EFSA report on scientific assistance on control and surveillance activities

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Two main questions

1. How long vaccination to eliminate LSD
2. What surveillance system for different scenarios
   - Infection status
   - Vaccination status

   and objectives:
   - Early detection of LSD
   - Demonstrate disease absence

Vaccination duration

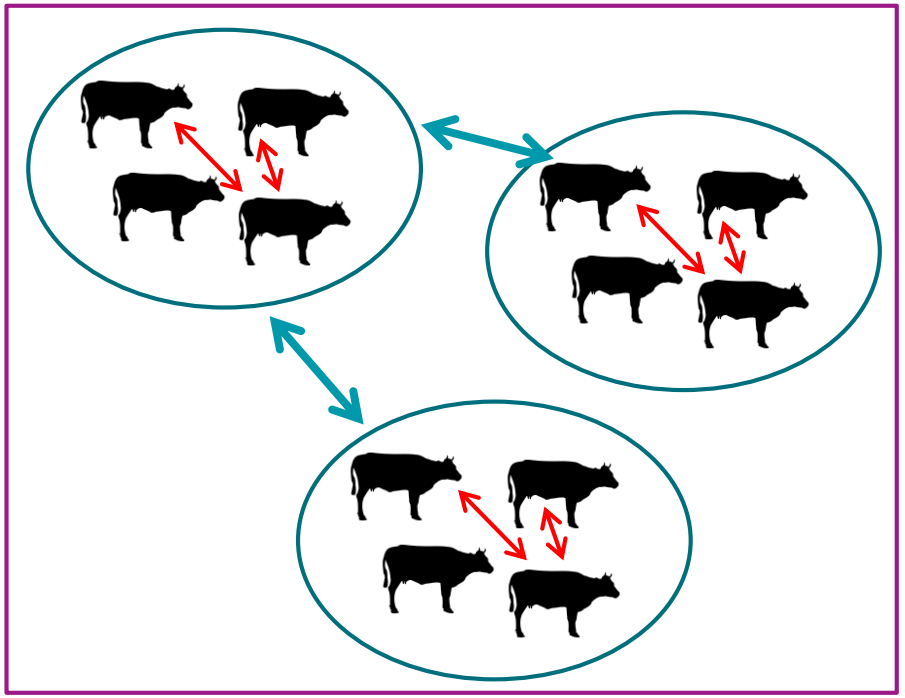
System used: spread model

2 case studies: Albania and Bulgaria/Greece

- Herd location and size
- Mean life expectancy
- Temperatures

Within-herd spread

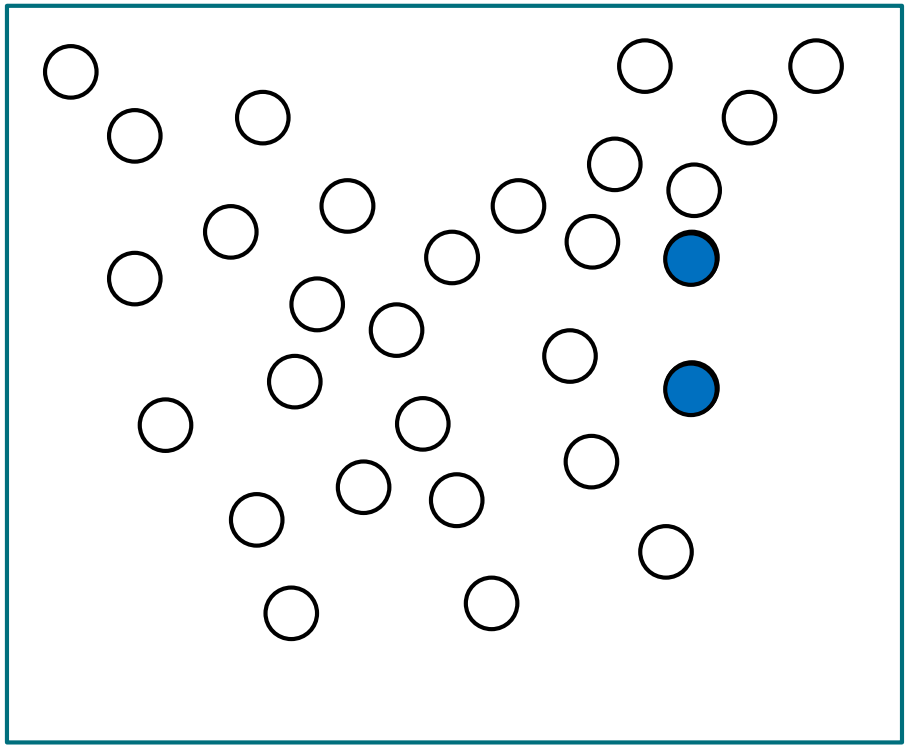
Between-herd spread

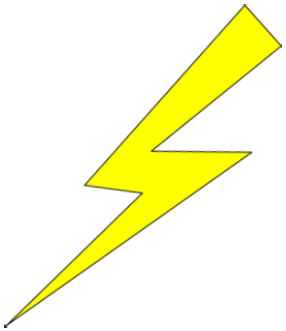


Assessment of vaccination duration

- Two important parameters:
  - Vaccination coverage: % vaccinated herds
  - Vaccination effectiveness: % vaccinated animals that were protected from infection under field conditions

