Introduccion y Estudio de caso: Aplicación del análisis de redes a reservorios de infección en vida silvestre

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Objectivos

- Conceptos básicos del análisis de redes en ecologia de enfermedades
- Como usar análisis de redes puede ayudar a investigar reservorios de infeciones
- Aplicación en vida silvestre: Canguros y cerdos ferales

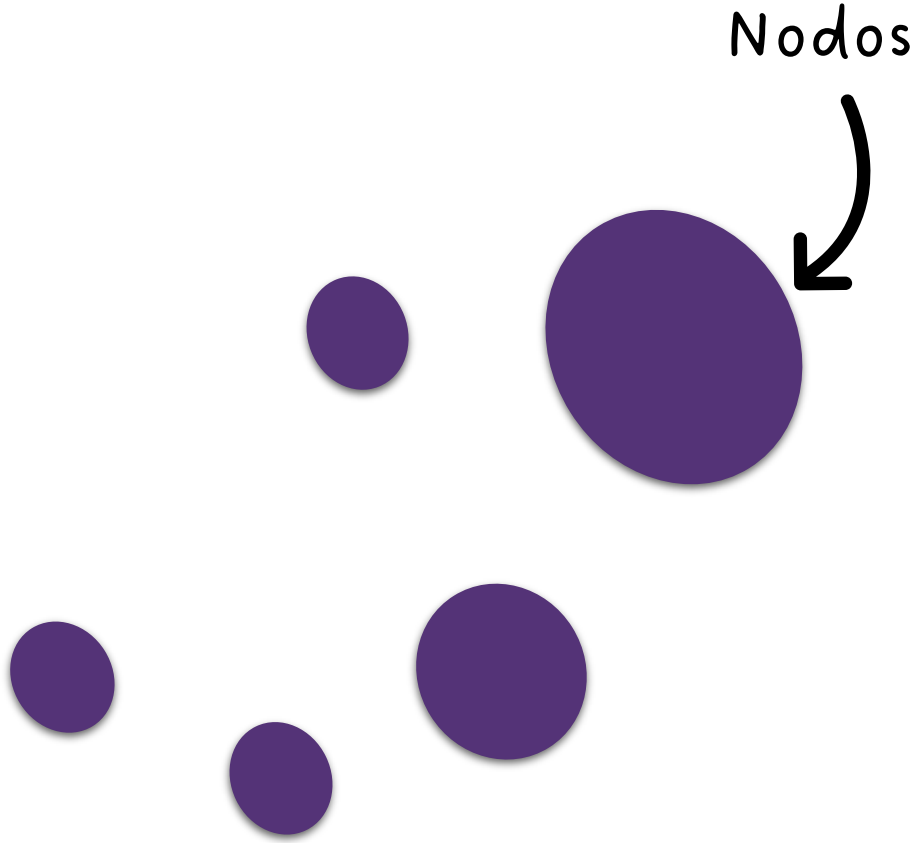
Por que análisis de redes

Las redes permiten identificar:

- Contactos criticos entre individuos
- Individuos/sitios claves para la progagacion (nodos)
- Patrones de conectividad y transmision

Conceptos claves en redes

- Nodos y conecciones (Links)



