Linking ecotopes maps and camera traps to assess effectiveness of management actions against African swine fever

LifeWatch Biodiversity Day – 26/01/2023

Author: Bollen Martijn
(martijn.bollen@uhasselt.be)

Co-authors: Neyens Thomas, Fajgenblat Maxime, De Waele Valérie, Licoppe Alain, Manet Benoît, Casaer Jim & Beenaerts Natalie

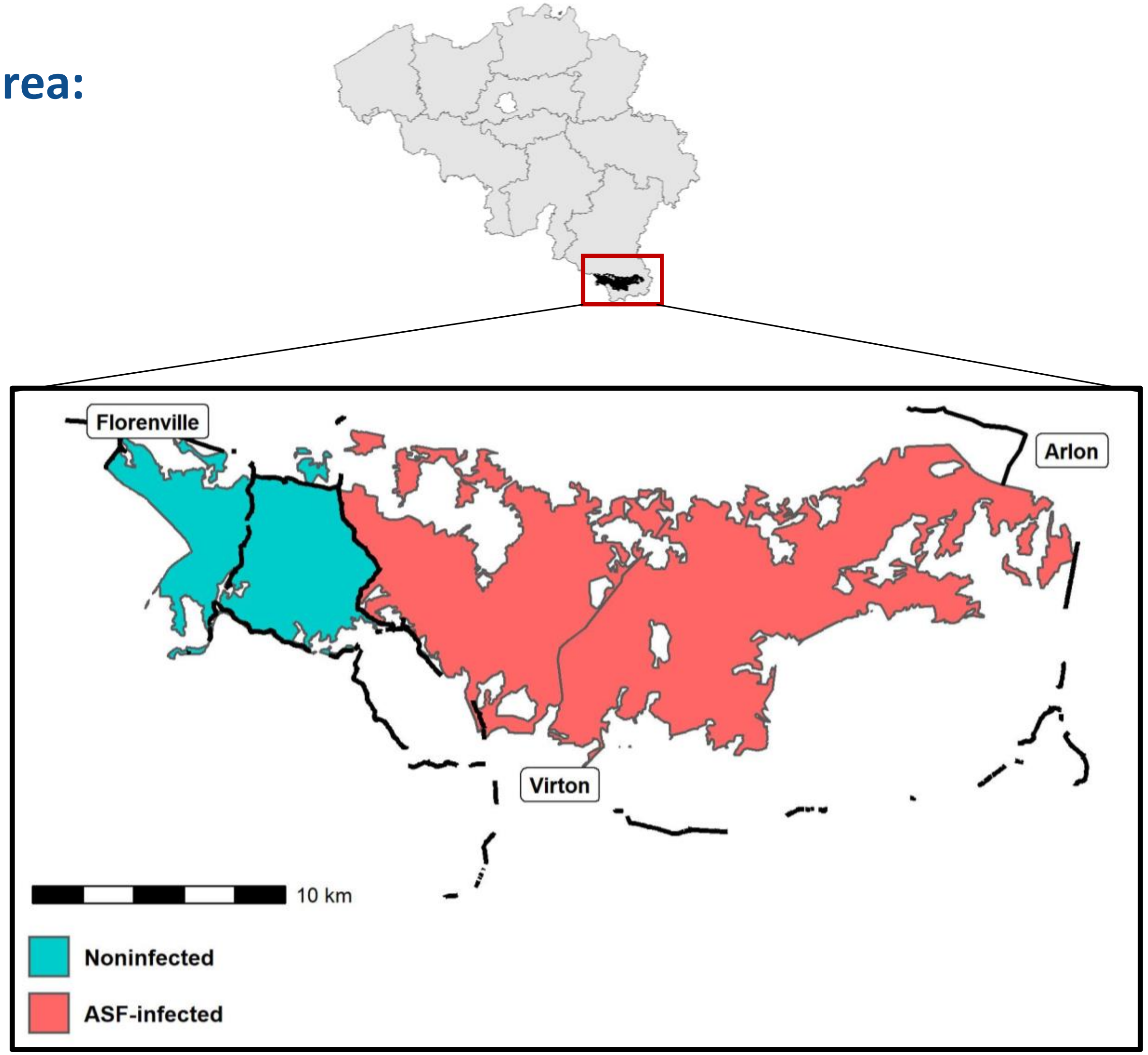
African swine fever (ASF):

- Highly lethal (viral) disease in suids
- Livestock, food security and swine populations
- (i) fencing, (ii) culling, (iii) carcass removal

