

# **The Social Network: *Network-based Solutions for Michigan CWD***



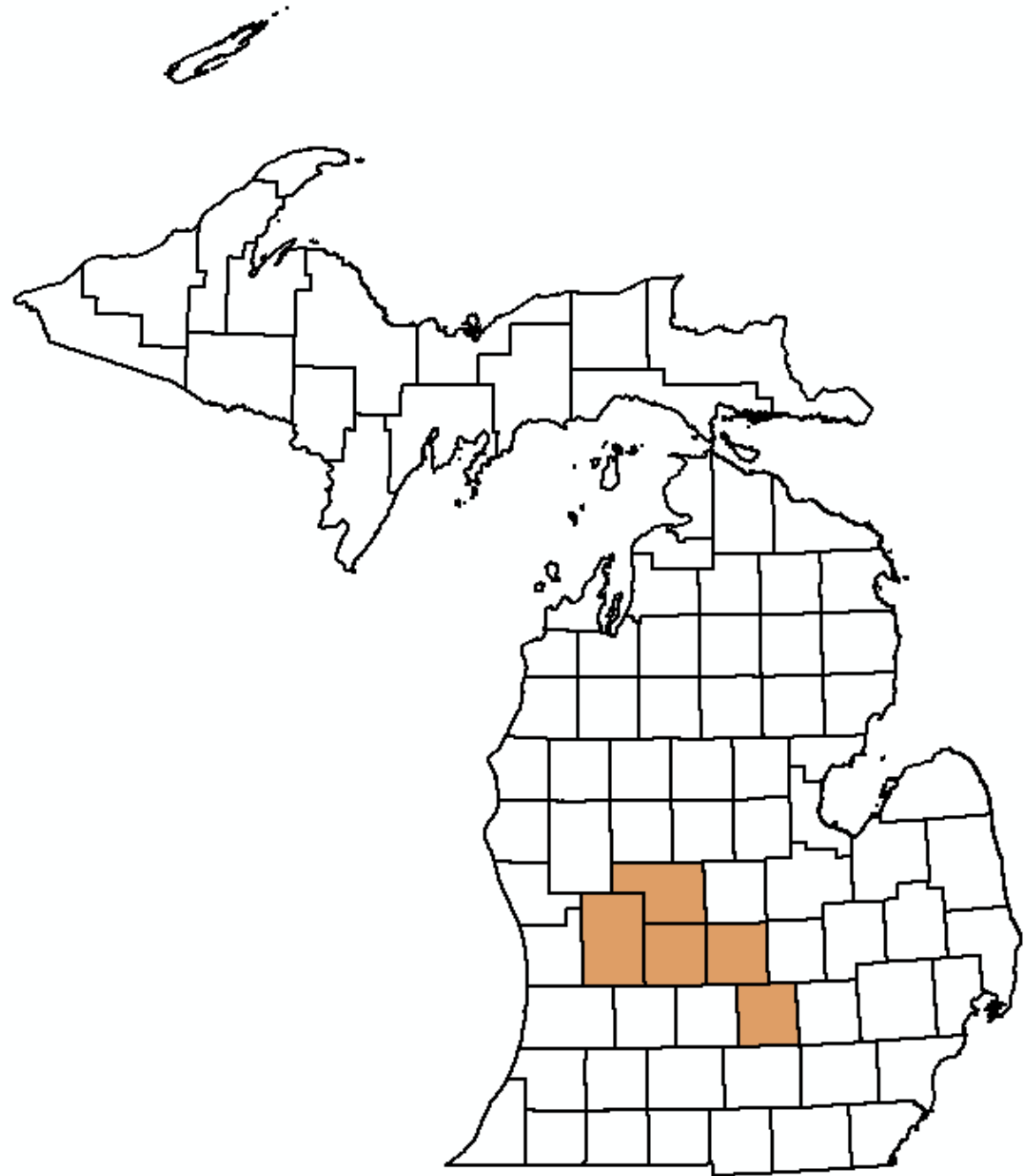


# Chronic Wasting Disease

- ❖ Neurodegenerative disease primarily affecting deer, elk and moose
- ❖ Can result in long-term population decline
- ❖ No treatment or genetic immunity
- ❖ **ALWAYS FATAL**

