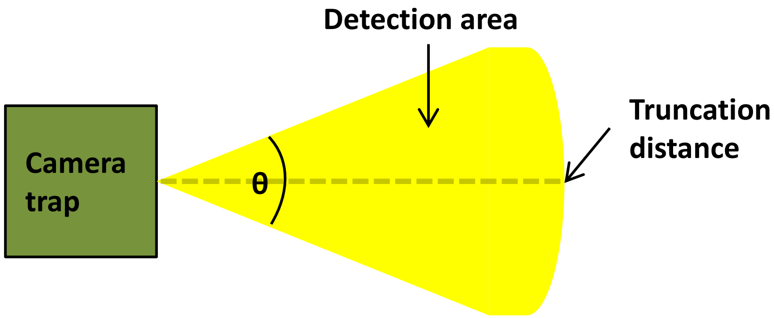


Example: Red deer observations in the Bavarian Forest National Park in different distances from the camera trap (in metres)

1. Why do we need observation distances?

$$D = \frac{2t \sum_{k=1}^{K} n_k}{\Theta\, \omega^2 \sum_{k=1}^{K} T_k \hat{P}_k} \frac{1}{\hat{A}}$$

2s



t= Time difference between snapshot moments

K= Number of camera trap locations

n_k= Number of observed animals at camera trap location k

ϴ= Angle of view

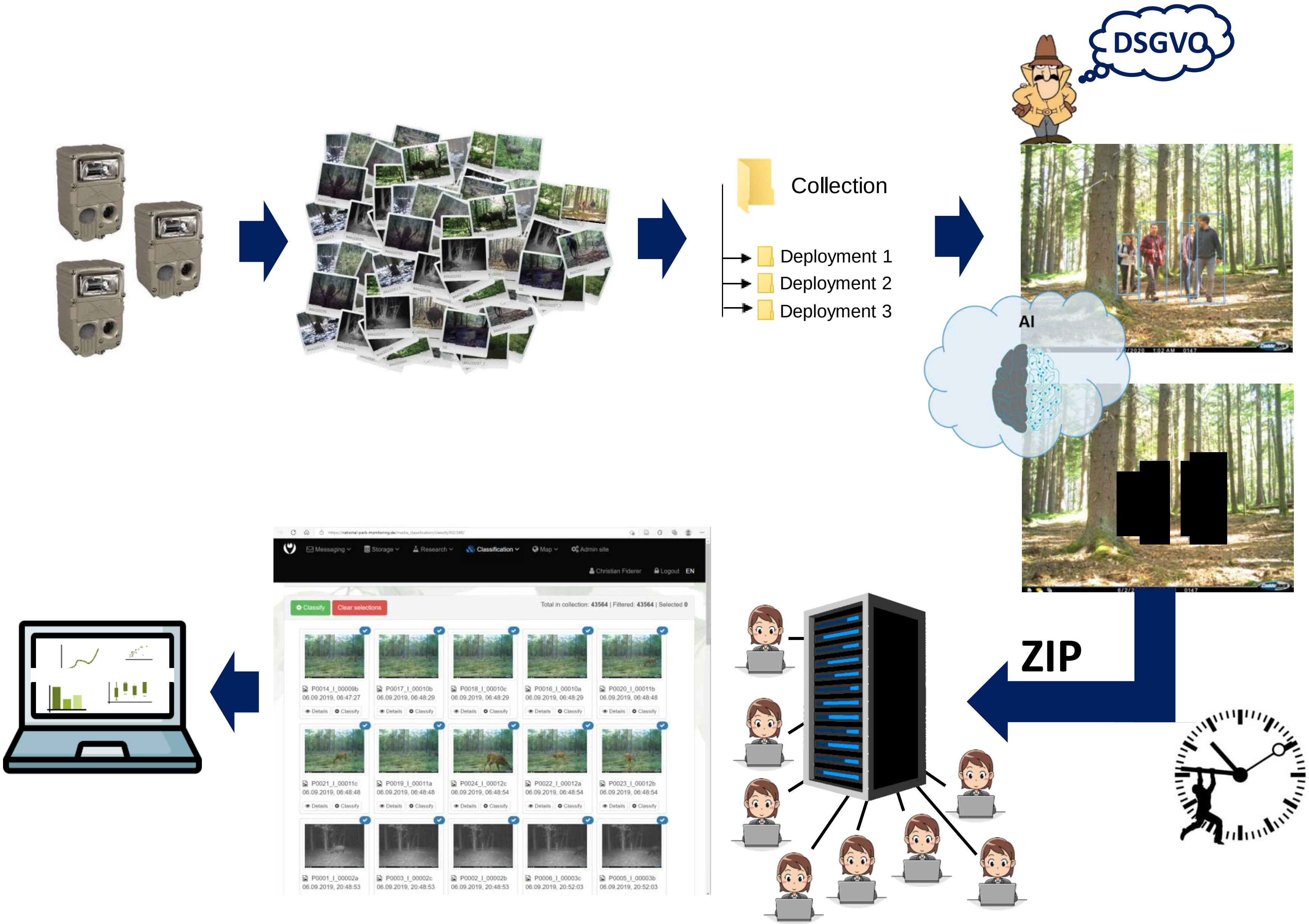
ω= Truncation distance

T_k= Deployment time

$\hat{P}_k$ = Estimated probability of obtaining an image of an animal within ϴ and ω at a snapshot moment

$\hat{A}$ = Activity level

2. How to obtain observation distances?



2. How to obtain observation distances?

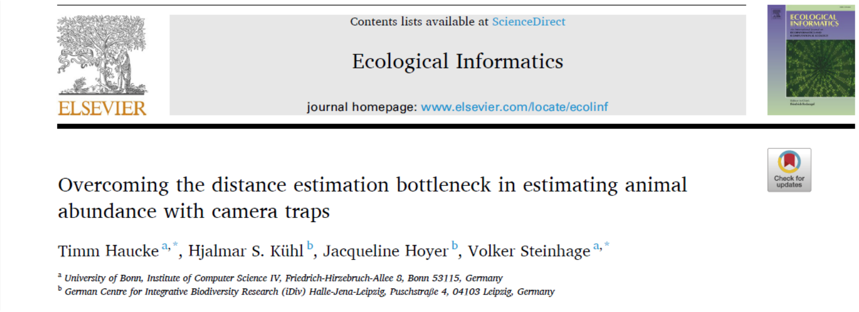
- Manual estimation of observation distances based on distance markers in 1,2,…, 15 m distance