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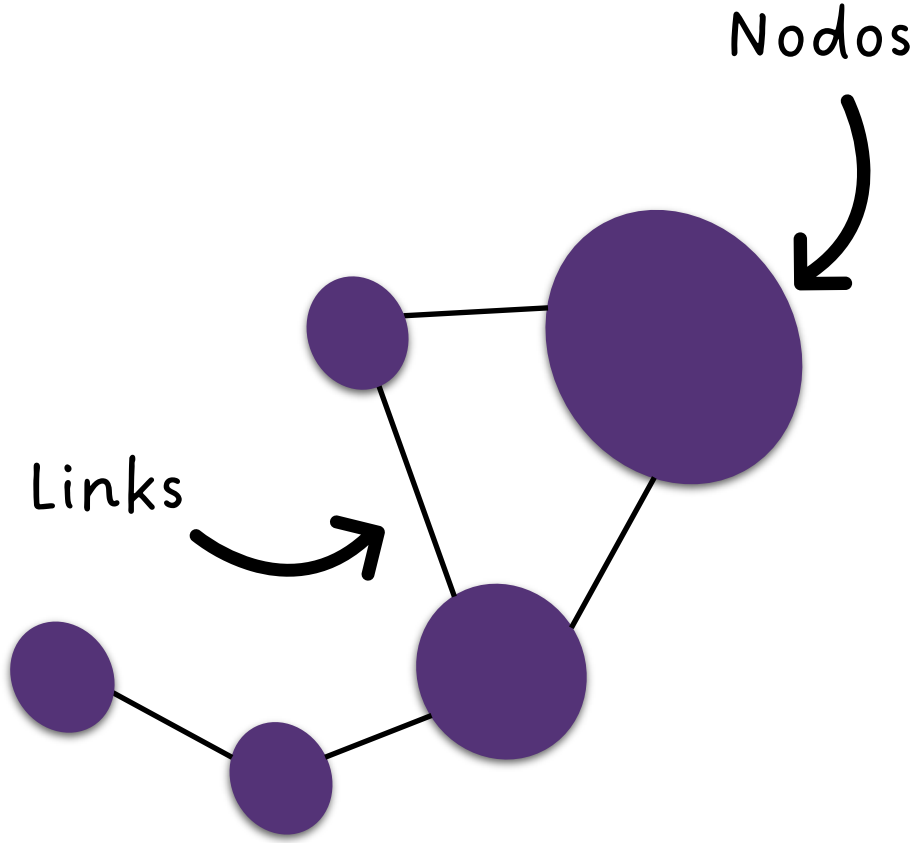
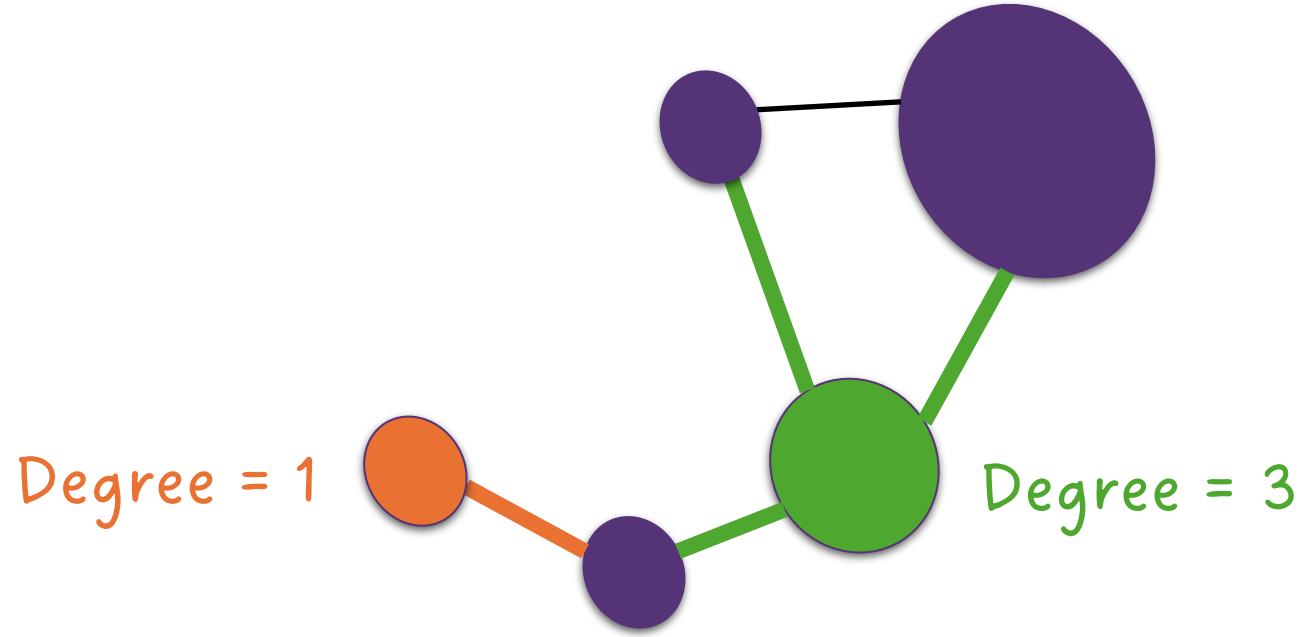