Vaccination coverage and effectiveness

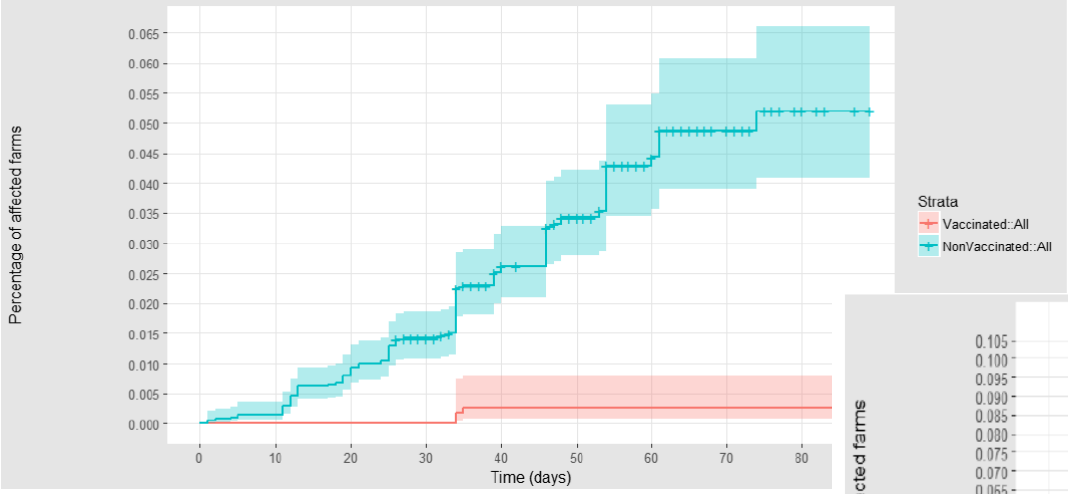




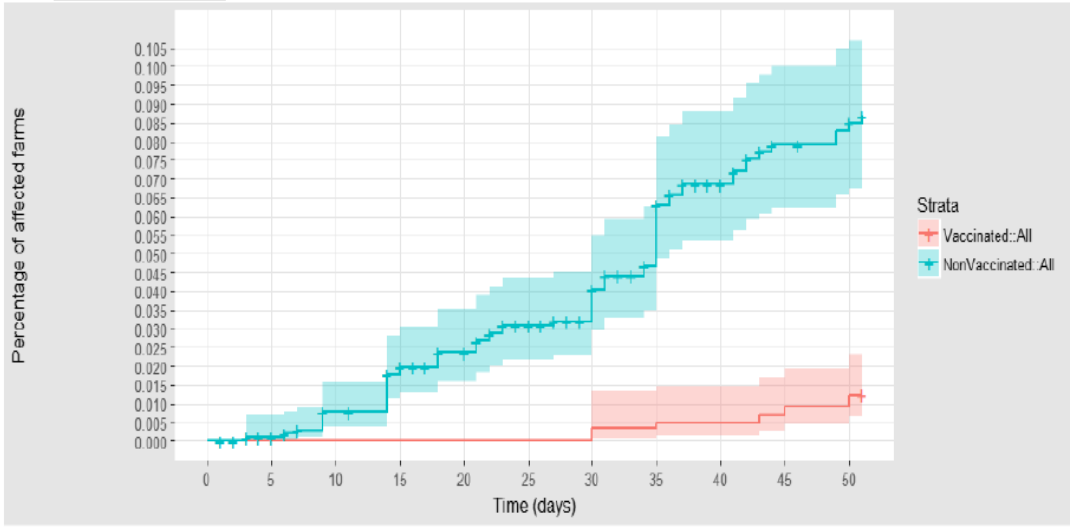
Example

- 29 farms
- 18 vaccinated>> coverage 62%
- 16 protected>> 88%

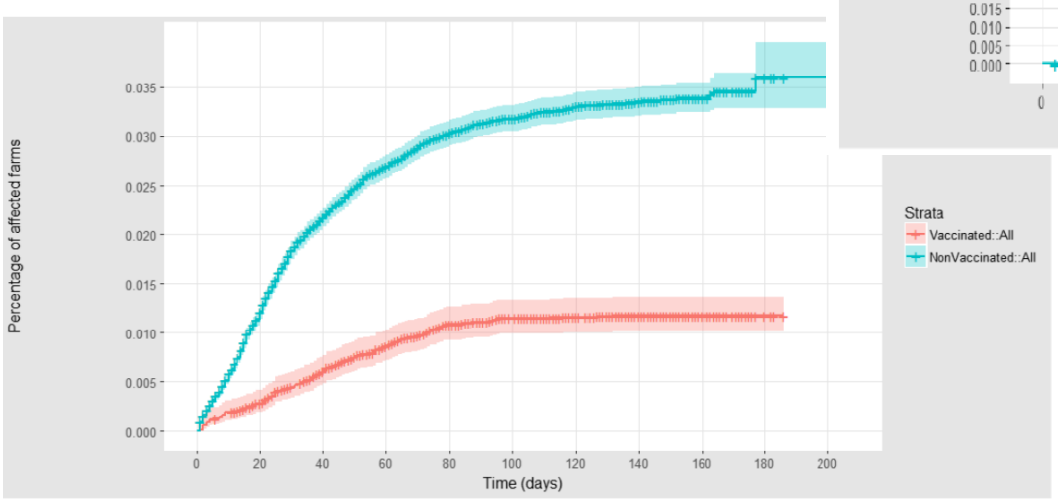
Estimation of vaccination effectiveness



Bulgaria: 95%



Greece: 84%



Albania: 65%

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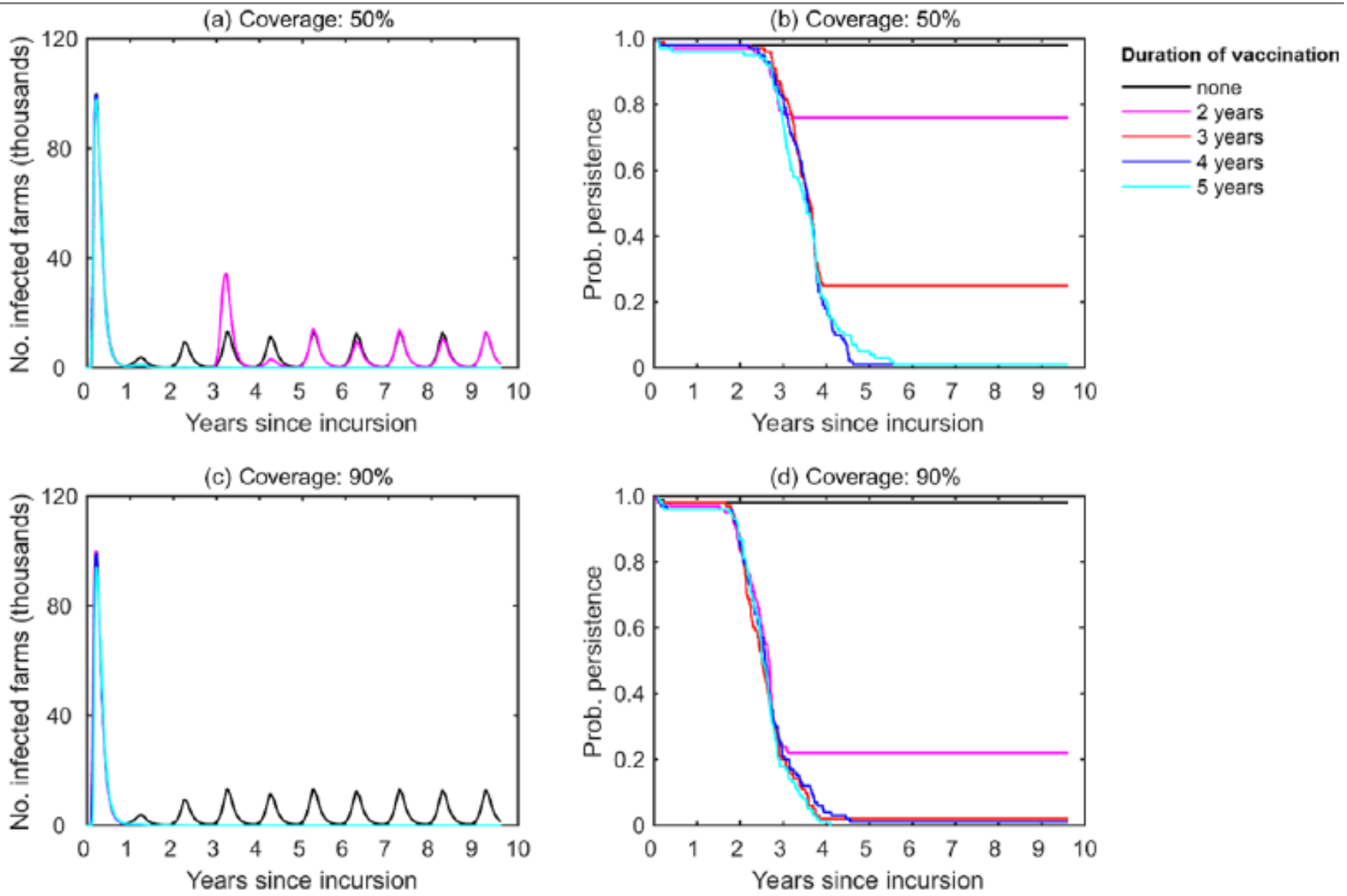
Vaccination duration for LSD elimination



Vaccination duration for LSD elimination

Simulated spread in Albania

vaccination effectiveness: 65%

	2 years	3 years	4 years	5 years
VC 50%	PERSIST P=80%	PERSIST P=30%	**OK**	**OK**
VC 90%	PERSIST P=20%	**OK**	**OK**	**OK**

Vaccination duration for LSD elimination

Simulated spread in Greece/Bulgaria

Coverage	VE	2 years	3 years	4 years	5 years
70%	80%	**PERSIST** P: 20%	**PERSIST P<5%**	**OK**	**OK**
	95%	**PERSIST** P<20%	**PERSIST P<5%**	**OK**	**OK**
90%	80%	**PERSIST** P<20%	**OK**	**OK**	**OK**
	95%	**OK**	**OK**	**OK**	**OK**