3. Semi-automatic distance estimation

- Animal detection via MegaDetector (Beery et al. 2019)
- Relative depth estimation by a deep learning algorithm (DPT, Ranftl et al. 2021)
- Transformation to absolute distance estimates based on at least two reference images with an object in a known distance
- The 20th percentile inside the bounding box around an animal is extracted → estimated distance to the animal

5 m

10 m



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Overcoming the distance estimation bottleneck in estimating animal abundance with camera traps

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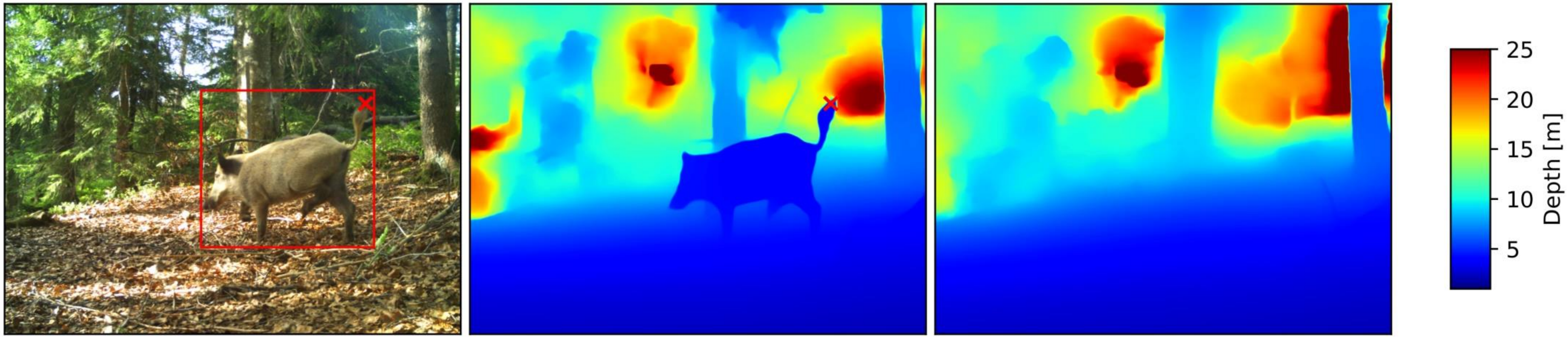
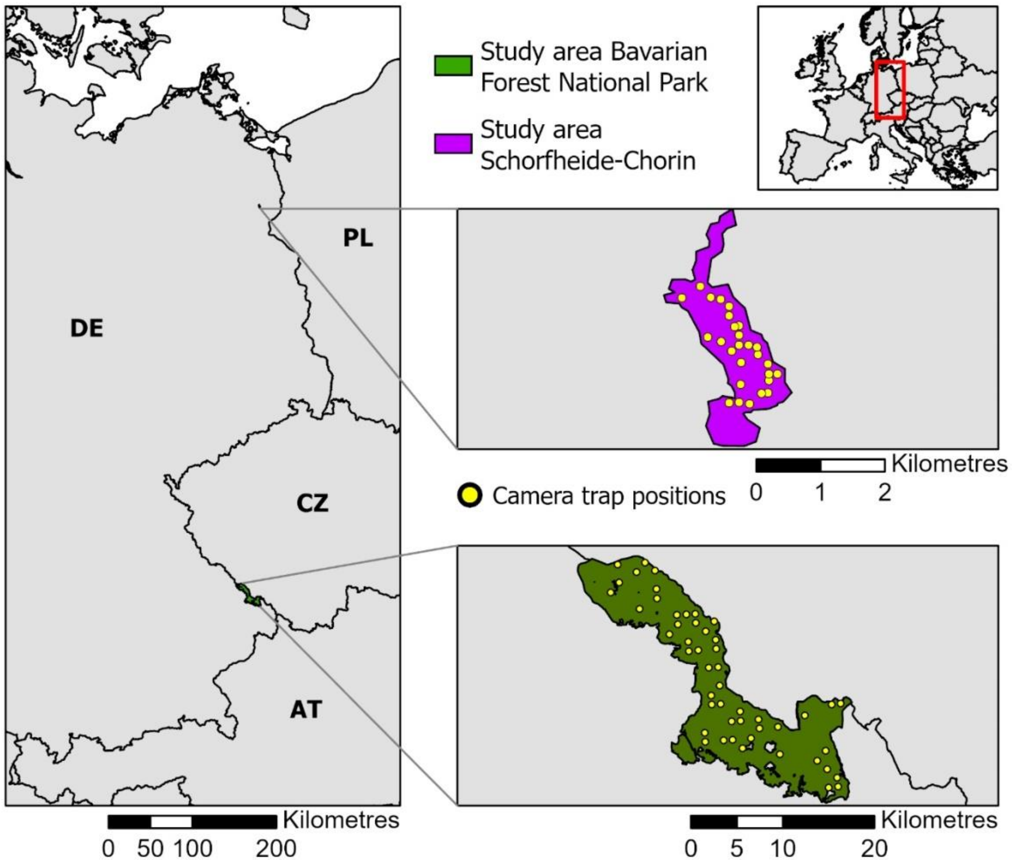
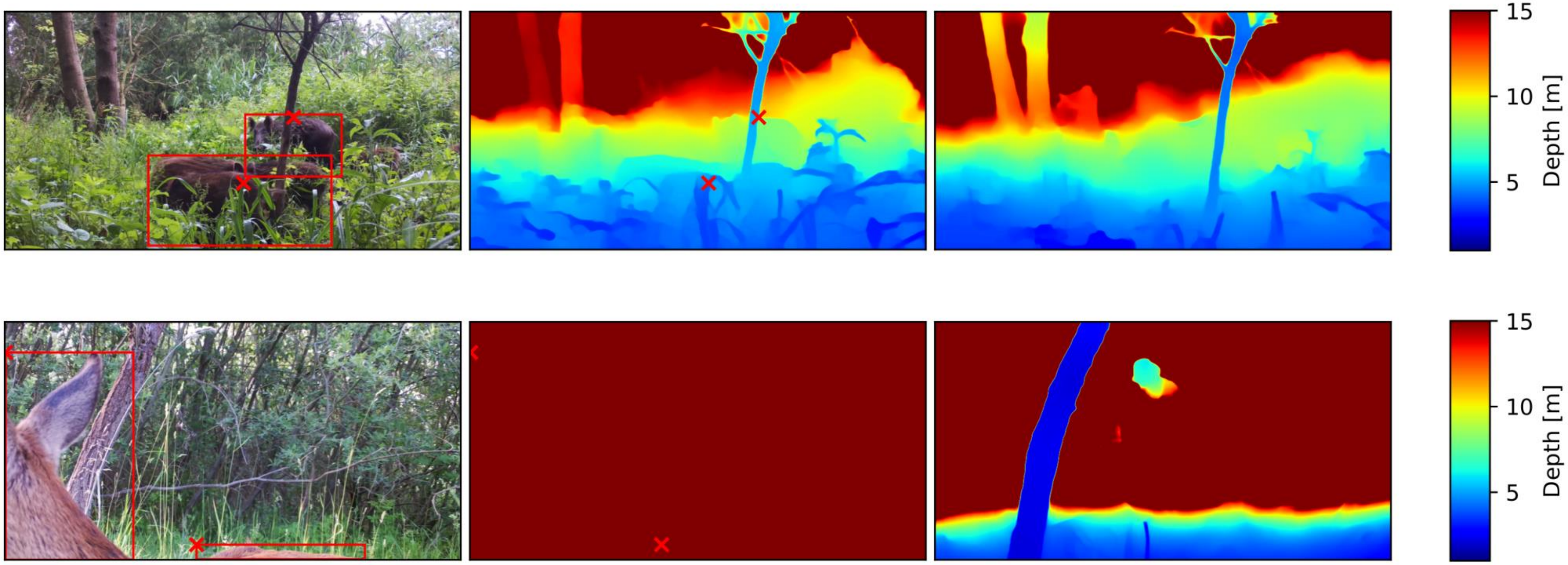