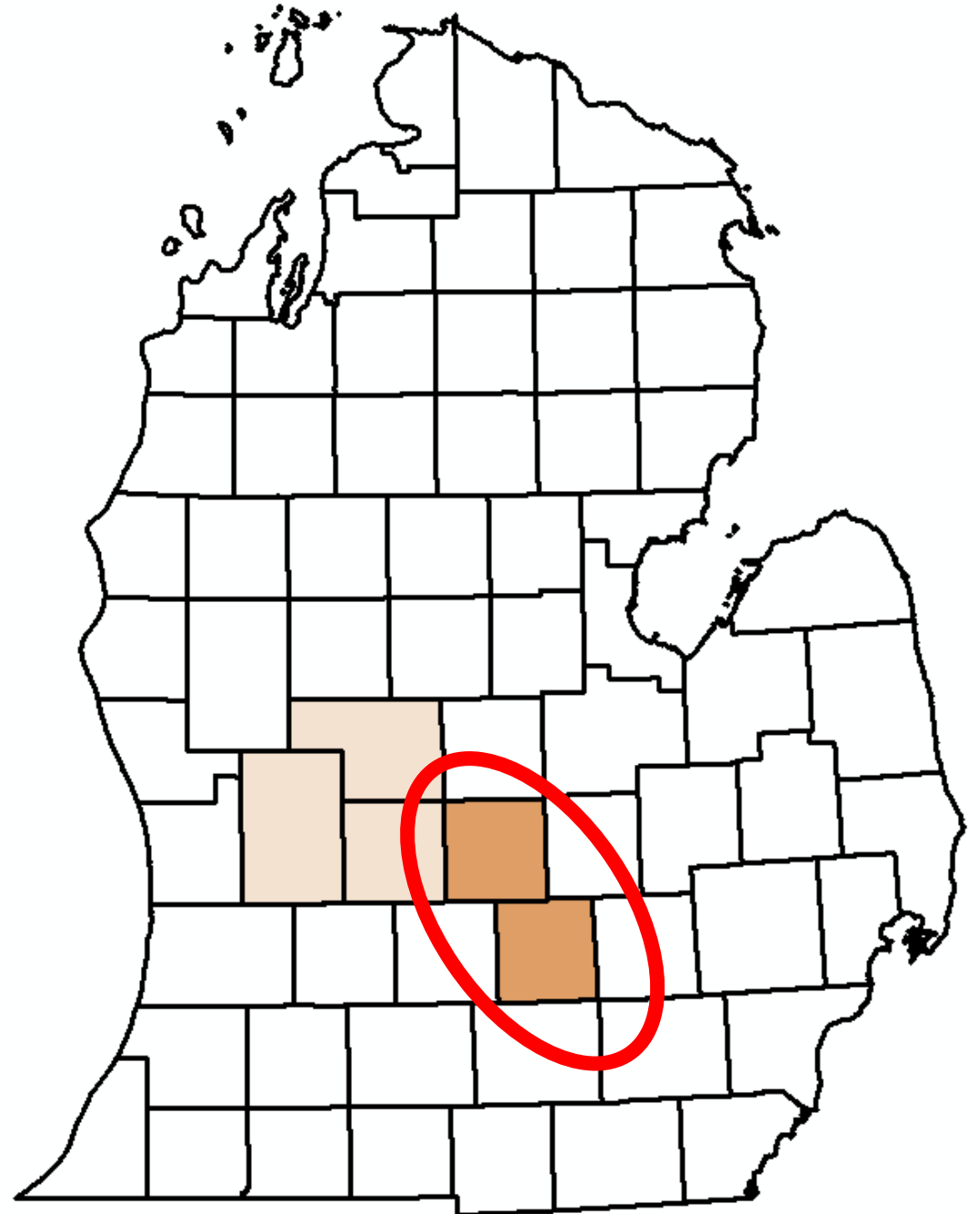
# Michigan CWD

- ❖ First detected in free-ranging deer in *May 2015*
- ❖ Since detected in 5 counties in the Lower Peninsula
- ❖ Considered **emergent** within our study area



# Michigan CWD

- ❖ First detected in free-ranging deer in *May 2015*
- ❖ Since detected in 5 counties in the Lower Peninsula
- ❖ Considered **emergent** within our study area
- ❖ How has it spread, and where could it be headed?