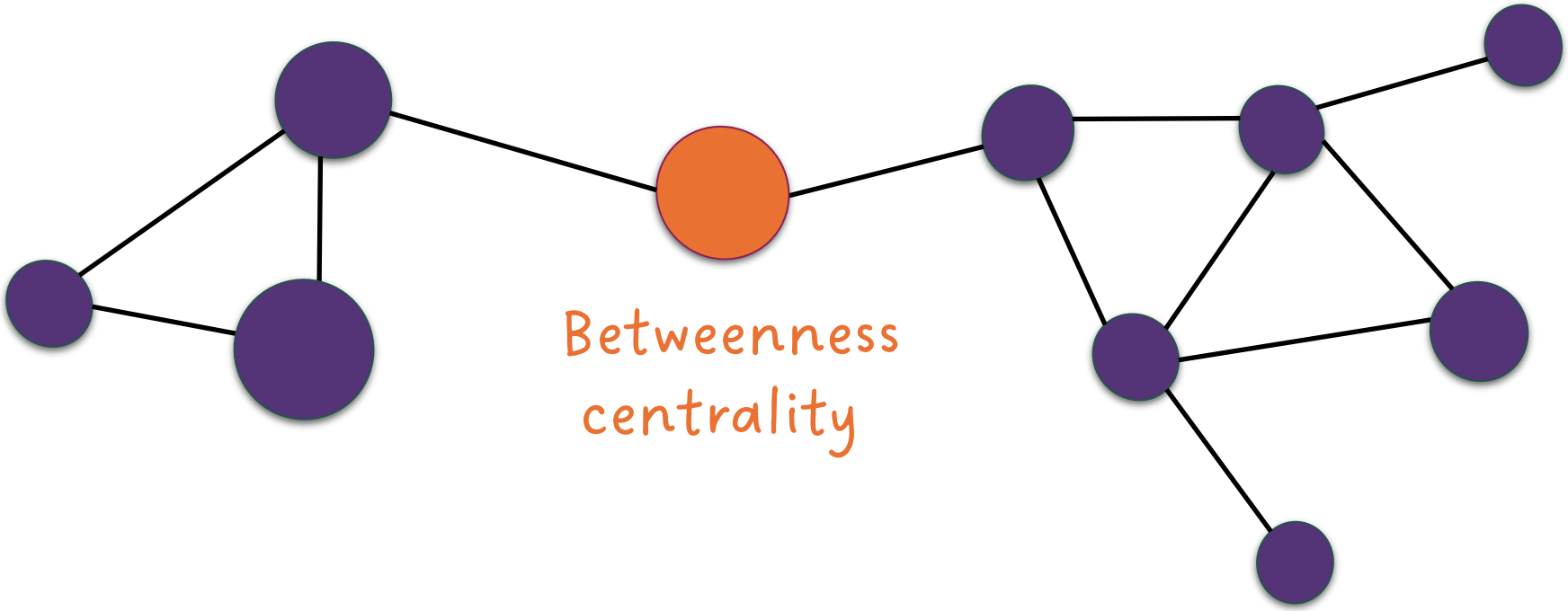
Conceptos claves en redes

- **Grados (degree)** es el número de conexiones (o enlaces) que tiene con otros nodos.