4. Example datasets



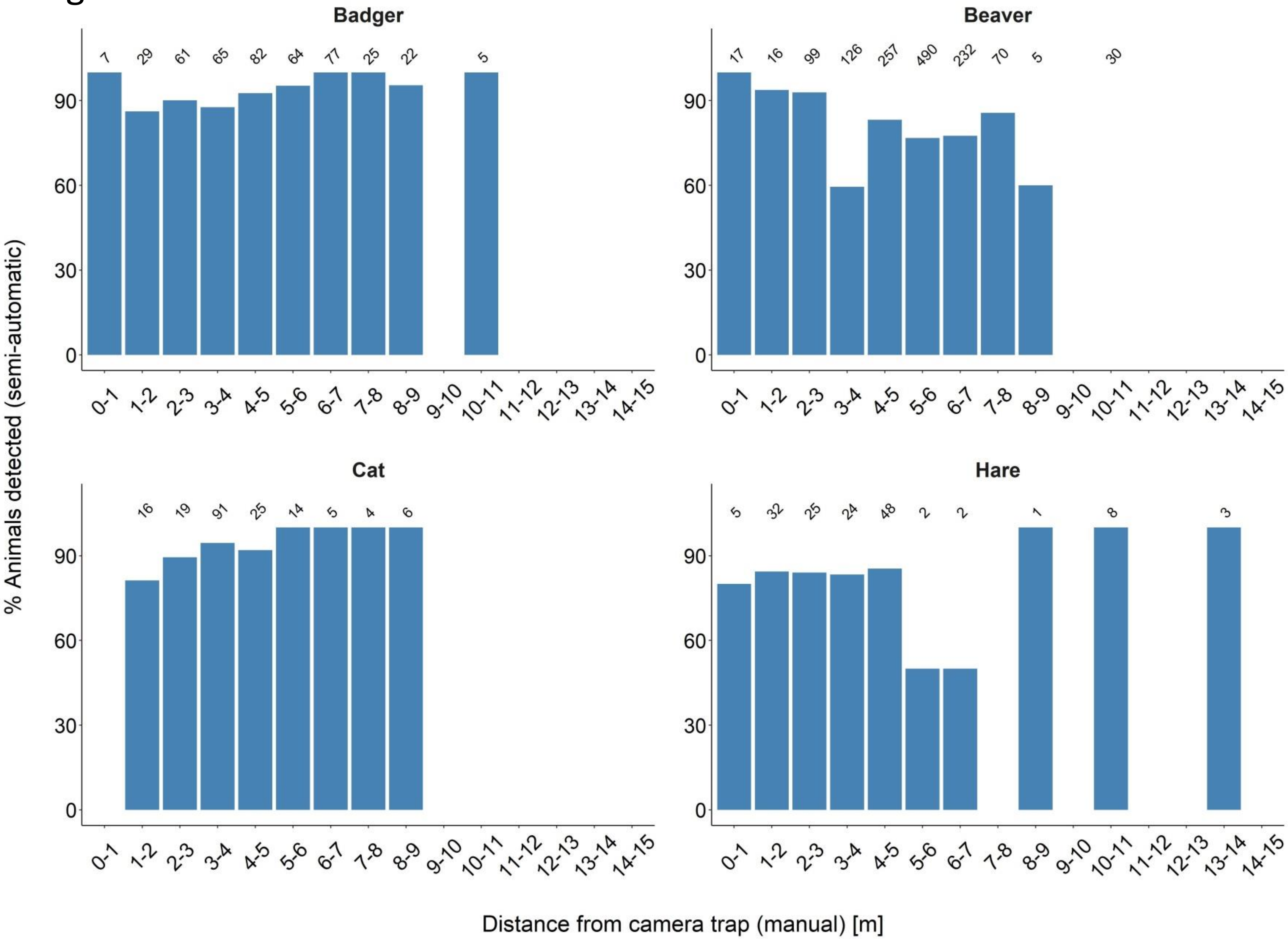
Brandenburg	Bavaria
Wetland biosphere reserve Schorfheide-Chorin	Low mountain range Bavarian Forest National Park
June –August 2019	June – August 2018
60 s-videos (motion-triggered)	Photos (motion-triggered)
2 s snapshot interval	Snapshot interval depends on delays between photos
Distances estimates for all observed animals	Distance estimates for a subset of observed animals