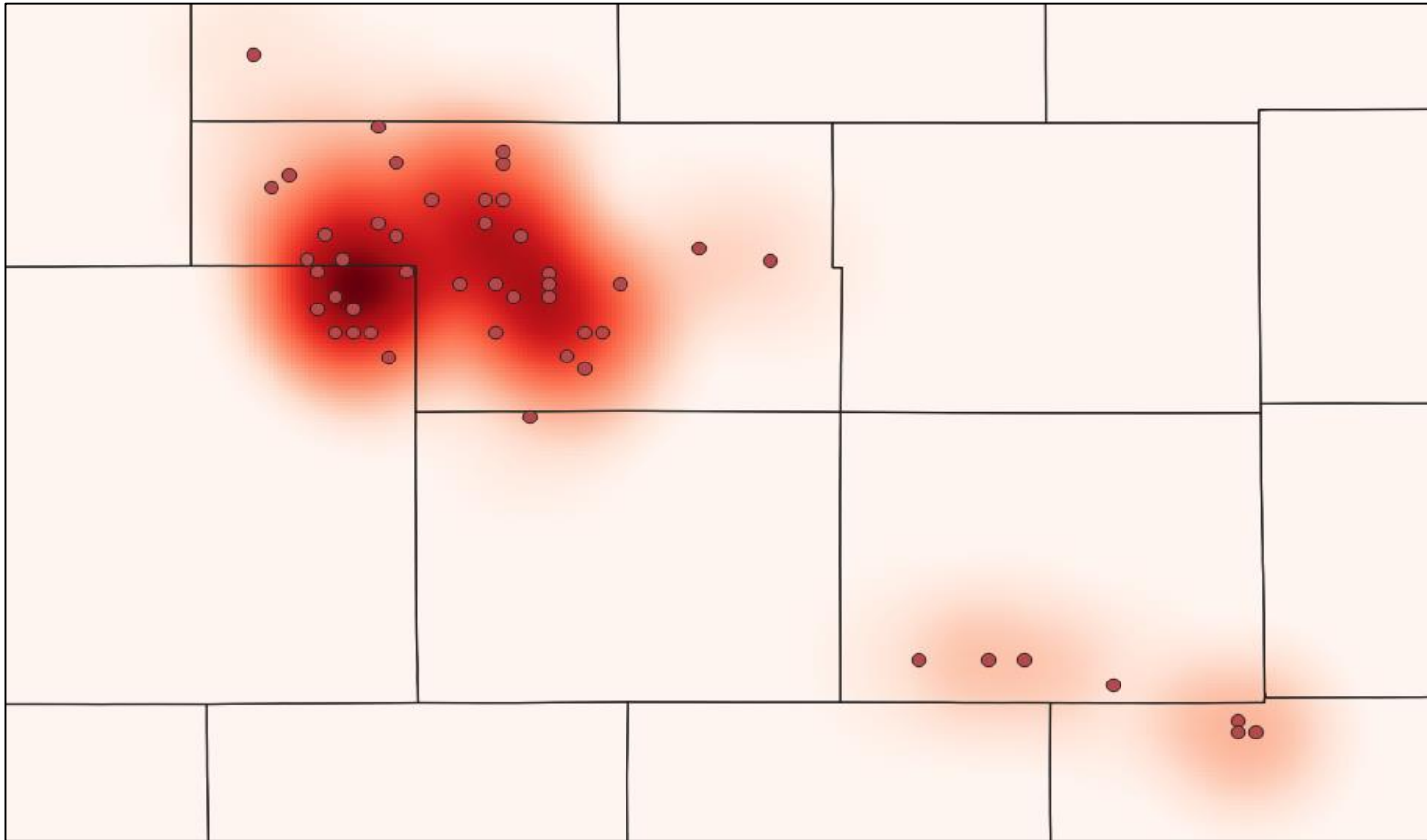




# Social Behavior Drives Disease Spread

- ❖ Deer form social groups
- ❖ Contact rates higher within than between groups
- ❖ Individuals behave differently
- ❖ Forms a heterogeneous contact structure

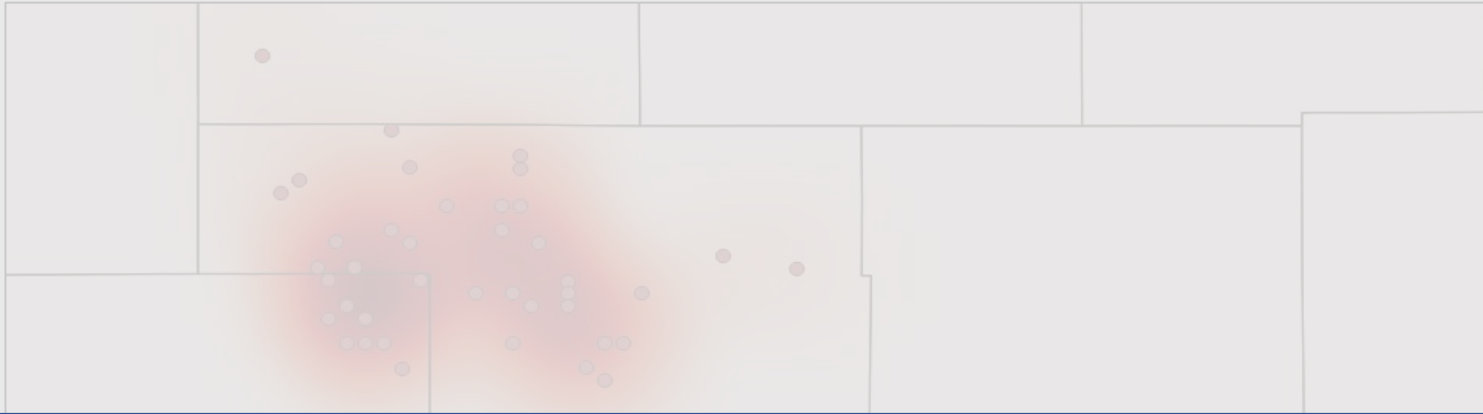




# Modeling Disease Spread

## Traditional Models (SIRS)

- ❖ Common models assume *homogenous contact structure*
- ❖ Cannot account for 'super spreaders'
- ❖ Require a lot of data
- ❖ *Not often applicable in emergent cases*