Scenarios to consider for surveillance

1. No infection, no vaccination
2. No infection, vaccination is continued
3. No infection, vaccination is stopped
4. Past infection, vaccination is stopped

Elements assessed for surveillance

- objective of the surveillance
- type of surveillance
- possible source of infection
- susceptible target population
- risk areas
- risk period
- diagnostic tests
- design prevalence or threshold of detection.
- sample size
- sampling frequency

Surveillance design for early detection

Key issue: estimate design prevalence for early detection and sampling frequency

Or

How to detect LSD in the **quickest way** in order to **minimise losses**

LSD spread model: 3 possible uses >>>>>

Sampling frequency for early detection

Model used to predict time to detection and sampling frequency

Table 3: Impact of season on predicted time to detection (in days) and related number of infected herds at detection of lumpy skin disease outbreaks

Time of incursion	Median time to detection (95% prediction interval)	Median percentage of infected herds at detection (95% prediction interval)
Albania		
1 January	75 (14–134)	0.0025 (0.0005–0.011)
1 April	30 (0–77)	0.0015 (0.0005–0.006)
1 July	15 (0–110)	0.0015 (0.0005–0.0205)
1 October	48 (4–75)	0.0065 (0.0005–0.0255)
Bulgaria and Greece		
1 January	62 (36–160)	0.015 (0.001–0.072)
1 April	21 (0–107)	0.004 (0.001–0.041)
1 July	22 (0–141)	0.004 (0.001–0.042)
1 October	45 (6–77)	0.027 (0.001–0.096)

In 2017, there were 198,000 cattle herds in Albania and 88,000 in Bulgaria and Greece, considered together.

Prevalence at different time to detection

Table 4: Median (95% prediction interval) percentage of herds infected at detection when detection occurs 21, 28 or 35 days after an incursion or re-emergence of infection upon arrest of vaccination

Scenario	Time to detection[(a)]		
	21 days	28 days	35 days
Albania, incursion in June	0.003 (0.0005–6.5)	0.009 (0.0005–20.1)	0.21 (0.0005–35.1)
Albania, re-emergence (2 years of vaccination, 50% coverage)	0.032 (0.0007–0.15)	0.048 (0.0007–0.23)	0.12 (0.0027–0.55)
Albania, re-emergence (3 years of vaccination, 50% coverage)	0.023 (0.0005–0.20)	0.055 (0.0005–0.43)	0.20 (0.0005–1.4)
Albania, re-emergence (2 years of vaccination, 90% coverage)	0.026 (0.0005–0.066)	0.049 (0.005–0.11)	0.12 (0.0005–0.31)
Bulgaria and Greece, incursion in June	0.0045 (0.0011–2.9)	0.015 (0.0011–9.6)	0.074 (0.011–6.7)
Bulgaria and Greece, re-emergence (2 years of vaccination, 70% coverage, 80% effectiveness)	0.016 (0.0045–0.28)	0.025 (0.0045–0.54)	0.032 (0.0057–0.97)
Bulgaria and Greece, re-emergence (2 years of vaccination, 70% coverage, 95% effectiveness)	0.011 (0.0023–0.69)	0.016 (0.0023–1.6)	0.041 (0.0023–2.9)
Bulgaria and Greece, re-emergence (2 years of vaccination, 80% coverage, 95% effectiveness)	0.020 (0.0011–0.065)	0.029 (0.0023–0.17)	0.042 (0.0011–0.34)