5. Automatic detection



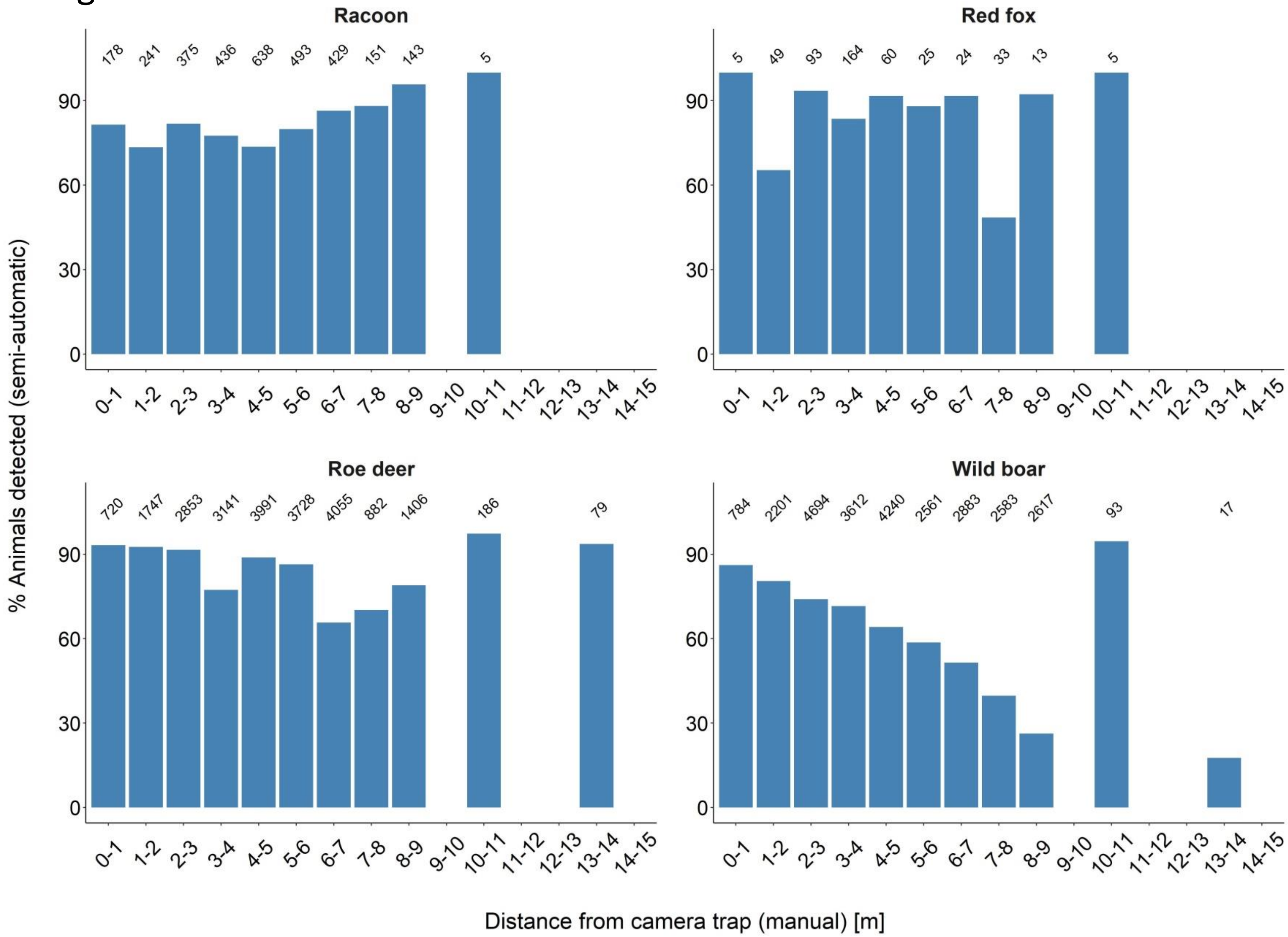
5. Automatic detection

Brandenburg



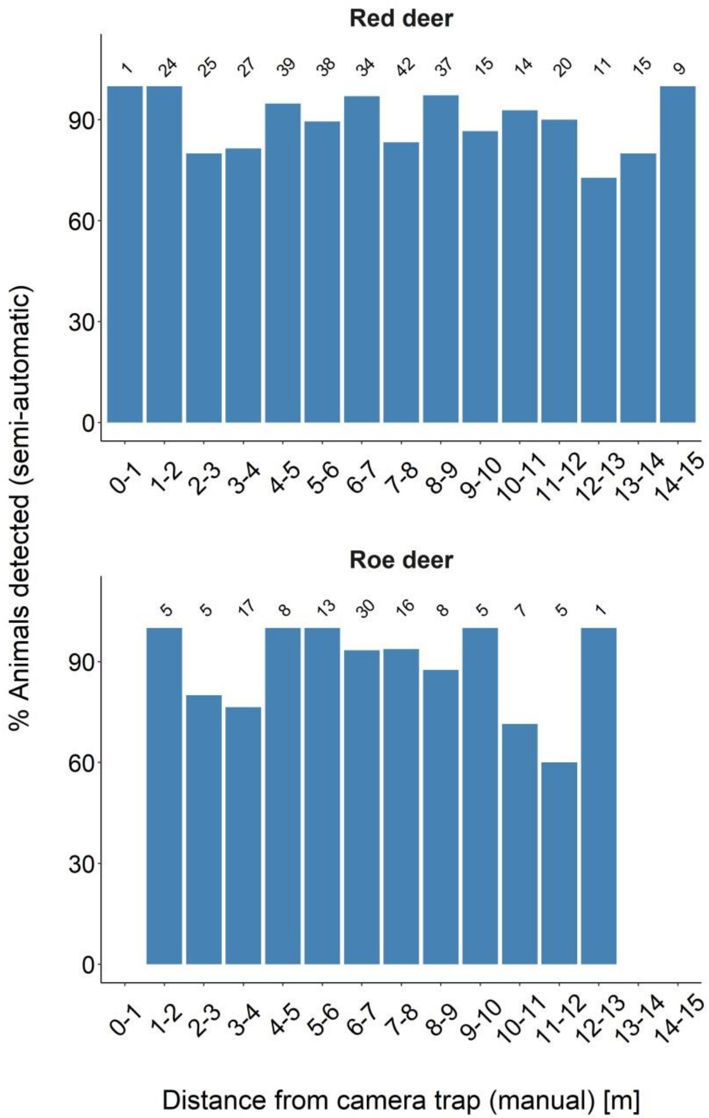
5. Automatic detection

