

# VMP 991: Transboundary Animal Disease Spatial Epidemiology

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Introduction to concepts of disease ecology and their  
application to transboundary animal diseases data

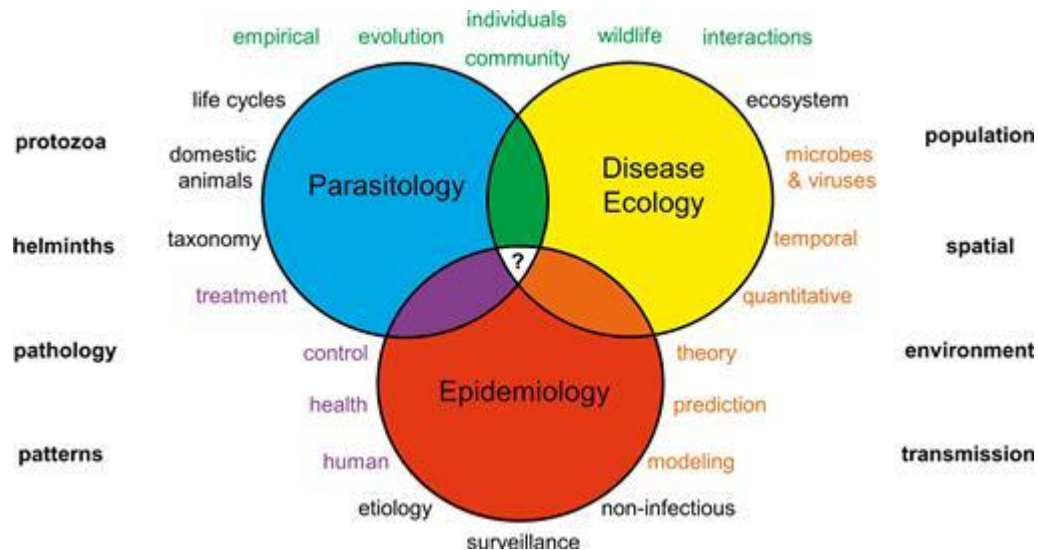
Felipe Sanchez  
2022-04-19

# What is disease ecology?

Disease ecology strives to understand the mechanisms and scale of pathogen impacts on host individuals, populations, communities and ultimately ecosystem function. The study of infectious diseases is a highly interdisciplinary field, drawing on genetics, molecular biology, immunology, epidemiology and ecological modeling.



<https://serc.si.edu/research/research-topics/parasite-disease-ecology/disease-ecology>





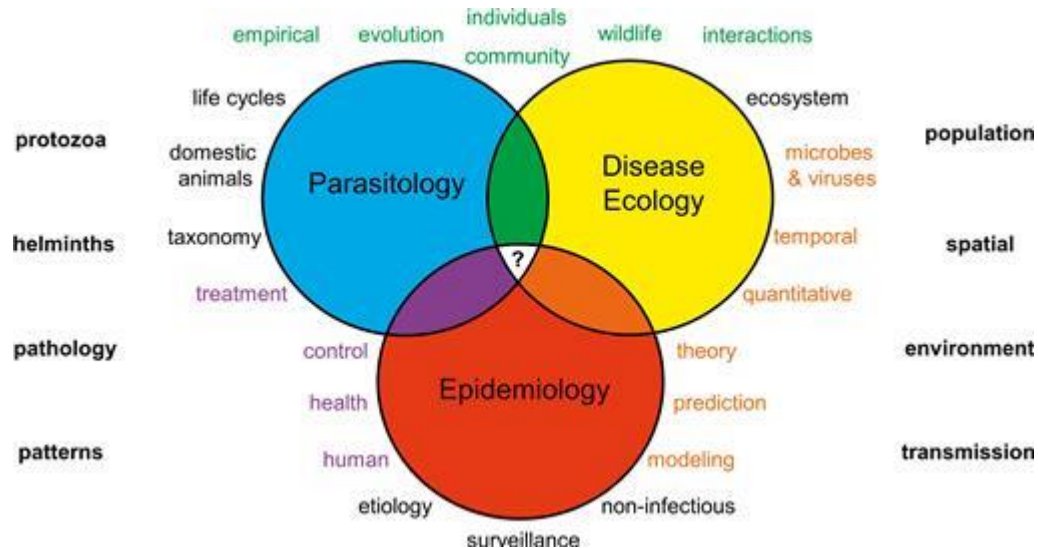
# What is disease ecology?

As you can see from the image below, disease ecology takes into consideration a lot of factors and encompasses a lot of fields.

We will focus on disease transmission (spread) modelling, which is the bread and butter of the Machado Lab.