## Traditional Models (SIRS)

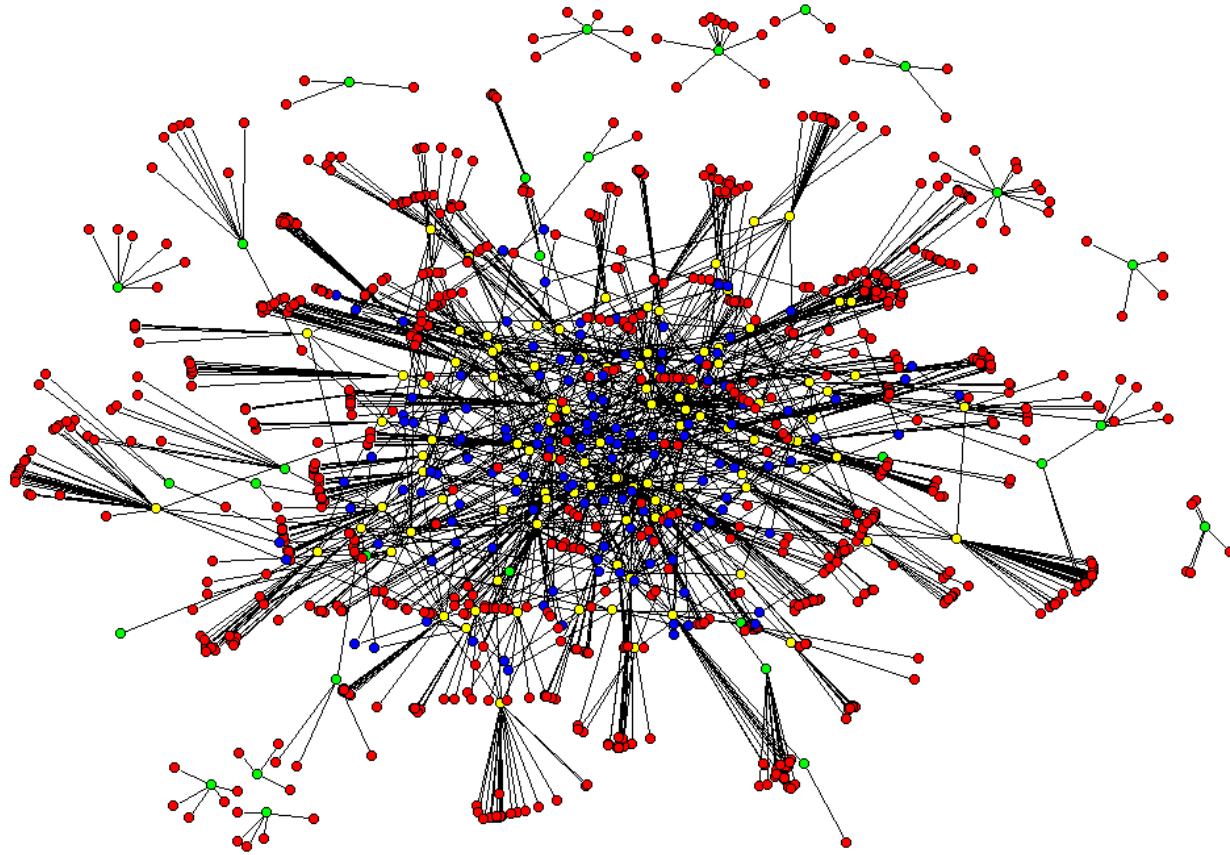
❖ Common models

***NEED A MORE REALISTIC MODELING FRAMEWORK***

# Modeling Disease Spread

- ❖ Require a lot of data
- ❖ Not often applicable in emergent cases





# Modeling Disease Spread

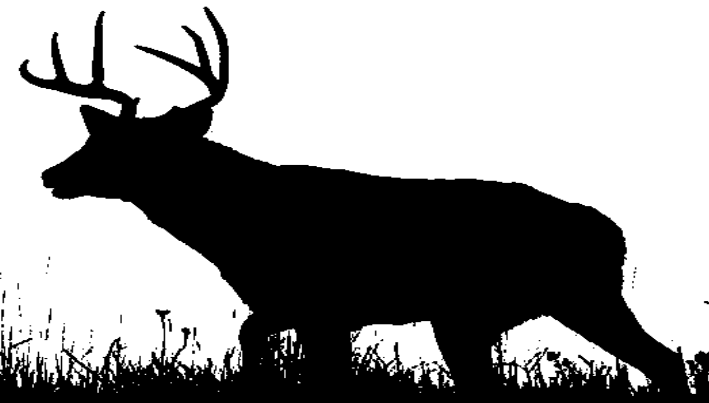
## Network-based Models

- ❖ Directly accommodate heterogeneity in contact rate & structure
- ❖ Improved predictions of disease dynamics
- ❖ Require *detailed characterization of host social network*



# Objectives

- ❖ Assess social, spatial, temporal, and demographic factors affecting inter-individual **contact rates** and **individual connectedness** within social networks.

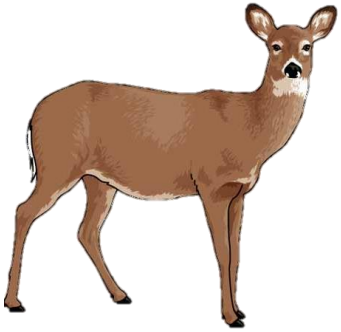


# Objectives

- ❖ Assess social, spatial, temporal, and demographic factors affecting inter-individual contact rates and individual connectedness within social networks.
- ❖ Parameterize network-based simulation models to assess the influence of **heterogenous contact structure** on disease dynamics.