Brandenburg



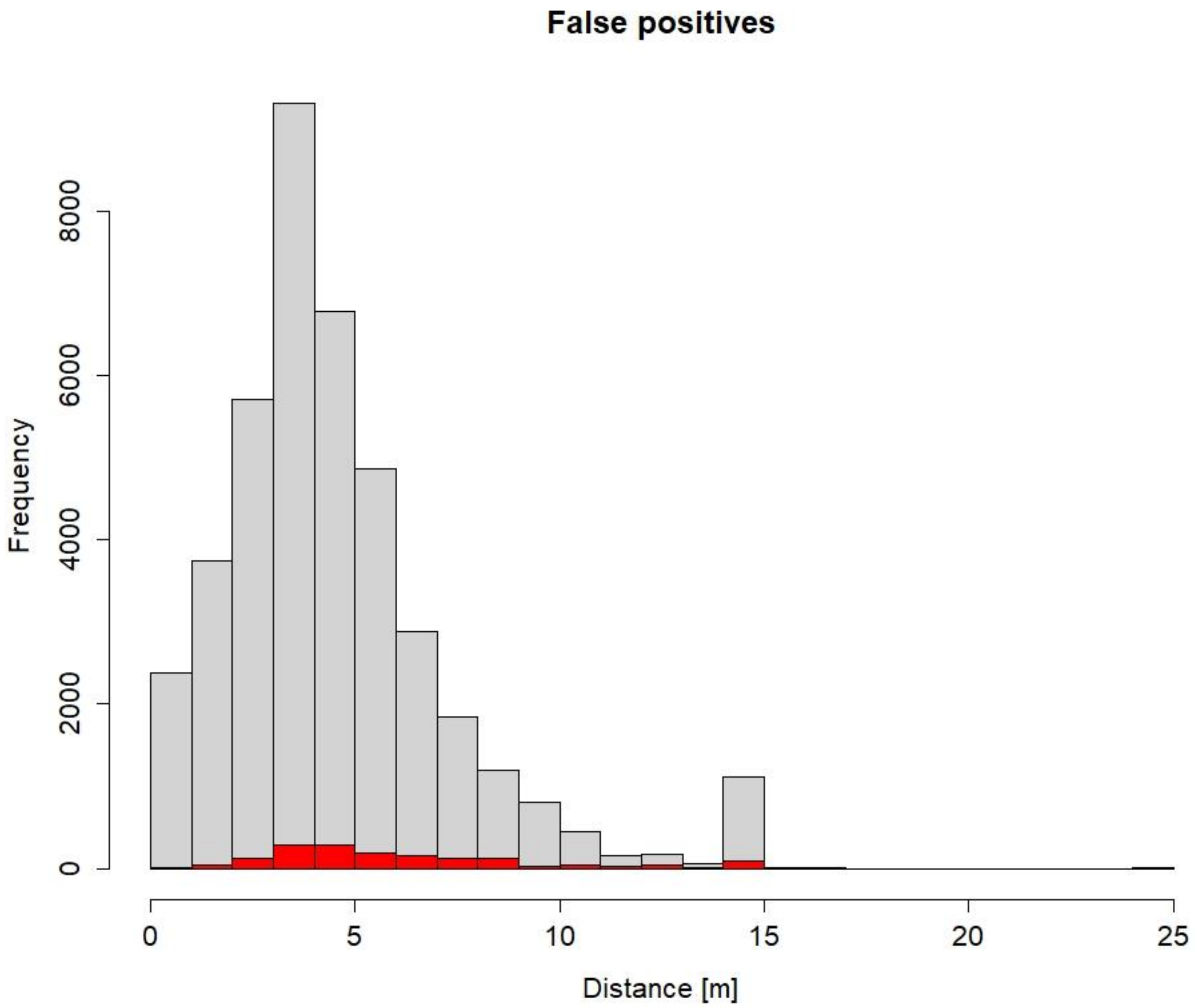
5. Automatic detection

Bavaria

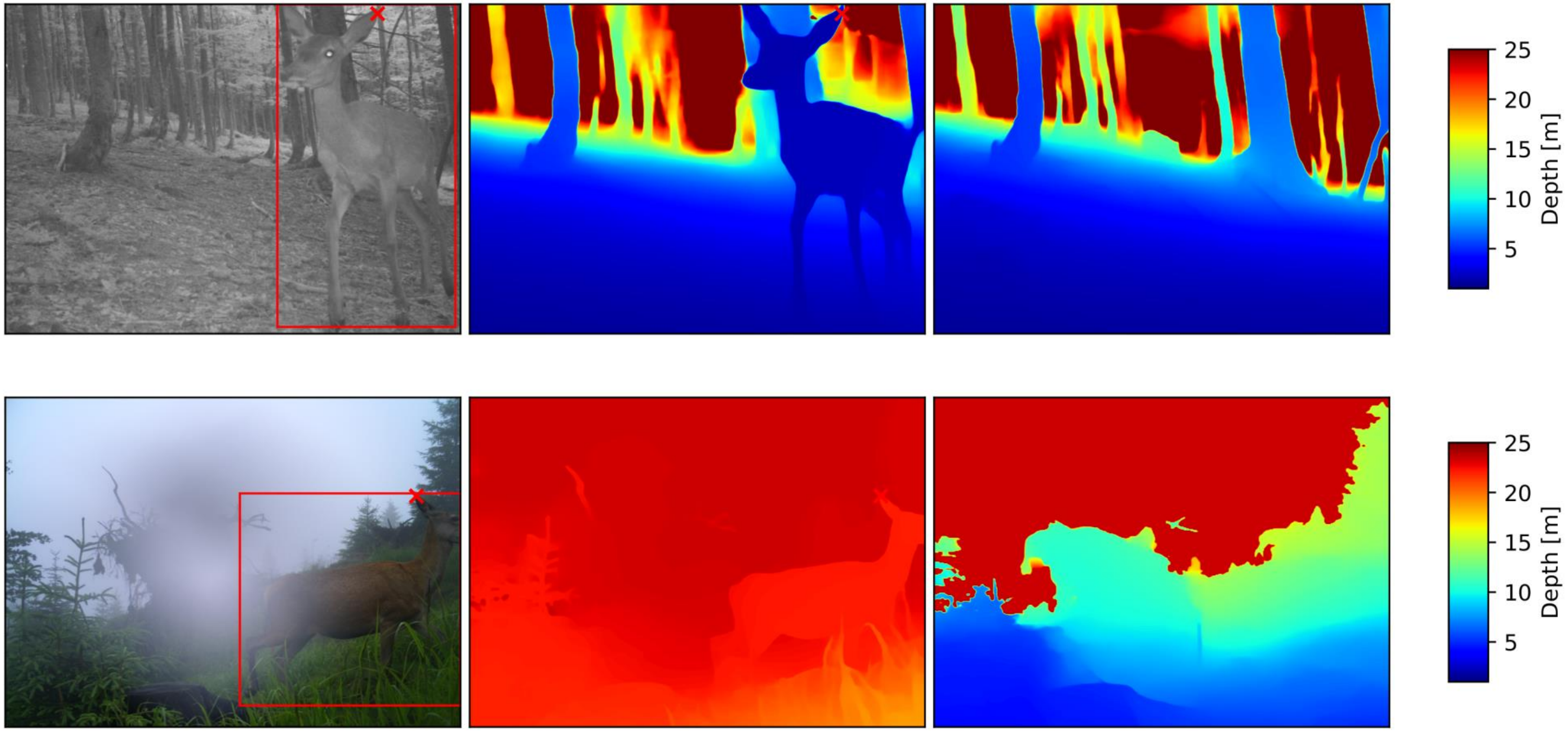


5. Automatic detection