<https://serc.si.edu/research/research-topics/parasite-disease-ecology/disease-ecology>



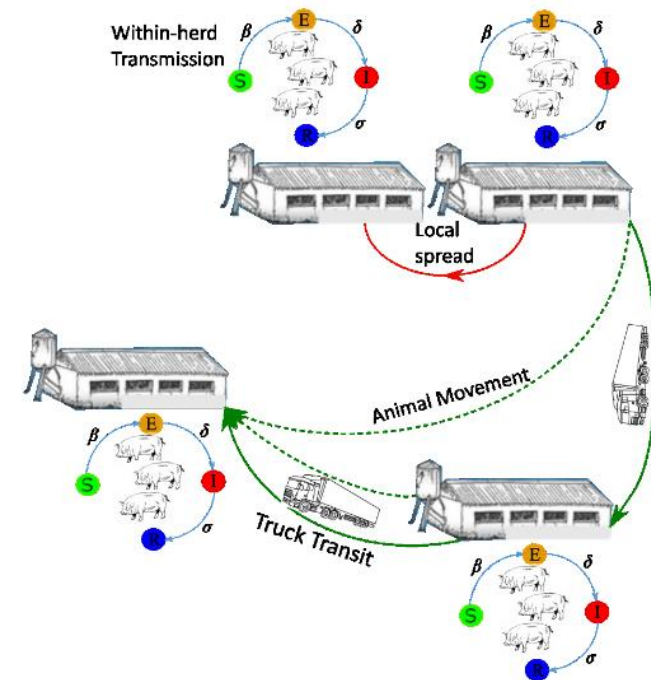
# Threshold theorem

For a disease to spread, it must be successfully transmitted to a new host before its current host dies or recovers.

The threshold theorem:

If the density of susceptible hosts is below some critical value, then the transmission of a disease, on average, will not occur rapidly enough to cause the number of infected individuals to increase.

In other words, the reproductive rate of a disease must be greater than 1 for there to be an epidemic, with the reproductive rate being defined as the average number of new infections created per infected individual.



Andraud et al. 2022. Modelling African swine fever virus spread in pigs using time-respective network data: scientific support for decision-makers

Watch this video for more information on the math behind pandemics

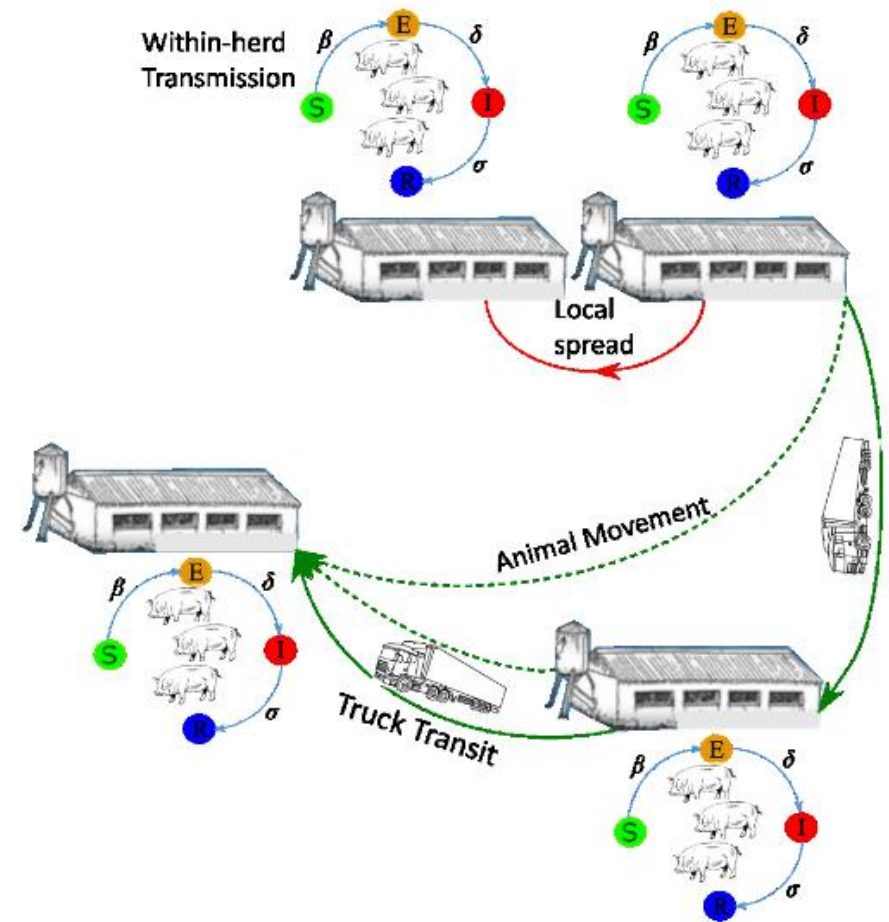
<https://www.youtube.com/watch?v=Qrp40ck3WpI>

# Transmission Routes

Lets focus on African Swine fever transmission.