Time to detection at given prevalence

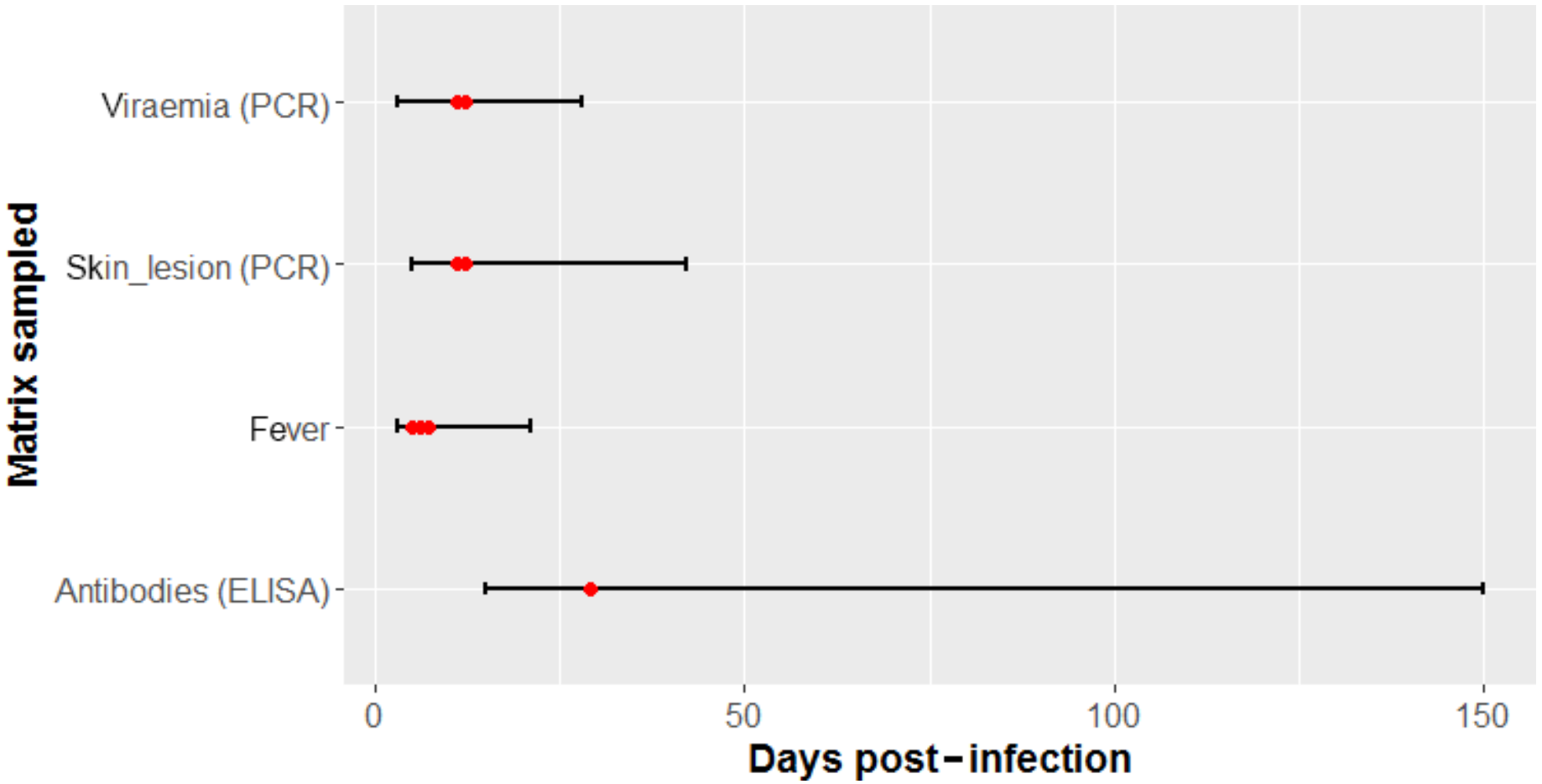
Table 5: Median (95% prediction interval) time (days)[(a)] to reach design prevalence after an incursion or a vaccination campaign has stopped

Scenario	Design prevalence		
	0.1%	1%	5%
Albania, incursion in June	35 (12–97)	38 (16–104)	43 (20–110)
Albania, re-emergence (2 years, 50% coverage)	34 (14–81)	54 (40–102)	77 (60–125)
Albania, re-emergence (3 years, 50% coverage)	31 (15–97)	45 (34–111)	60 (46–125)
Albania, re-emergence (2 years, 90% coverage)	35 (28–220)	54 (44–338)	74 (62–112)
Bulgaria and Greece, incursion in June	36 (10–118)	47 (18–93)	56 (24–111)
Bulgaria and Greece, re-emergence (2 years, 70% coverage, 80% effectiveness)	51 (14–75)	88 (36–143)	116 (64–139)
Bulgaria and Greece, re-emergence (2 years, 70% coverage, 95% effectiveness)	47 (8–147)	75 (25–358)	89 (43–151)
Bulgaria and Greece, re-emergence (2 years, 80% coverage, 95% effectiveness)	45 (25–95)	70 (45–124)	90 (66–140)