Brandenburg



6. Comparison of the distance estimates



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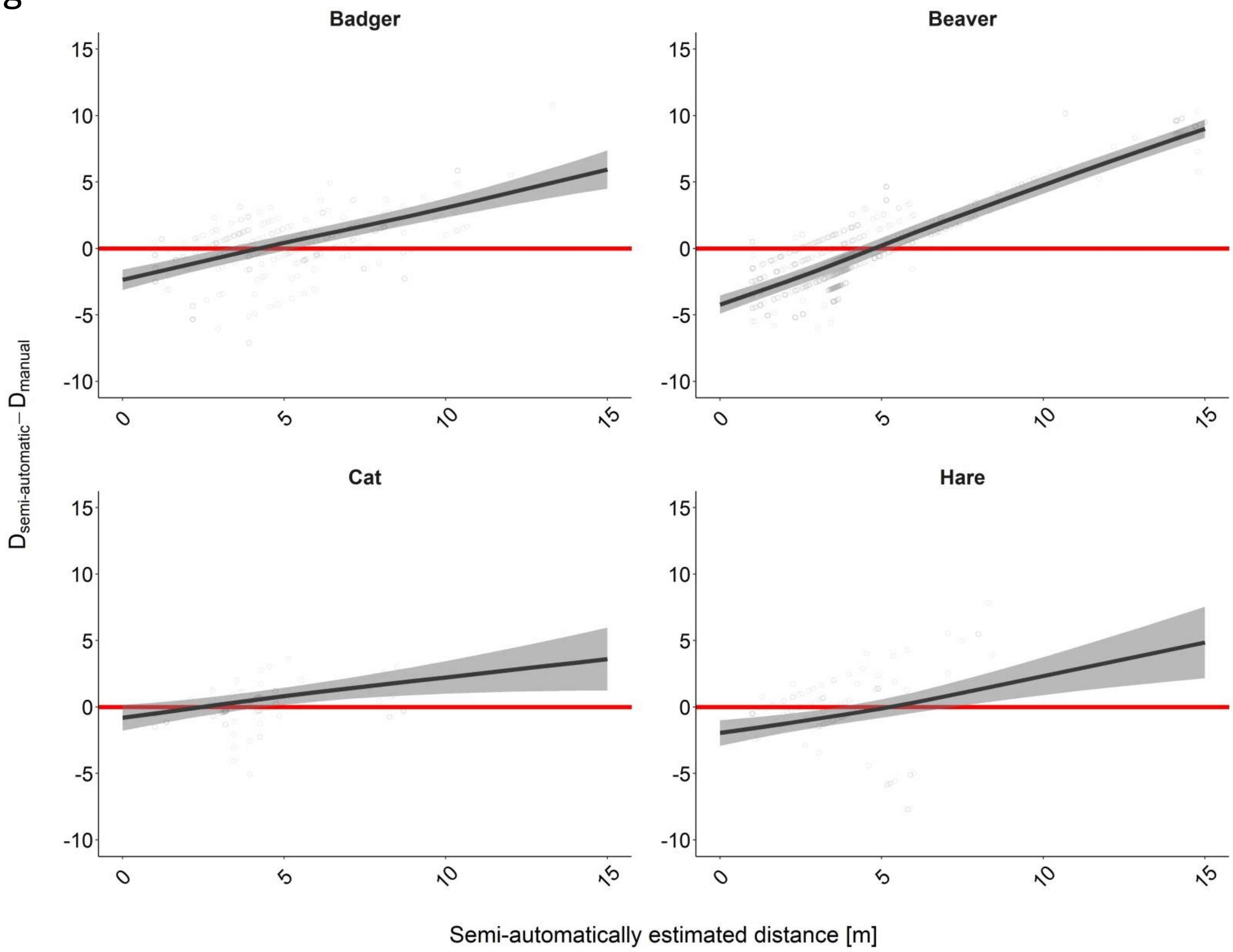
Brandenburg