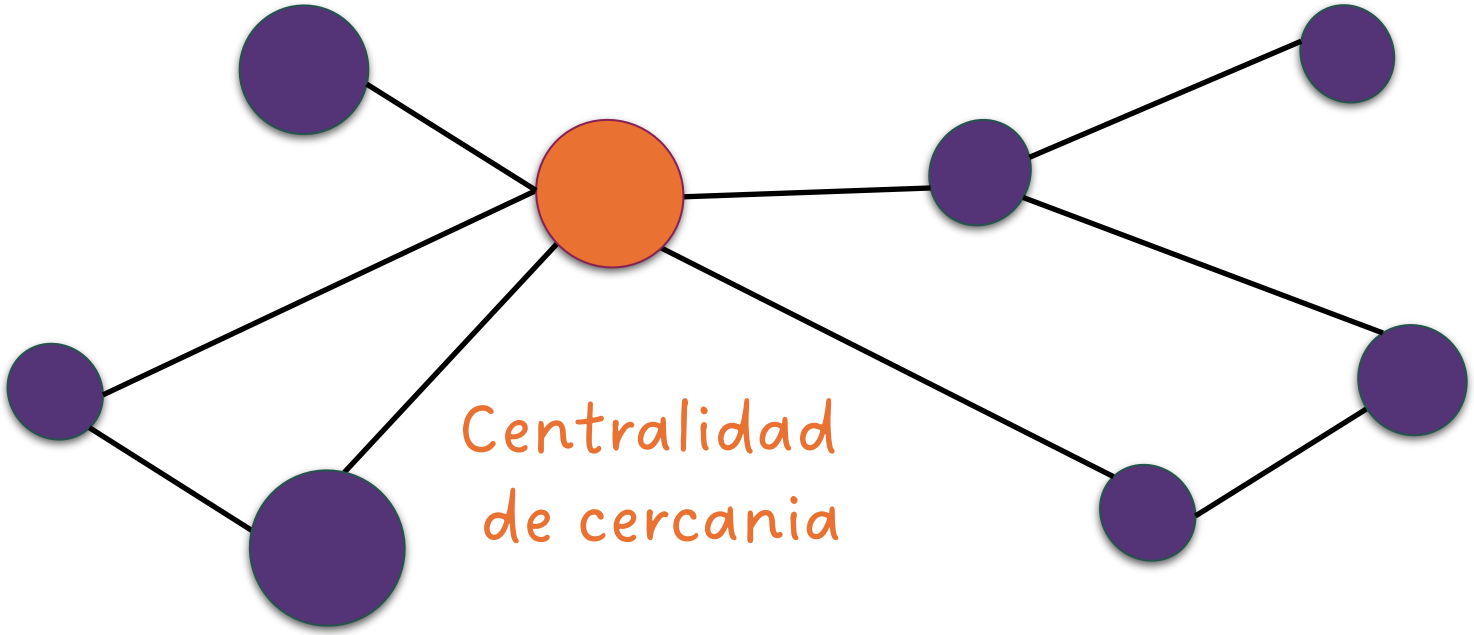
Conceptos claves en redes

- **Centralidad de intermediación (betweenness centrality)** es el número de caminos más cortos entre pares de otros nodos que pasan por ese nodo, dividido por el número total de caminos más cortos entre esos pares.