Diagnostic tests

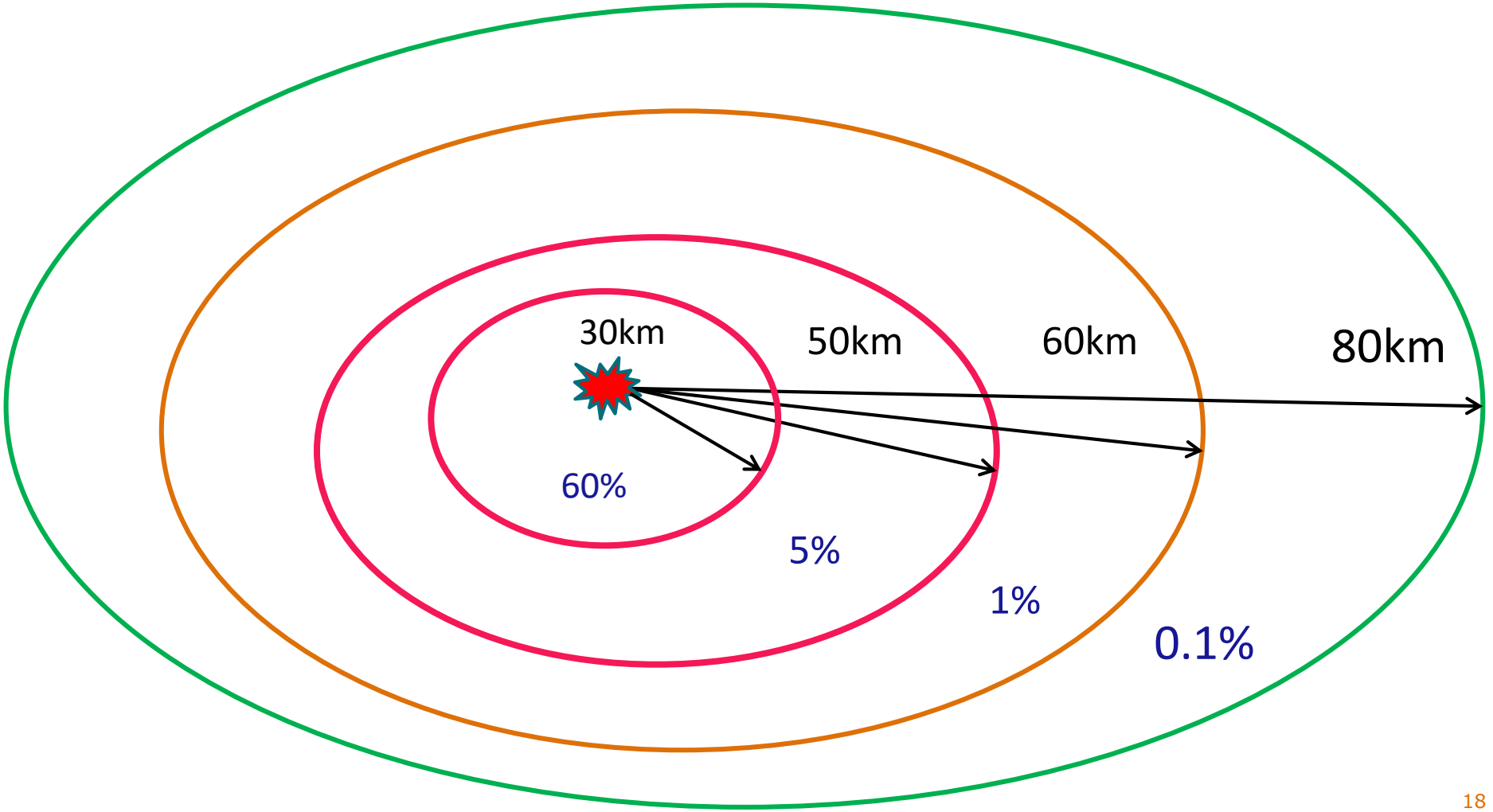
		Sensitivity	Specificity
Clinical detection		75%	
PCR	**blood**	90-100%	96-100%
	Skin lesion	95-100%	100
ELISA	**Experiment**	83%	99.7%
	Field	59%	99.7%
Immunoperoxidase monolayer assay	**Experiment**	100%	100%
	Field	53%	100%