Transmission dynamics can be extremely hard to tease out. They usually involve a lot of actors, from many different sources, interacting and contributing to potential disease introduction.

Such interactions create convoluted networks of potential interactions that make it hard to pin-point the exact contribution each of these sources contributes.



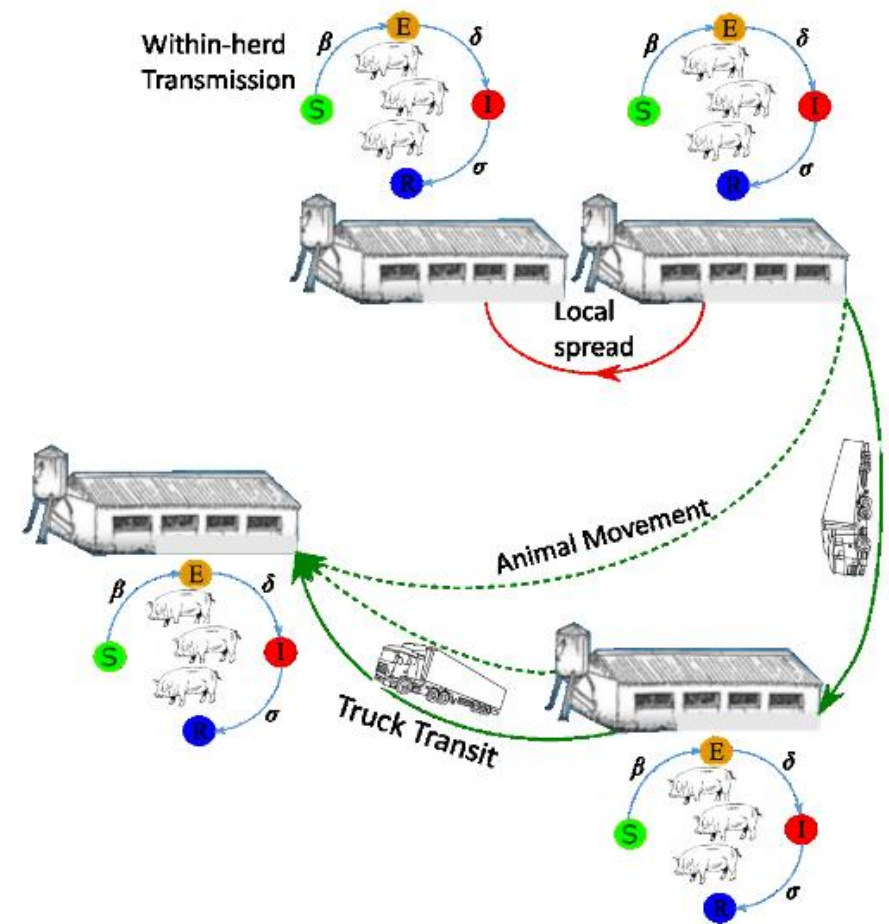
Andraud et al. 2022. Modelling African swine fever virus spread in pigs using time-respective network data: scientific support for decision-makers



# Transmission Routes

Transmission can occur at two spatial scales:

- Local transmission(spread)
  - Transmission occurring between neighboring farms at a distance of ??
  - A lot of this information remains unknown and is actively being researched
- Animal movement
  - Transmission that occurs (usually over longer distances, but can also occur on a local scale) by the transportation of infected pigs, feed, and fomites (personnel, farm equipment).