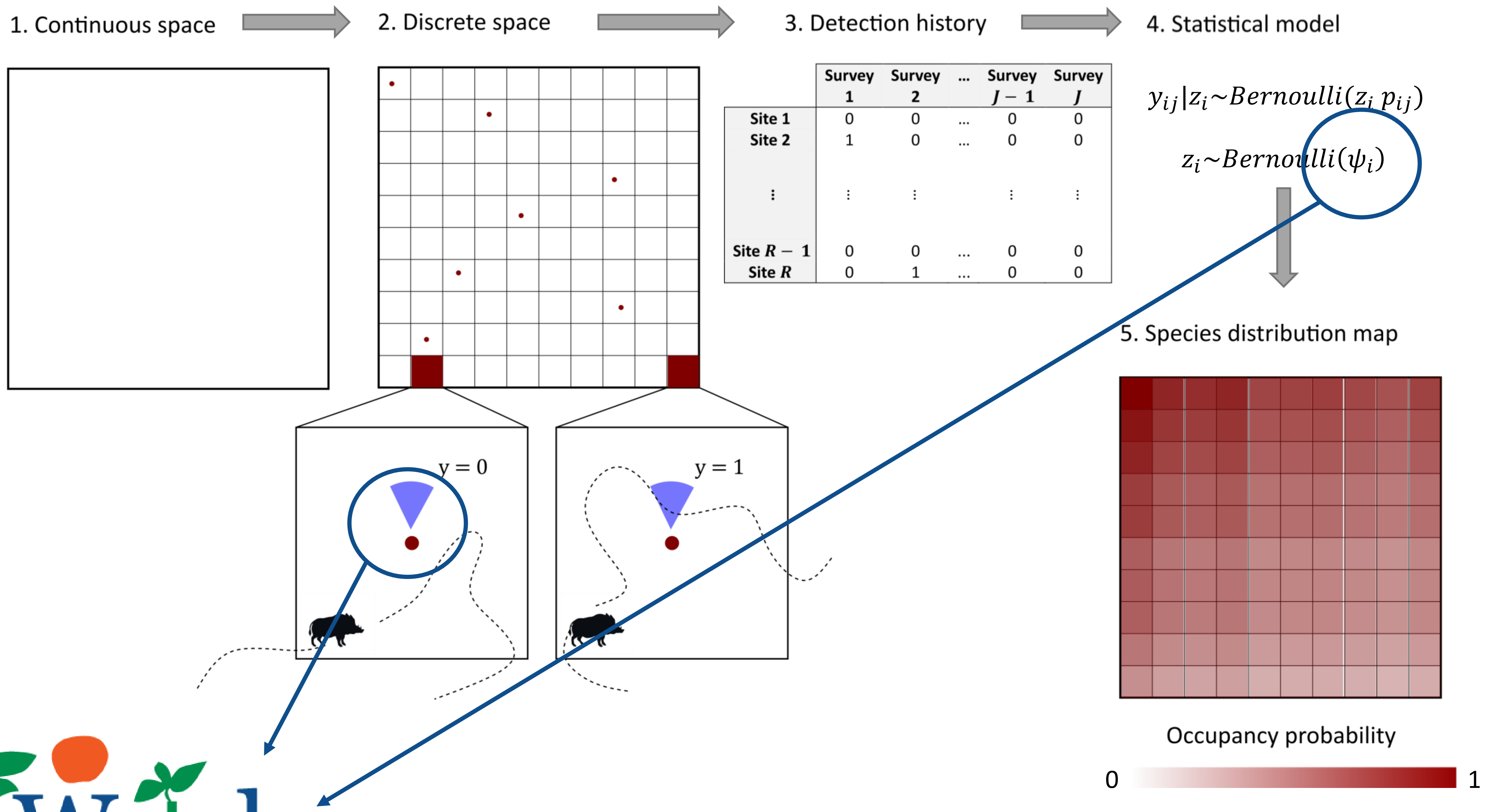
Research questions:

1. Impact of ASF + management on wild boar?
2. Camera traps, a good monitoring tool?

Study area:



First cases in September 2018

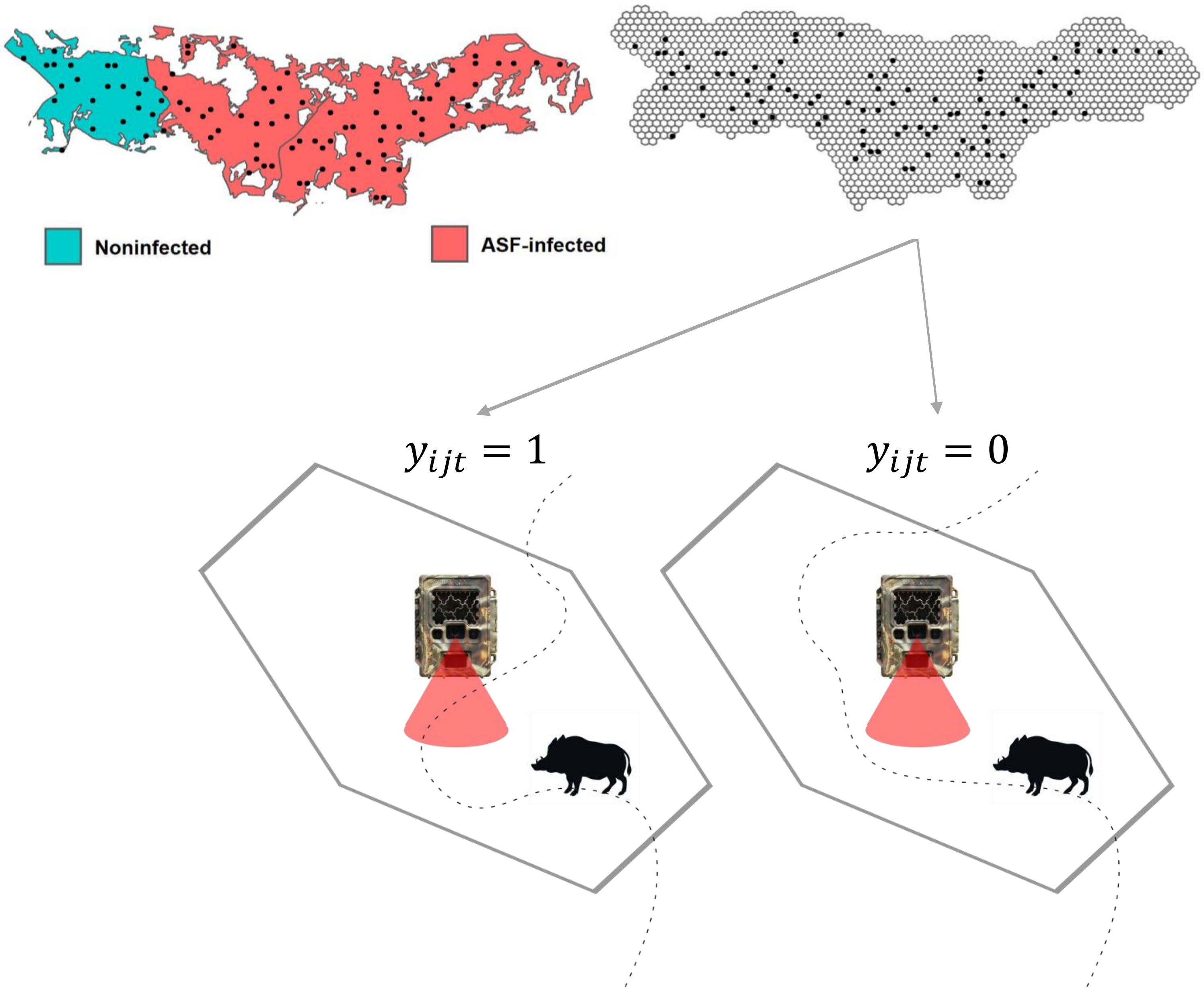


LifeWatch
BELGIUM

Random stratified sampling:

92 camera traps, 15 observation months

A posteriori, grid layer superimposed



Binary data:

For **site** $\boldsymbol{i}$ = 1, 2, …, *R*,
at **survey day** $\boldsymbol{j}$ = 1, 2, …, J,
in **observation month** $\boldsymbol{t}$ = 1, 2, …, T,

A series of **binary observations,** $\boldsymbol{y_{ijt}}$

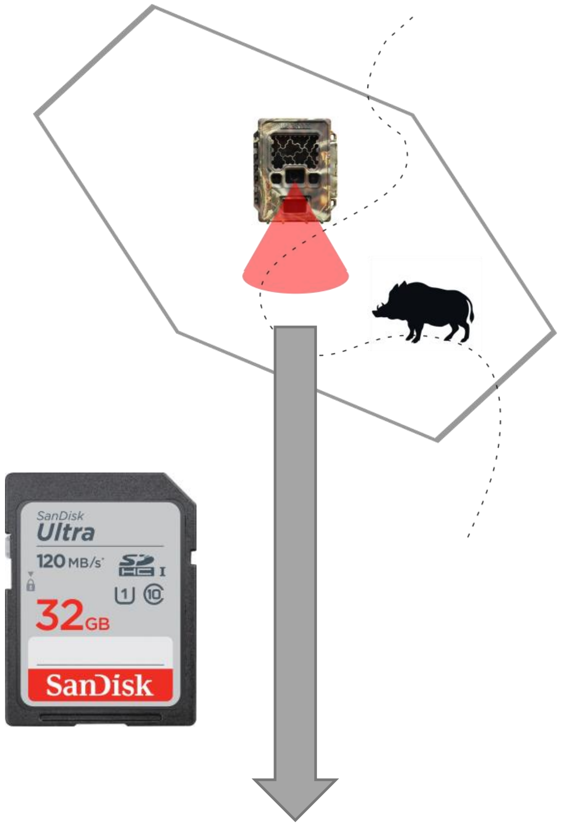
Data collection > data storage > data processing:

42 136 observation periods of 24 h

671 wild boar captured (5 photos/ trigger)

Many additional triggers …

Solution: **Agouti to archive, annotate and export camera trap data**



File	Description
`datapackage.json`	Metadata regarding the data package and camera trap project.
`deployments.csv`	Table with camera trap deployments.
`media.csv`	Table with media files captured by the camera traps.
`observations.csv`	Table with observations based on the media files.

Agouti.eu

Annotate

State-space (occupancy) model:

$$y_{ijt}|z_{it} \sim Bernoulli(z_{it}\, p_{ijt}),$$

$$z_{it} \sim Bernoulli(\psi_{it})$$

z_{it}: latent state of occupancy
($z_{it} = 1$: present, $z_{it} = 0$: absent)

p_{ijt}: detection probability
ψ_{it}: occupancy probability

Covariate modelling:

$$Logit(p_t) = \alpha^p + f_1^p(t)$$

$$Logit(\psi_{it}) = \alpha^\psi + ASF_i \cdot \beta^\psi_{ASF} + BL_i \cdot \beta^\psi_{BL} + t \cdot \beta^\psi_t + (ASF_i \cdot t) \cdot \beta^\psi_{ASF\cdot t} + f_2^\psi(x_1(i), x_2(i))$$

Model selection – leave-one-out (LOO) expected log predictive density:

Model	Covariates	Δ LOO	SE(Δ LOO)
Occupancy models (step 1)			
$\boldsymbol{\psi(5)}$	**Intercept + ASF + BL + month + ASF:month + HSGP (lon, lat)**	**0.00**	**0.00**
$\psi(4)$	Intercept + ASF + BL + month + HSGP (lon, lat)	-3.14	2.38
$\psi(6)$	Intercept + ASF + BL + GP (t) + HSGP (lon,lat)	-6.87	3.56
$\psi(3)$	Intercept + ASF + BL + HSGP (lon,lat)	-52.41	9.84
$\psi(2)$	Intercept + ASF + HSGP (lon,lat)	-53.62	9.94
$\psi(1)$	Intercept + HSGP (lon,lat)	-57.44	10.45

Model	Covariates	Δ LOO	SE(Δ LOO)
Detection models (step 2)			
$\boldsymbol{p(4)}$	**Intercept + GP (t)**	**0.00**	**0.00**
$p(2)$	Intercept + Biannual	-5.66	9.41
$p(1)$	Intercept	-12.40	10.88
$p(3)$	Intercept + Quarterly	-13.28	10.49

Detection probability:

$$Logit(p_t) = \alpha^p + \boxed{f_1^p(t)}$$

Gaussian process (GP): temporal variation

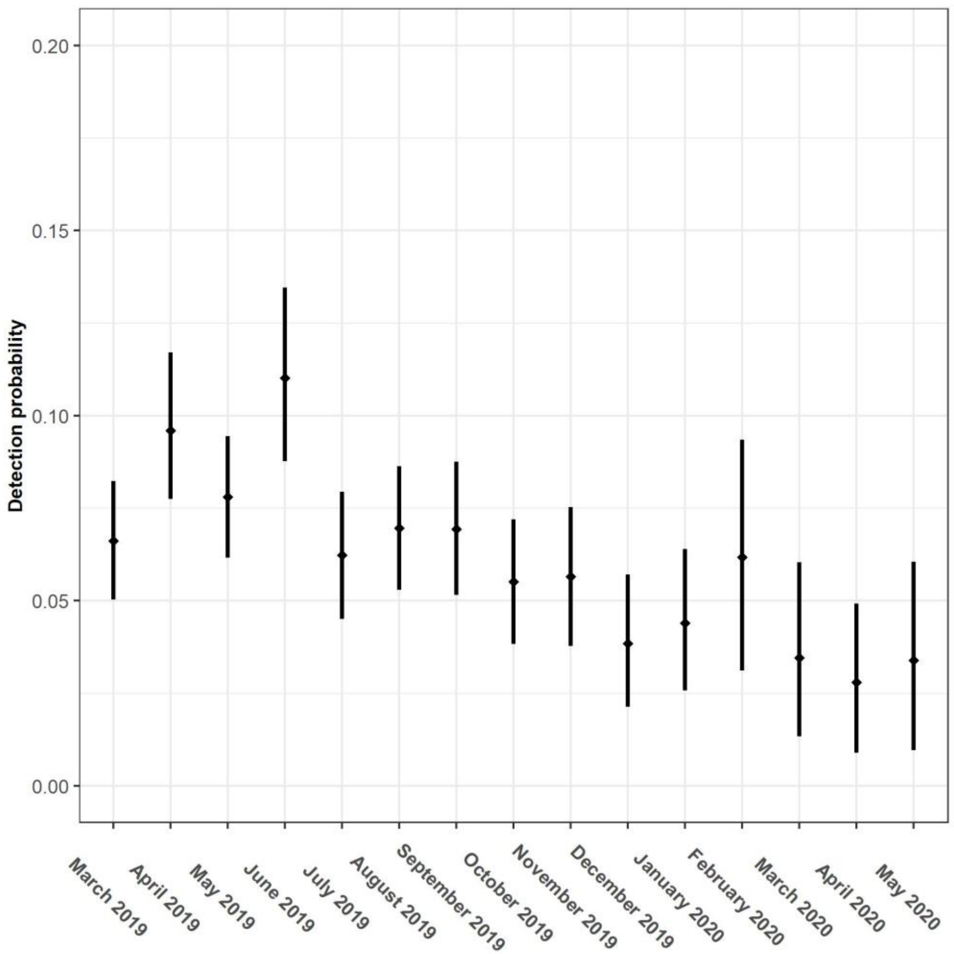
1. Low in general, around 5%

2. Slight decline over time:

   Possibly density-dependent

3. Additional inter-month variation:

   Not attributed to seasonality



Occupancy probability:

$$Logit(\psi_{it}) = \alpha^{\psi} + ASF_i \cdot \beta^{\psi}_{ASF} + BL_i \cdot \beta^{\psi}_{BL} + t \cdot \beta^{\psi}_{t} + (ASF_i \cdot t) \cdot \beta^{\psi}_{ASF \cdot t} + f^{\psi}_{2}(x_1(i), x_2(i))$$

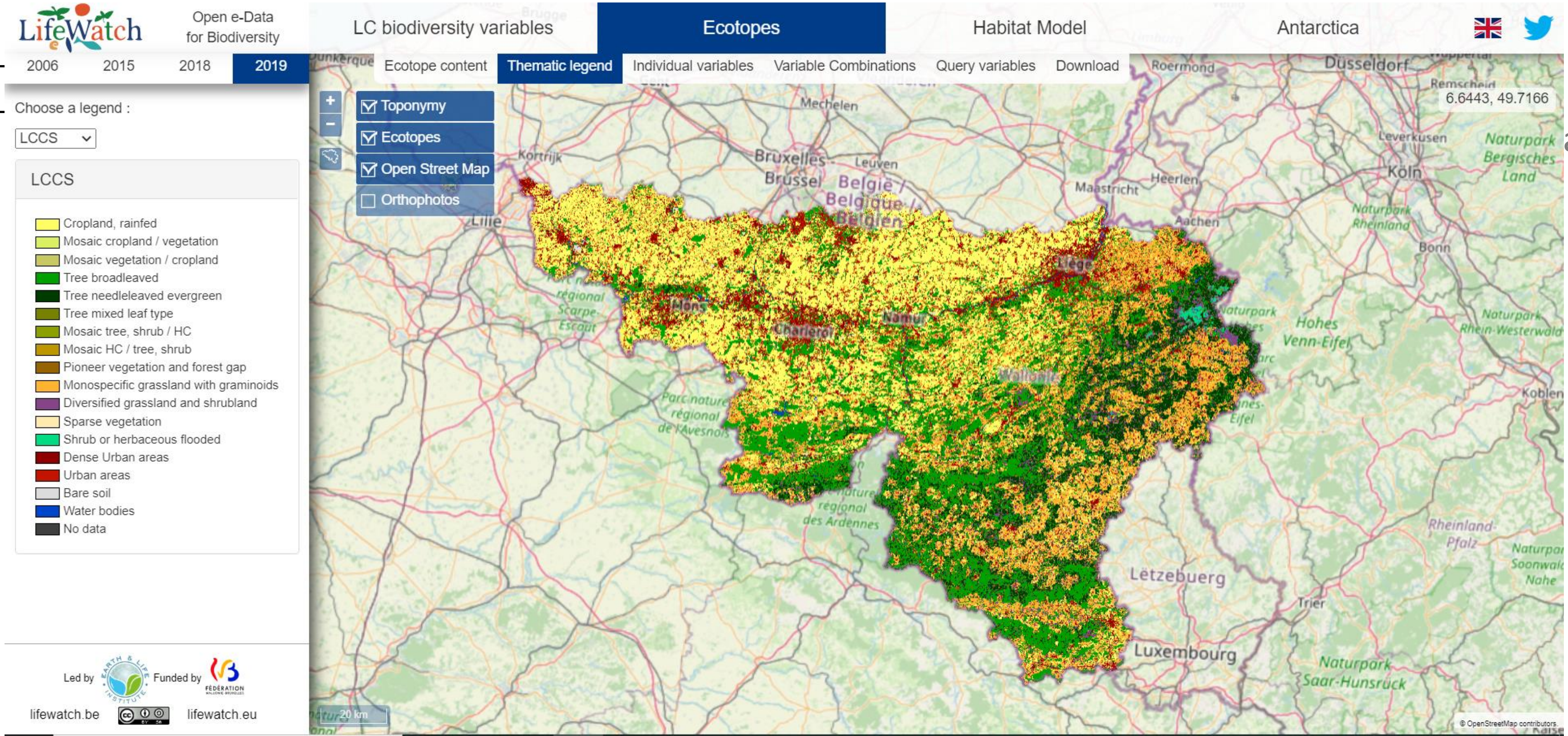
Binary ASF indicator:

$$site\ i \rightarrow ASF_i = 1, \quad if\ site\ i\ infected$$
$$site\ i \rightarrow ASF_i = 0, \quad if\ site\ i\ noninfected$$

% Coverage of site i with broadleaved forest land class

Parameter
α^{ψ}
β^{ψ}_{ASF}
β^{ψ}_{BL}
β^{ψ}_{t}
$\beta^{\psi}_{ASF \cdot t}$

action

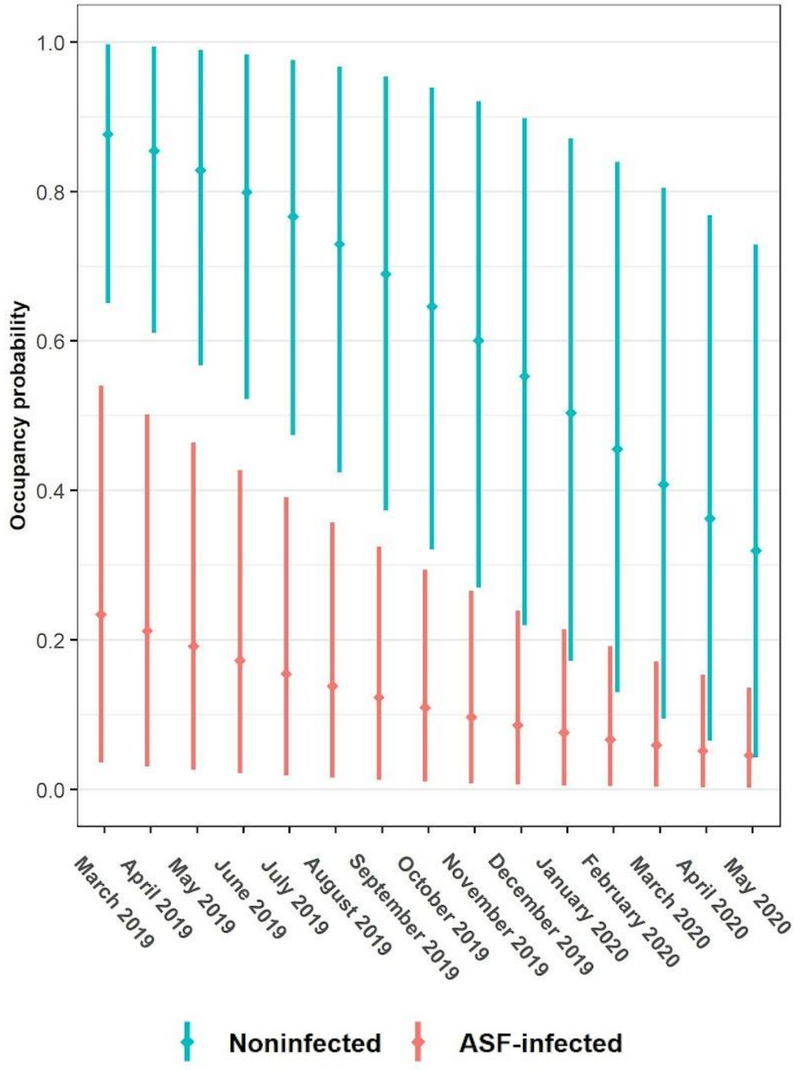


Occupancy probability:

1. Intial occupancy higher in noninfected zone
   - Late onset of the monitoring programme

2. Decline in occupancy throughout the study period in both zones
   - ASF and culling induced

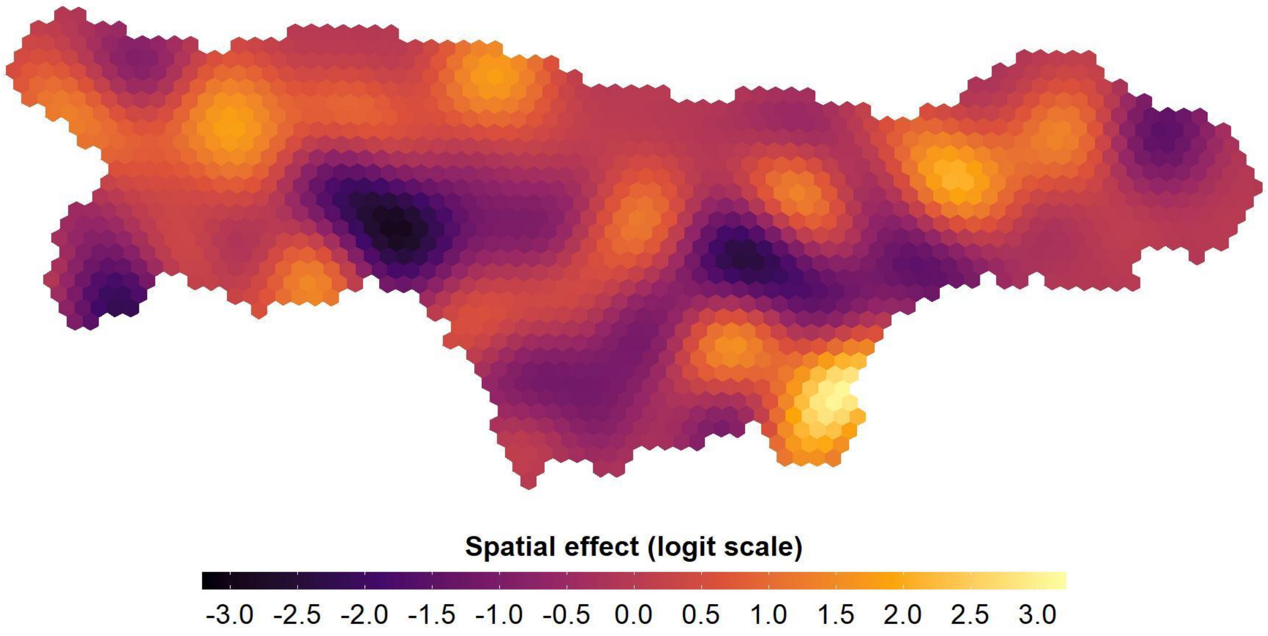
3. Sligthly stronger decline in the noninfected zone
   - Increased hunting success