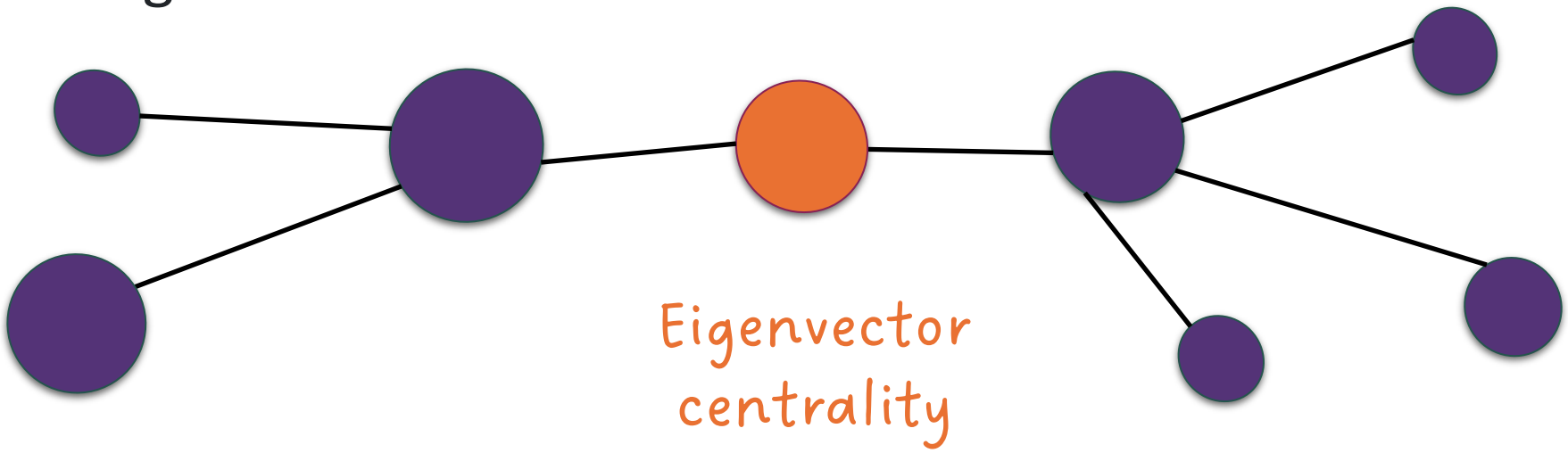
Conceptos claves en redes

- **Centralidad de cercanía (Closeness centrality):** mide que tan cerca esta un nodo del resto de los nodos (en terminos de distancias mas cortas). Un nodo con alta cercania puede acceder rapidamente al resto de la red.



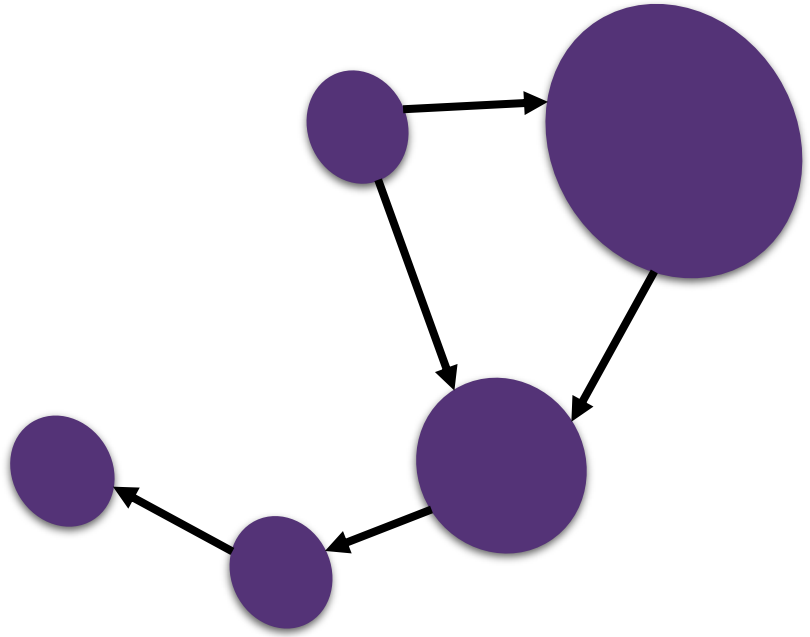
Conceptos claves en redes

- **Centralidad de vector propio (Eigenvector centrality):** Evalúa la importancia de un nodo no solo por su número de conexiones, sino por la importancia de los nodos con los que está conectado. Un nodo conectado a otros nodos muy influyentes tendrá una alta centralidad de eigenvector