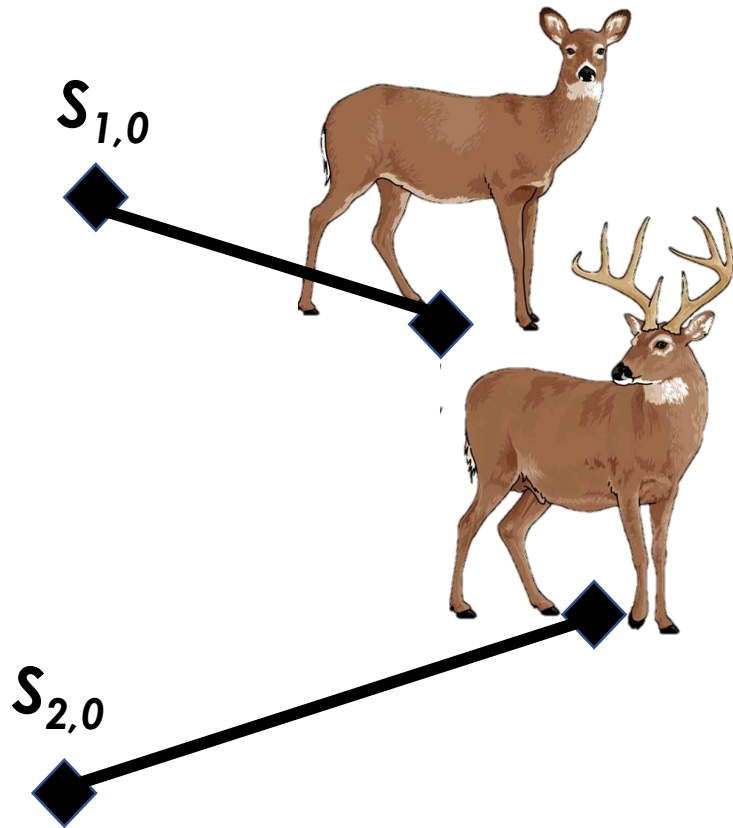


# Contact Rate & Structure



- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time

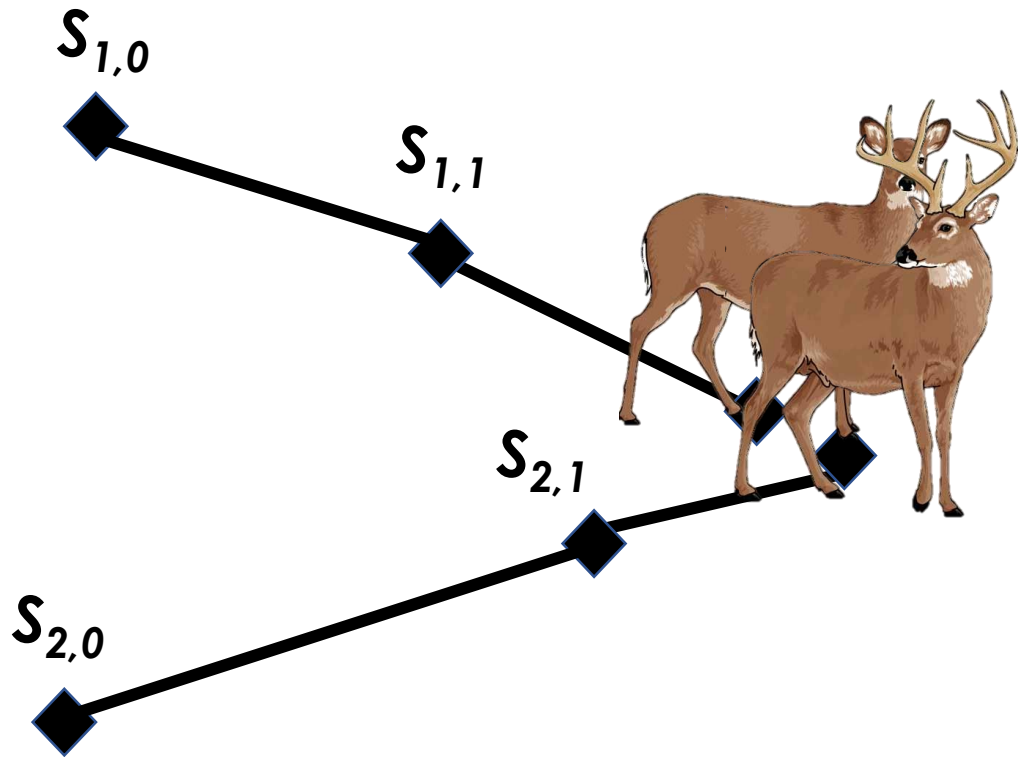
# Contact Rate & Structure



- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time

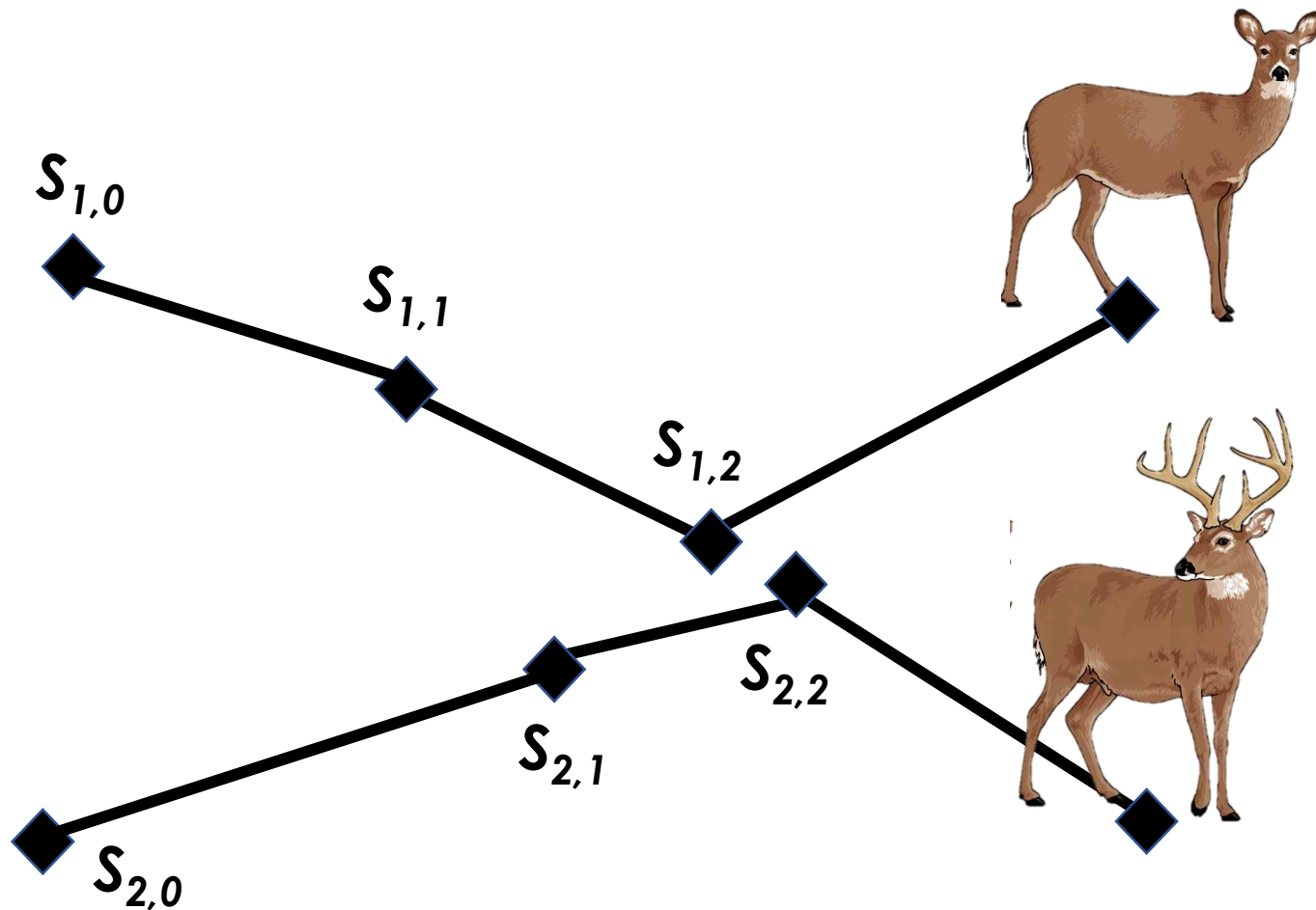


# Contact Rate & Structure



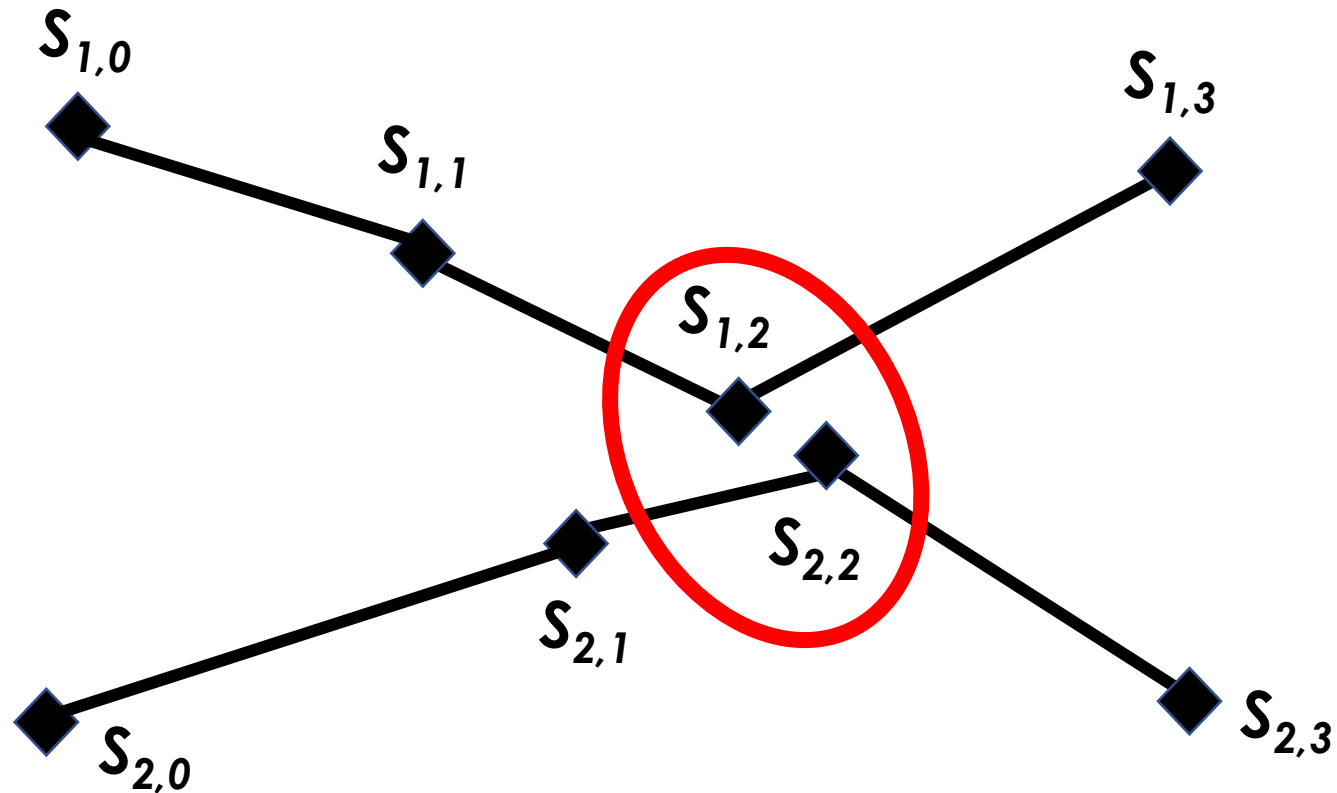
- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time