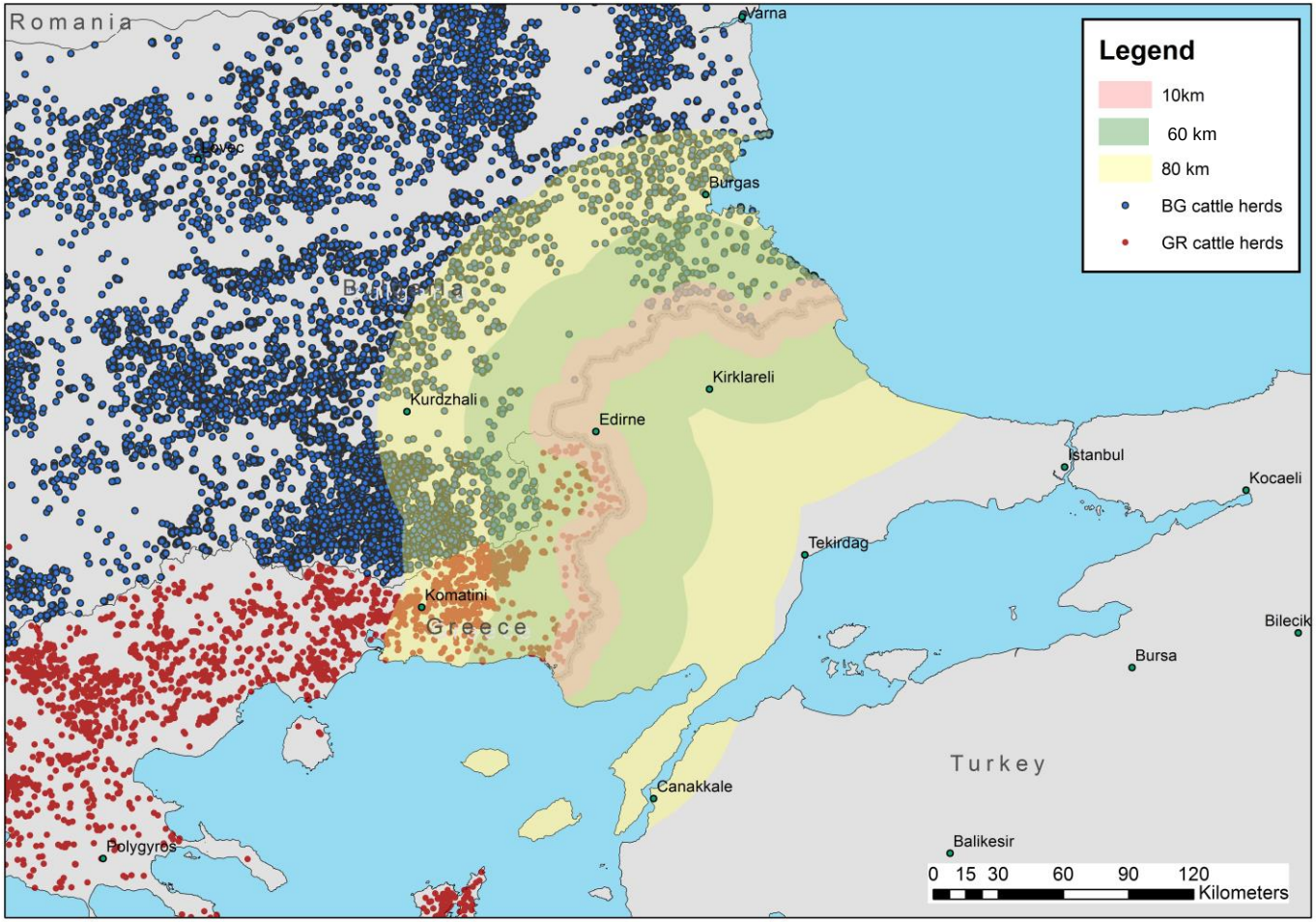
Diagnostic window



Buffer zone : probability of LSD «escape»

planning **risk based surveillance**





HERDS	Total	50 km	62km	80 km
Number	90,000	3100	5400	12,500
%		3.4%	6%	13%

Surveillance for early detection: example

- Test : clinical detection >> Se 75% (PCR confirmation)
- Sample area: area at risk (buffer zone)
- Target population: susceptible cattle population in the at risk area
- Active surveillance on areas at risk + passive surveillance on the whole country.
- Design prevalence at different times to detection
- Sampling frequency: 5 weeks
- Sample size at different design prevalence and buffer zones

synoptic table on surveillance at:
https://doi.org/10.5281/zenodo.1451440

Sample size for early detection

- Example: population size: 90,000 herds in naive country

		Buffer size		
Design prevalence	**Delay in detection**	**80 km (0.1%)**	**62 km (1%)**	**50 km (5%)**
0.0045%	21 days	8000	4140	n.a.
0.075%	35 days	681	360	427
1%	47 days	51	27	31
5%	56 days	9	5	5

Sample size calculator tools: http://efsa.openanalytics.eu

Demonstration of disease absence

Serology

- Design prevalence>> % ever infected herds (e.g. 3.5%)
- Test : ELISA >> Se: 83%
- Sampling period: after major risk period (April-Octber)
- Sample area: whole country
- Target population: Non-immunised fraction of cattle population
- Sample size: population+ Se+ design prevalence

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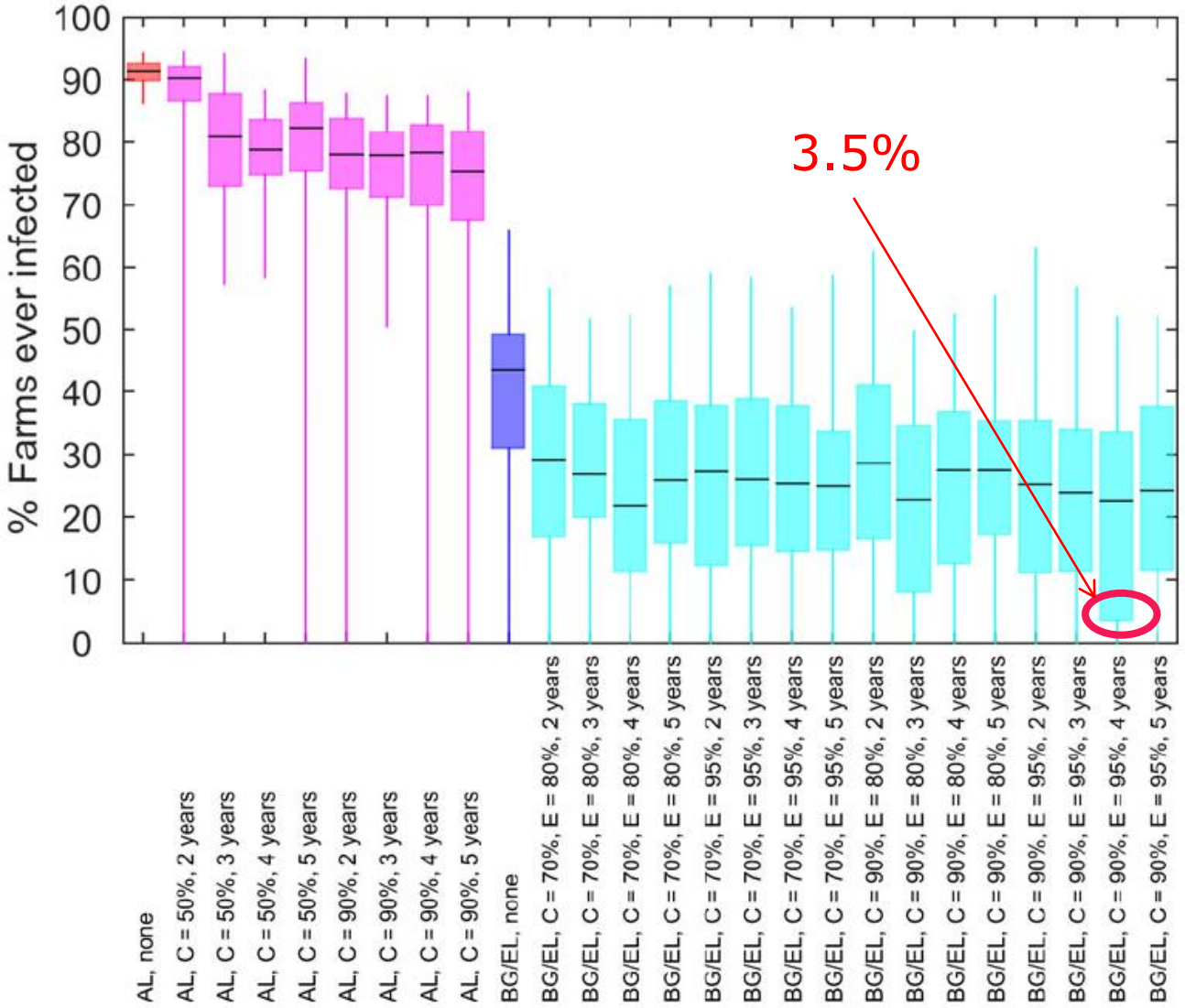
Design prevalence for demonstration of disease absence