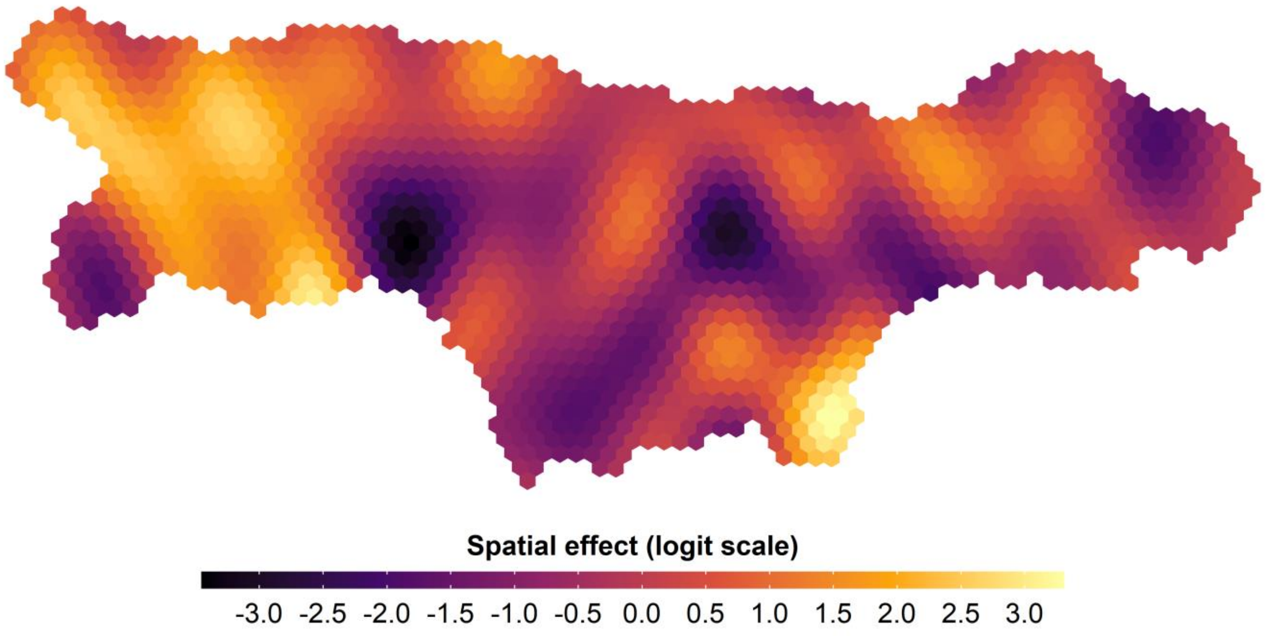


Occupancy probability:

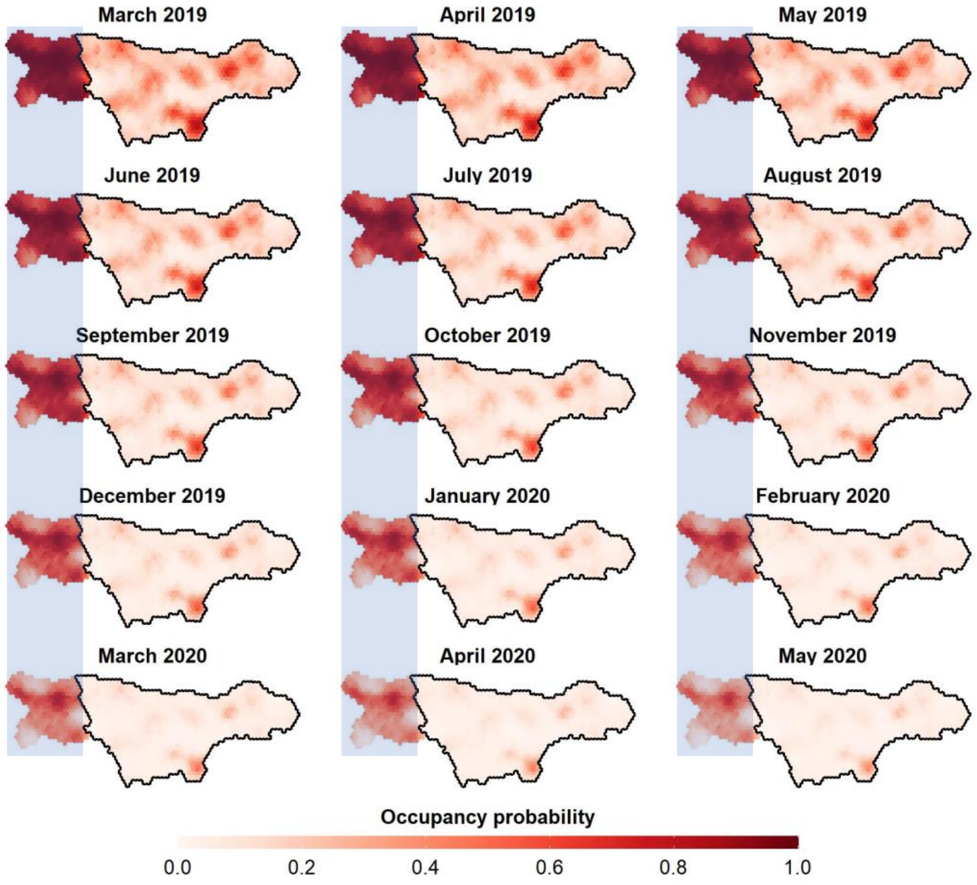
4. When removing β_{ASF}^{ψ}, the variation previously explained by this parameter is accounted for by the HSGP

    - Effectiveness of the fences





Conclusion:



Noninfected

ASF-infected

ASF- and management-induced occupancy decline (both zones)

Camera traps, usefull monitoring tools during ASF outbreaks

Thanks to

CMK
CENTRE FOR ENVIRONMENTAL SCIENCES
UHASSELT

Wallonie
service public
SPW

LifeWatch
BELGIUM

DSI
DATA SCIENCE INSTITUTE
UHASSELT

RESEARCH INSTITUTE
NATURE AND FOREST

VLAAMS
SUPERCOMPUTER
CENTRUM

Vlaanderen
is supercomputing

More information? Scan QR-code