Conceptos claves en redes

- Nodos y enlaces (inks)
- Grados, centralidad de intermediación, Centralidad de cercanía, centralidad de vector propio
- Tipos de redes:
  - **Directas** vs indirectas



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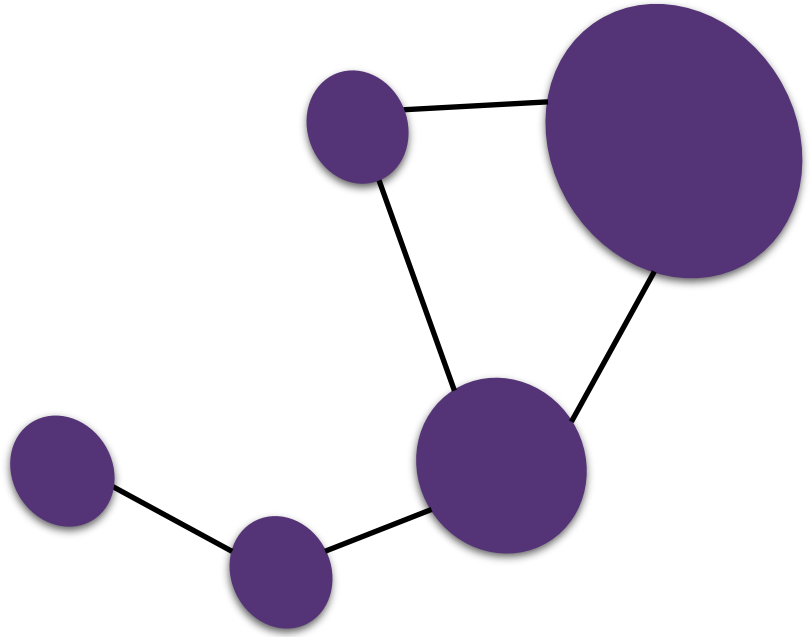


Ejemplo 1: Canguros y microbioma

Individuals strongly connected are more likely to share the same genotype

Sleepy lizard

"…bacteria are transmitted from host to host around the social network…"

(Bull et al 2012, photo © Australian Musuem)

Giraffes

"…links in the transmission network were more likely to occur between individuals that were strongly linked in the social network…"

(VanderWaal et al 2014)

Social network does not always predict the bacterial transmission

African elephants

"…habitat overlap between elephant social groups predicted *E. coli* genetic similarity…"

(Chiyo et al 2014)

Captive rhesus macaques

"…although we found no links between dyadic *E. coli* similarity and social contact frequencies,…"