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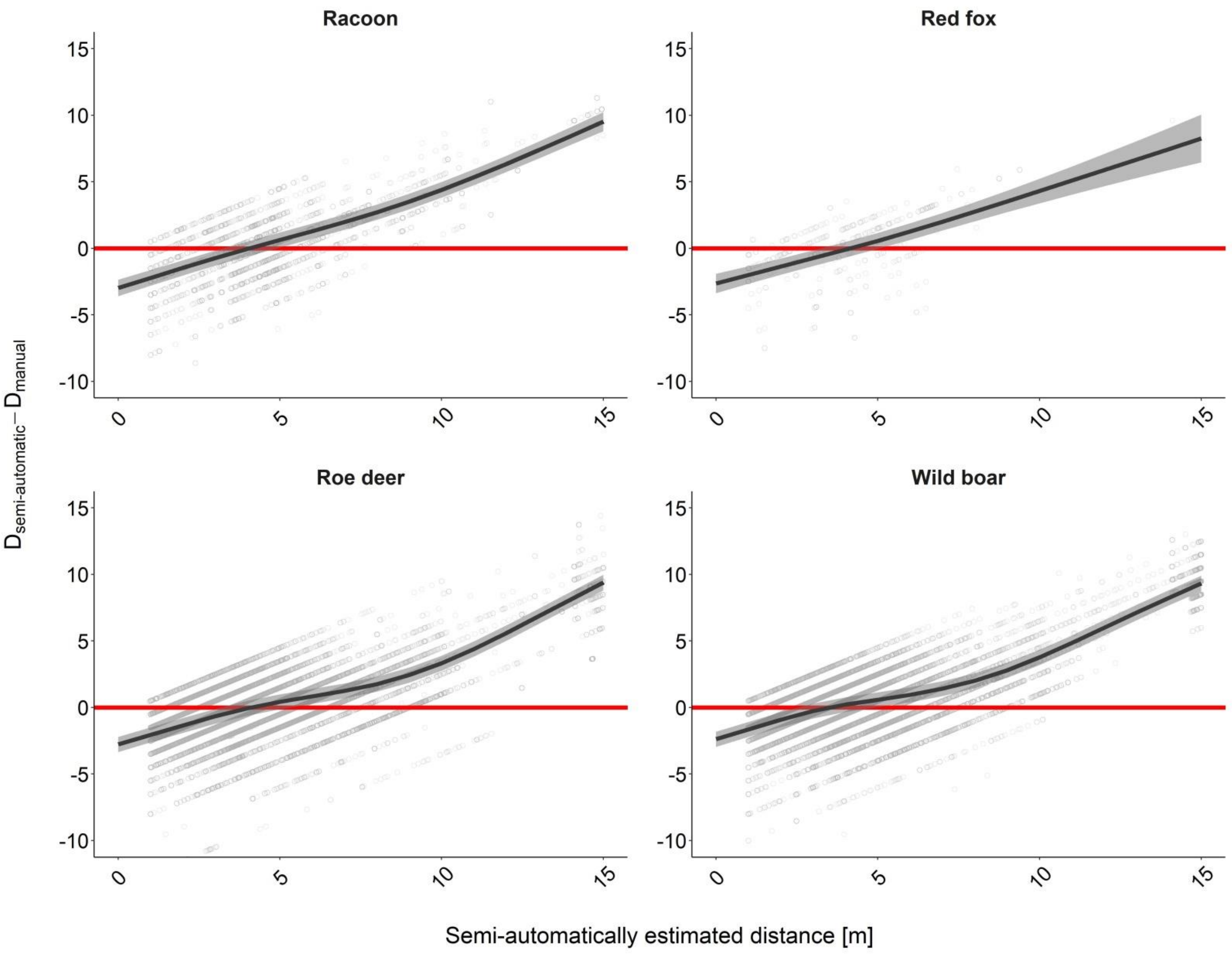
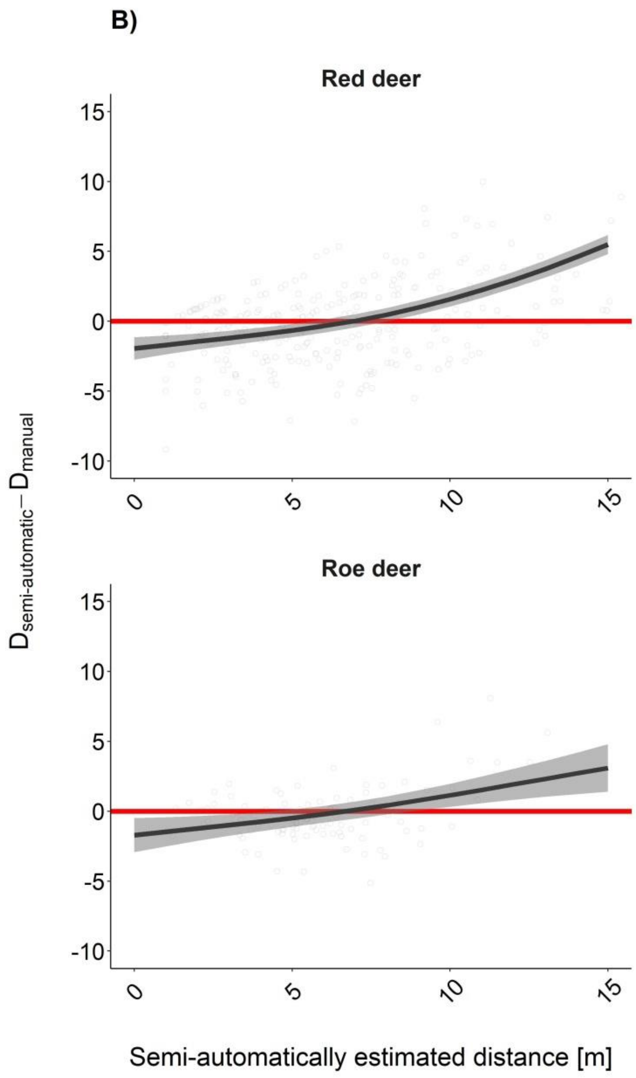
Brandenburg