# Contact Rate & Structure



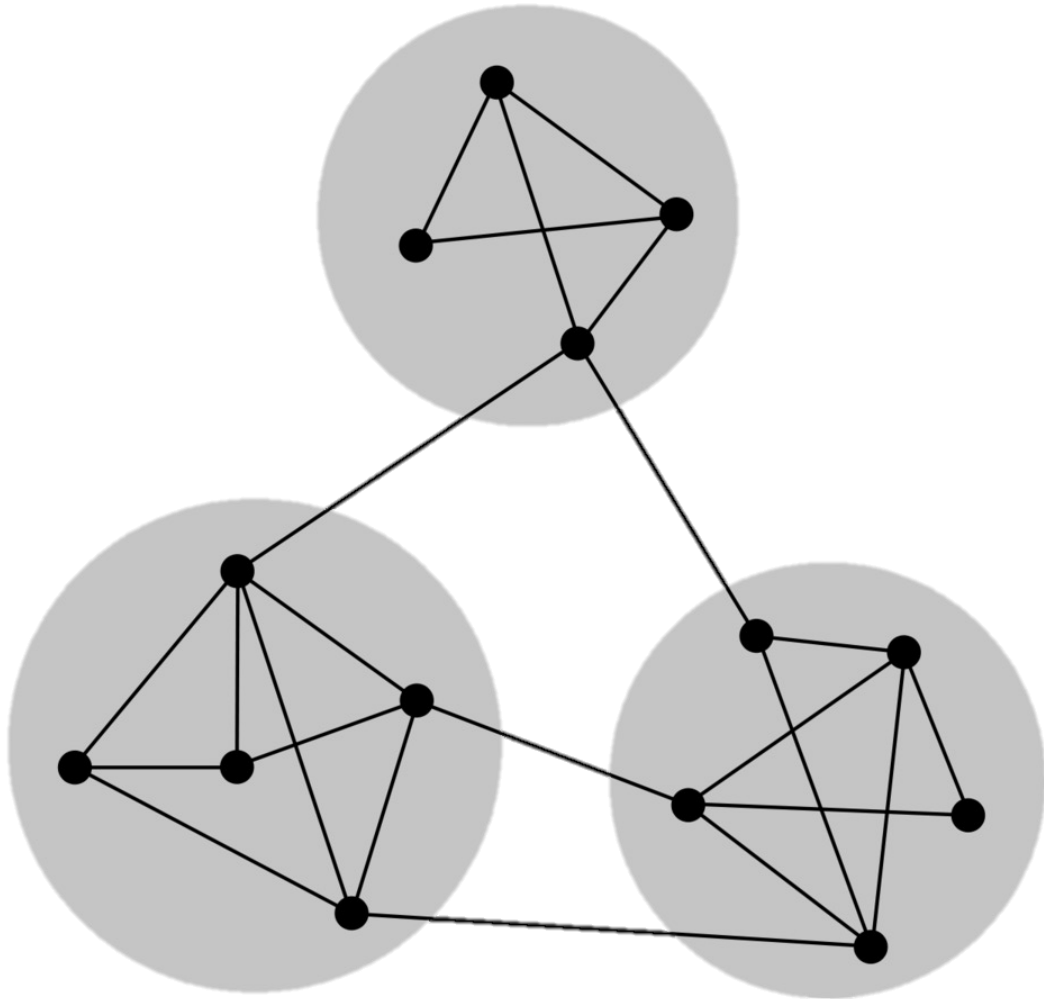
- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time

# Contact Rate & Structure



- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time
- ❖ **Rate: # contacts / time**