E.g.:

- Population size: 90,000
- Sample size: 103 herds

Results based on spread model

- Main characteristics of the model
  - Kernel: distance dependent
  - Herd size dependent

- Assumptions/limitations:
  - No info on vector movevement
  - No info on animal movements
  - No transmission mechanisms, just distance related

Keep in mind!

- Monitor vaccination campaign >> **vacc. effectiveness**
- Passive surveillance: key for early warning for LSD
- areas bordering endemic regions and areas previously infected >> active surveillance
- Feasibility of surveillance for early detection: adapt it
- Data gaps:
  - ✓ within-herd transmission
  - ✓ duration of immunity vectors
  - ✓ diagnostic test performances, under field conditions
  - ✓ exact farm location and type

Thank you for your attention !

EFSA Report available at:
http://www.efsa.europa.eu/en/press/news/181016

Farm size

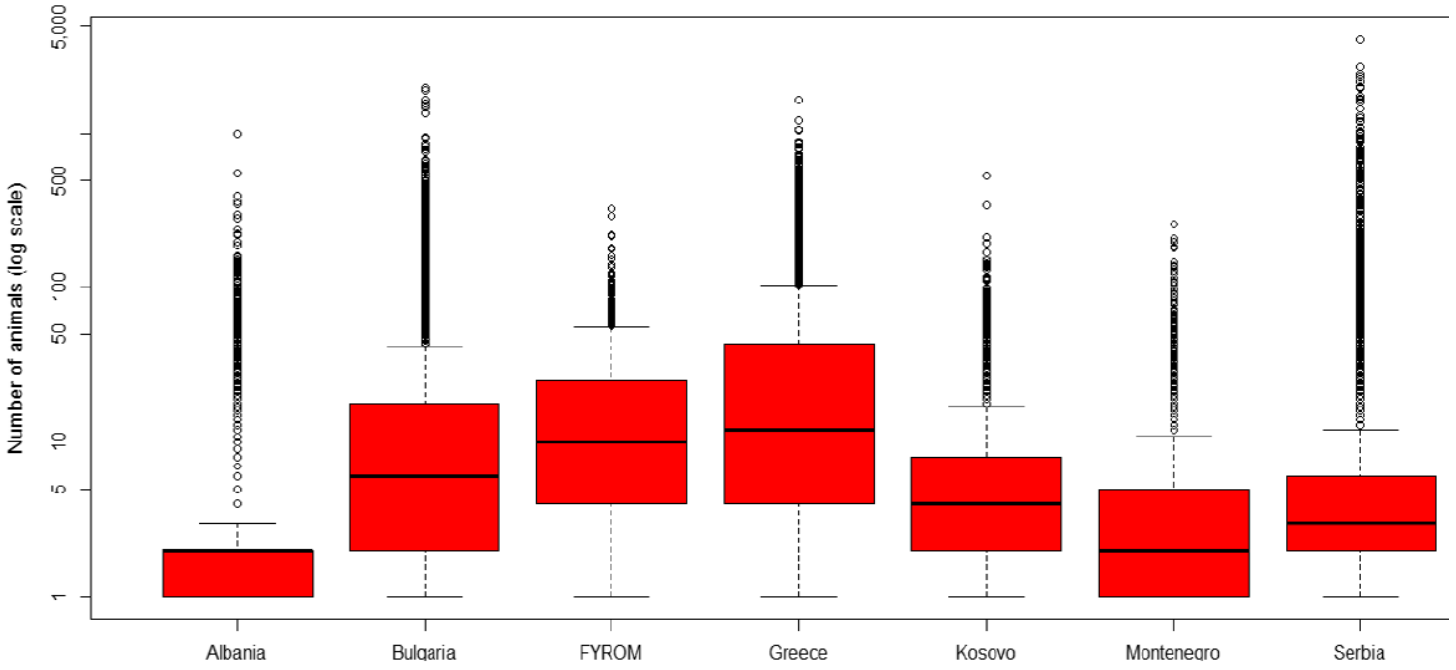


Figure 6: Distribution of farm size of the total cattle population in the affected countries