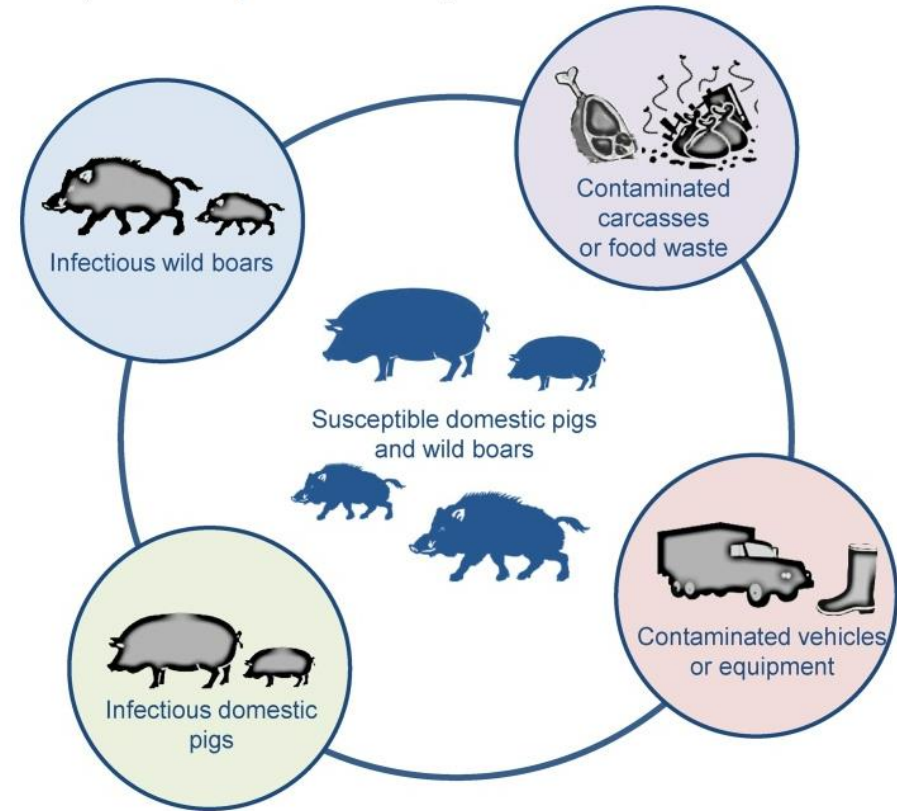
Andraud et al. 2022. Modelling African swine fever virus spread in pigs using time-respective network data: scientific support for decision-makers

# Transmission Routes

## Local transmission

May have different origins

- Airborne transmission occurring at a max distance of ??
- Indirect contact through shared farm equipment
- Vehicles moving from farm to farm
- Vector transmission (e.g. hematophagous flies, ticks)
- Wildlife-domestic interactions
- Contaminated feed



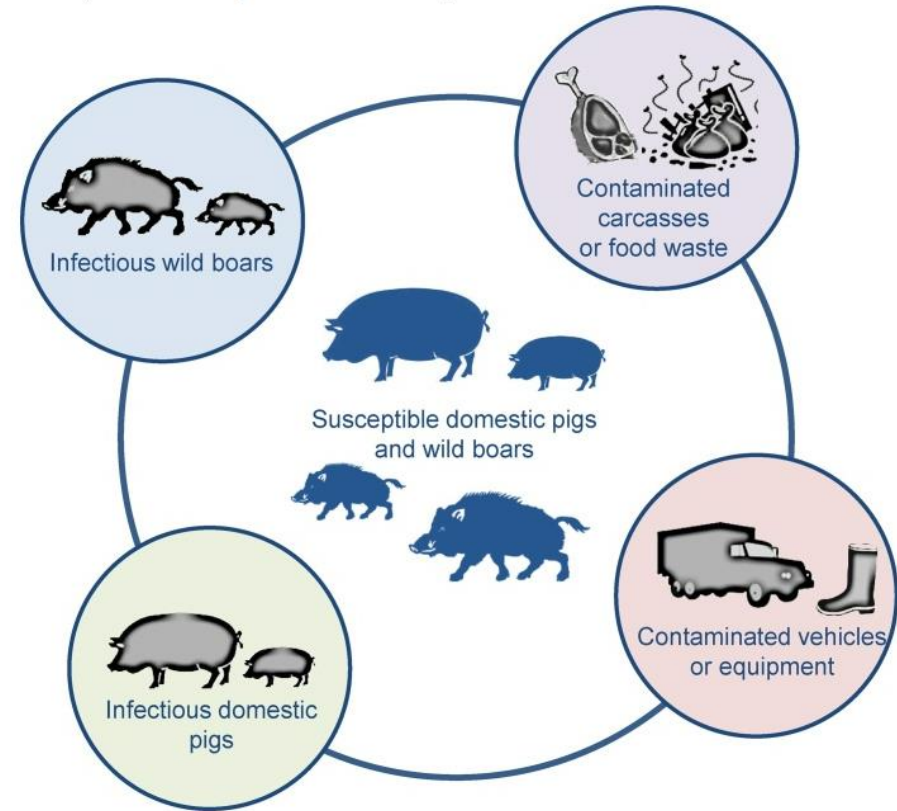
<https://asm.org/Articles/2022/March/African-Swine-Fever-Virus-Is-A-Global-Concern>

# Transmission Routes

## Animal movement transmission

May have different origins

- Vehicles moving from farm to farm
- Indirect contact through shared farm equipment
- Vector transmission (e.g. hematophagous flies, ticks)
- Contaminated feed



<https://asm.org/Articles/2022/March/African-Swine-Fever-Virus-Is-A-Global-Concern>



# Disease ecology considerations

Multiple pathways between domestic pigs and wildlife.

What environmental factors should be considered?

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Complex of epidemiological factors and transmission pathways involved in sustaining endemicity and facilitating geographical expansion of ASFV in eastern Europe (cycles 3 and 4, Figure 1)