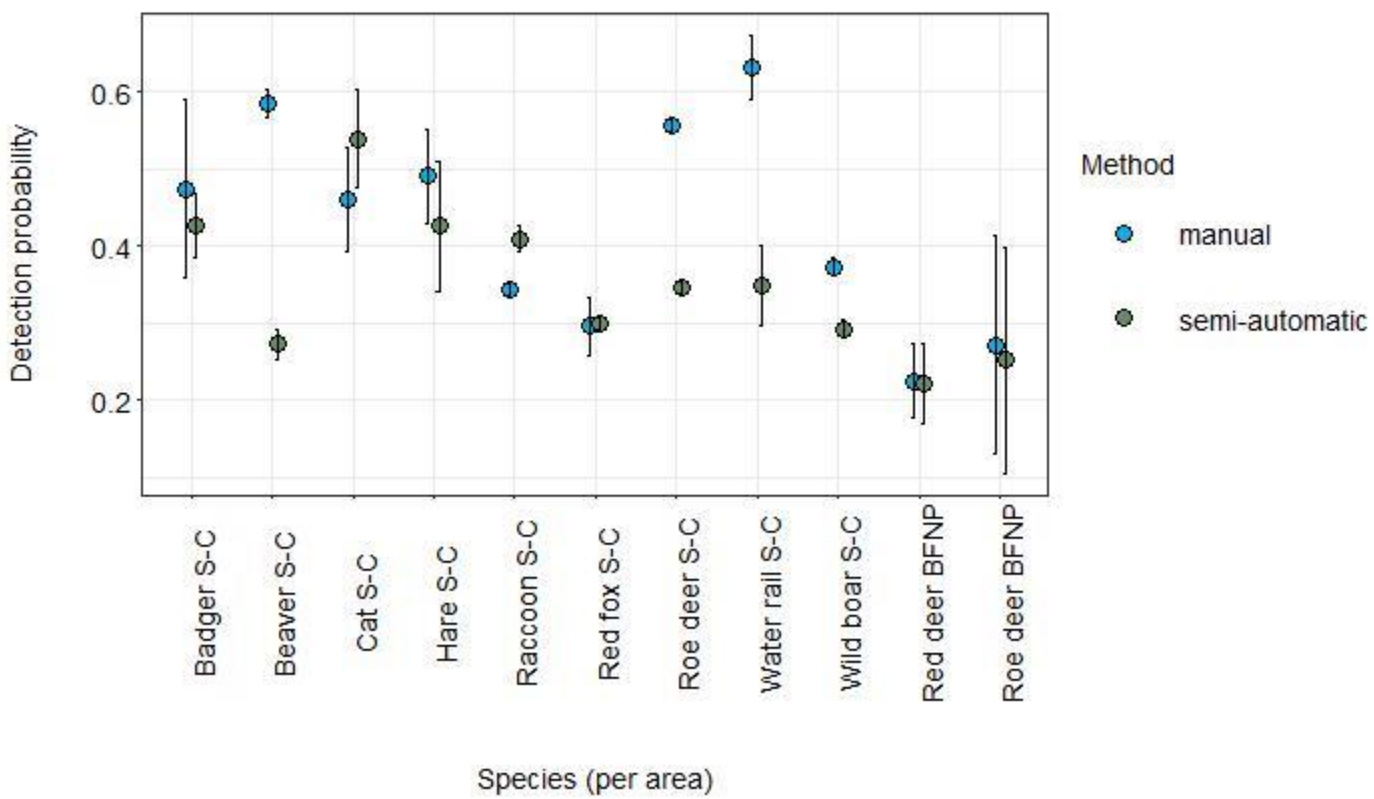


6. Comparison of the distance estimates

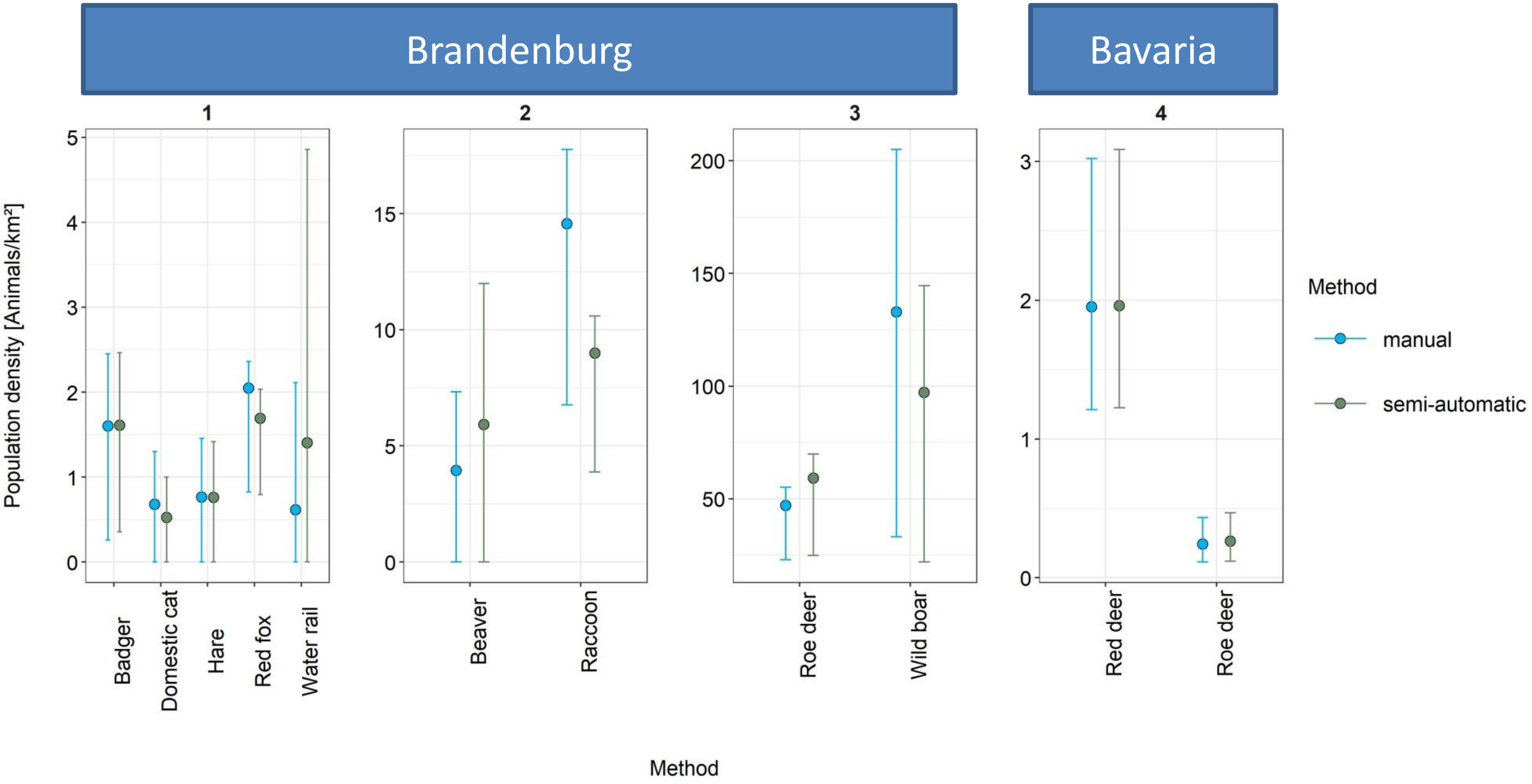
Bavaria



7. Comparison of the detection probabilities



8. Comparison of the population density estimates



9. Conclusions

- Semi-automatic distance estimates can reduce the time and effort that are needed for the population density estimation of unmarked species
- The number of false negatives is generally not related to the distance from the camera trap
- The agreement of manual and semi-automatic distance estimates is best at ca. 4 m
- Population density estimates are often robust, but problematic cases require further attention


Thank you for your attention