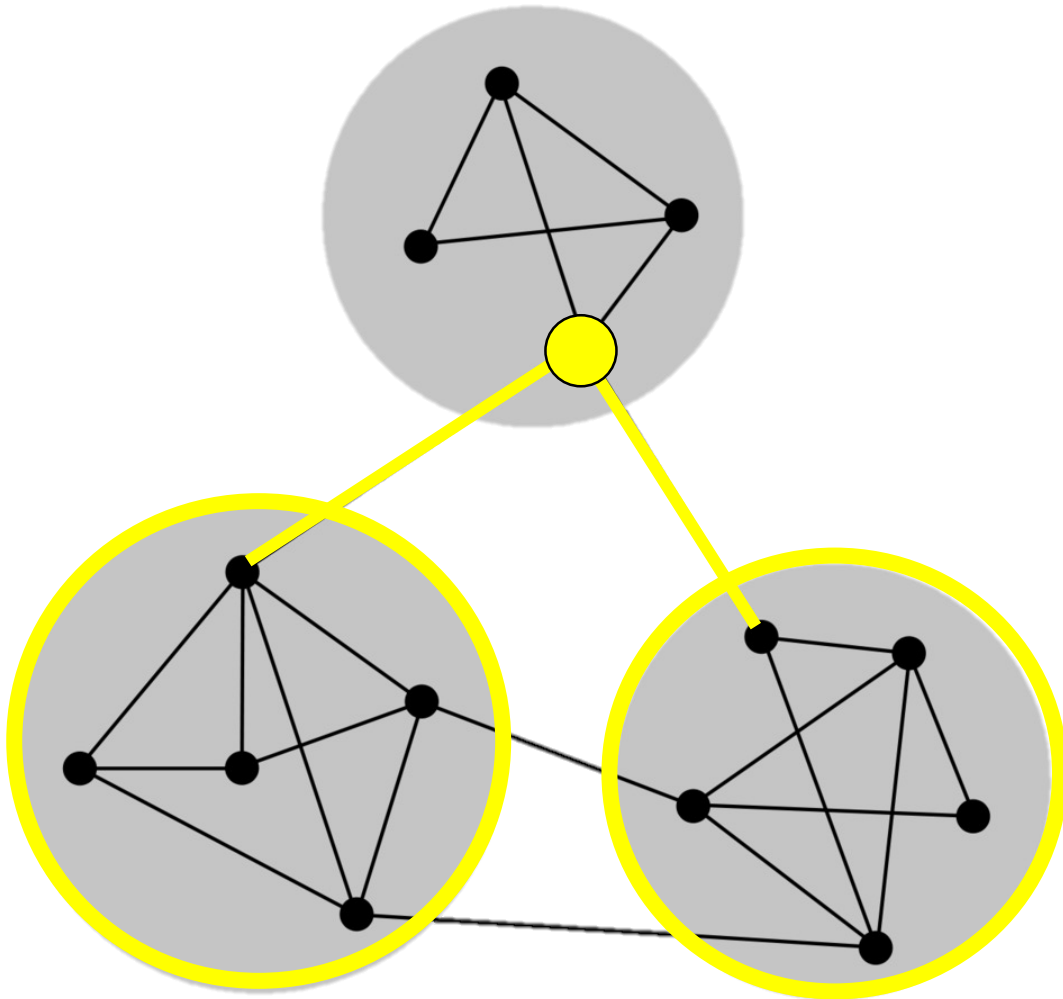
# Contact Rate & Structure



- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time
- ❖ **Rate: # contacts / time**
- ❖ **Structure: Individual connectivity to population**



# Contact Rate & Structure



- ❖ Contact networks extremely difficult to observe directly
- ❖ Can be inferred from GPS movement data
- ❖ Overlap in space and time
- ❖ **Rate: # contacts / time**
- ❖ **Structure: Individual connectivity to population**

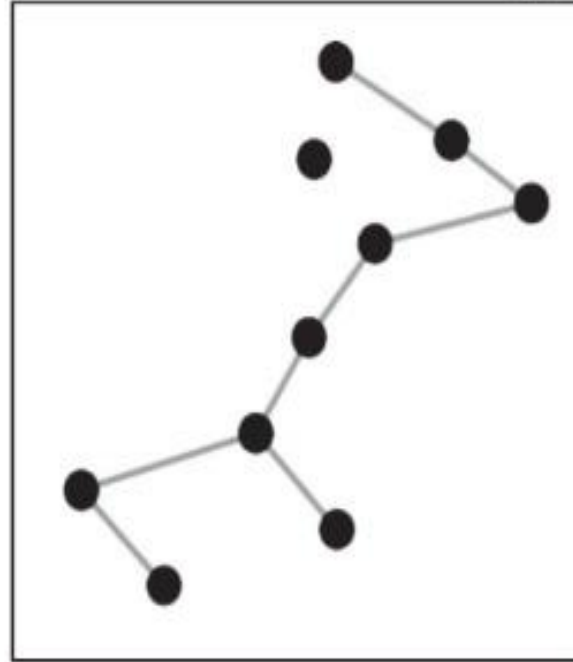
- ❖ Simulate contact networks from results of social network analysis
- ❖ Use simulated networks as inputs to disease models



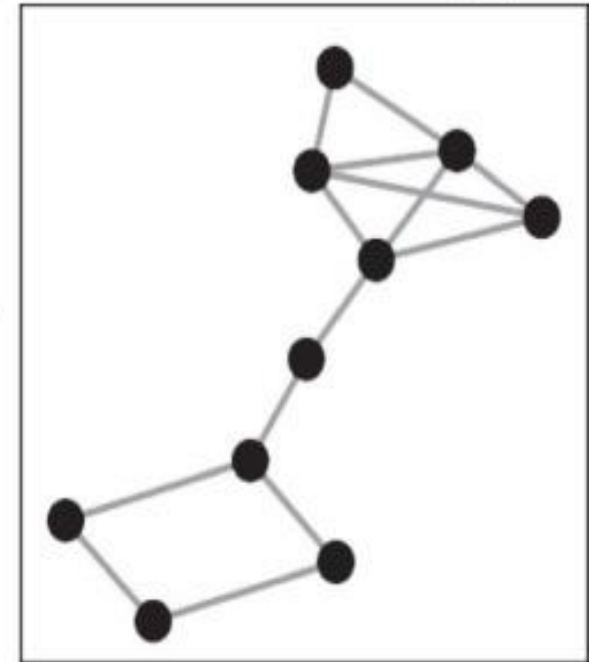
# Network Disease Models

- ❖ Simulate contact networks from results of social network analysis
- ❖ Use simulated networks as inputs to disease models
- ❖ Assess effects of heterogeneous contact structure on disease emergence
- ❖ If spatially & temporally explicit, assess spread risk

(a) transmission network ( $\beta$ )



(b) contact network ( $K$ )



$= \gamma^*$

# Network Disease Models



# *Intellectual Merit*

- ❖ Unite the fields of movement ecology & wildlife epidemiology
- ❖ Advance understanding of heterogenous contact structure as a driver of **disease emergence**
- ❖ Identify types of individuals prone to being 'super spreaders'





# *Intellectual Merit*

- ❖ Unite the fields of movement ecology & wildlife epidemiology
- ❖ Advance understanding of heterogenous contact structure as a driver of **disease emergence**
- ❖ Identify types of individuals prone to being 'super spreaders'

# *Broader Impacts*

- ❖ Improve **disease surveillance** & facilitate removal of **high-risk individuals**
- ❖ Guiding Principles of the Michigan Department of Natural Resources **CWD Response Plan**
- ❖ Presentation to non-science audiences (schools, hunter groups)



**MSU FORESTRY** 



College of Agriculture  
and Natural Resources