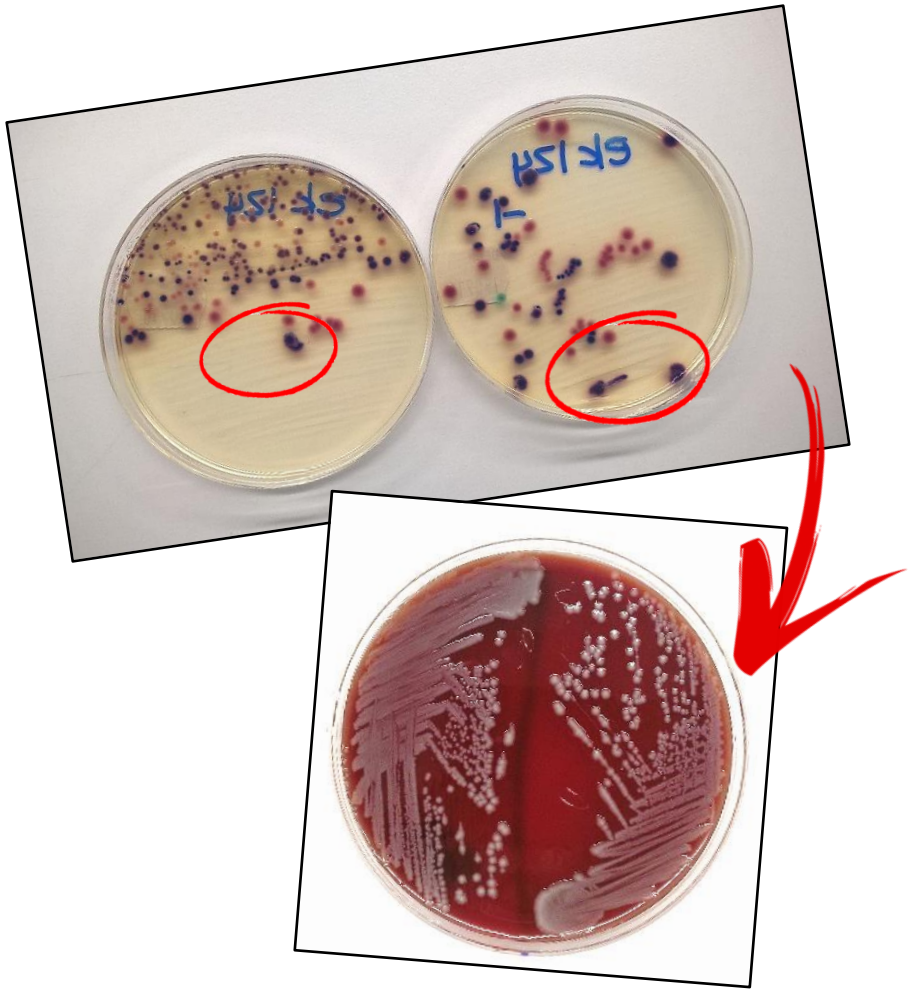
(Balasubramaniam et al 2018)

Hipótesis: asociaciones sociales predicen microbiota compartida.

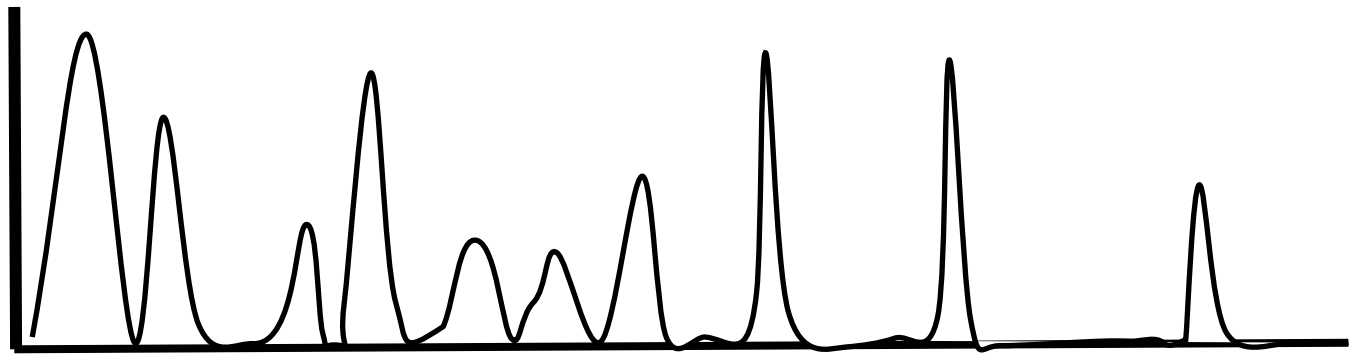
Métodos:

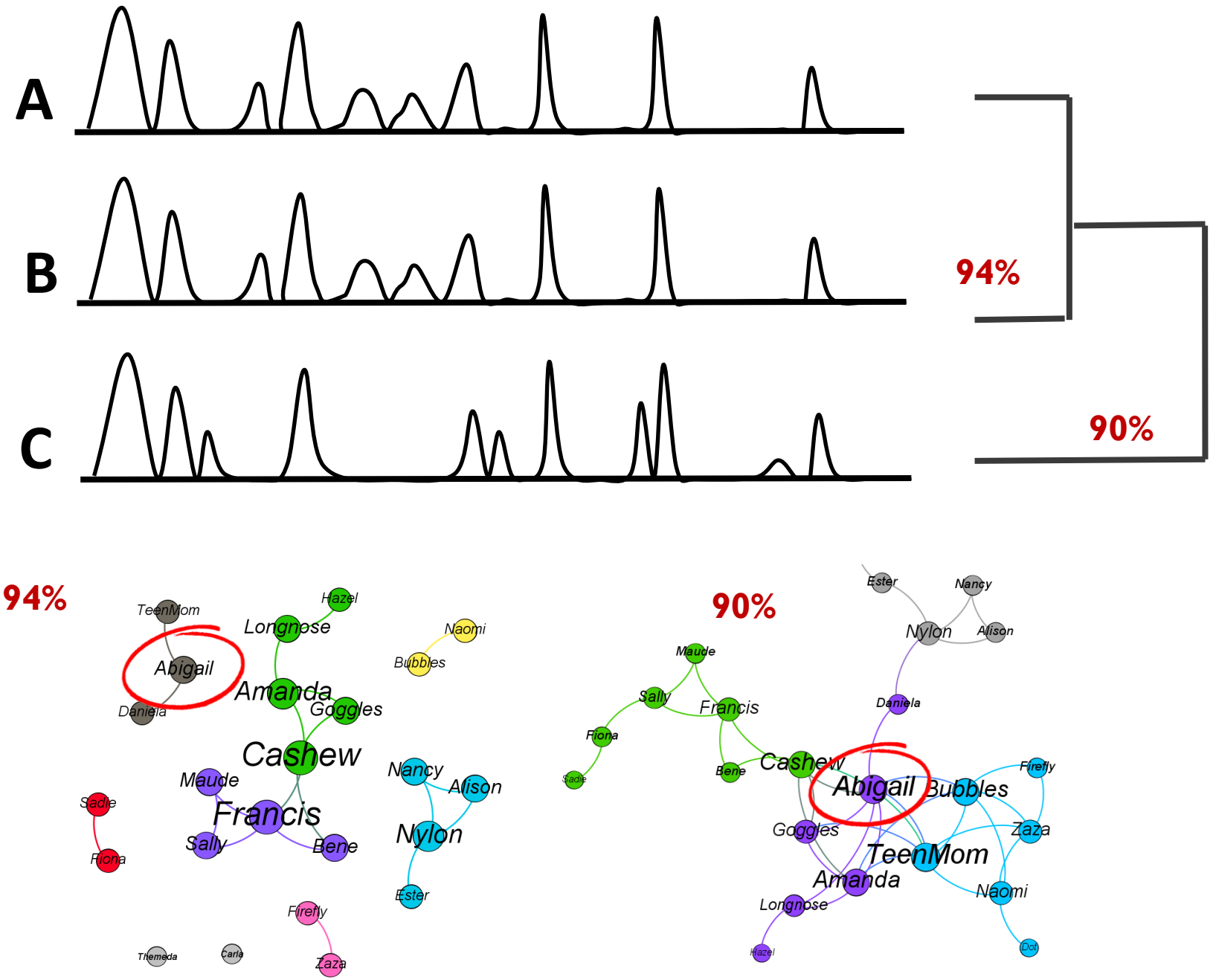
- Observación directa de asociaciones
- Análisis de microbioma feca (E. coli)
- Red basada en bacterias compartidas

BOX-PCR



fingerprint

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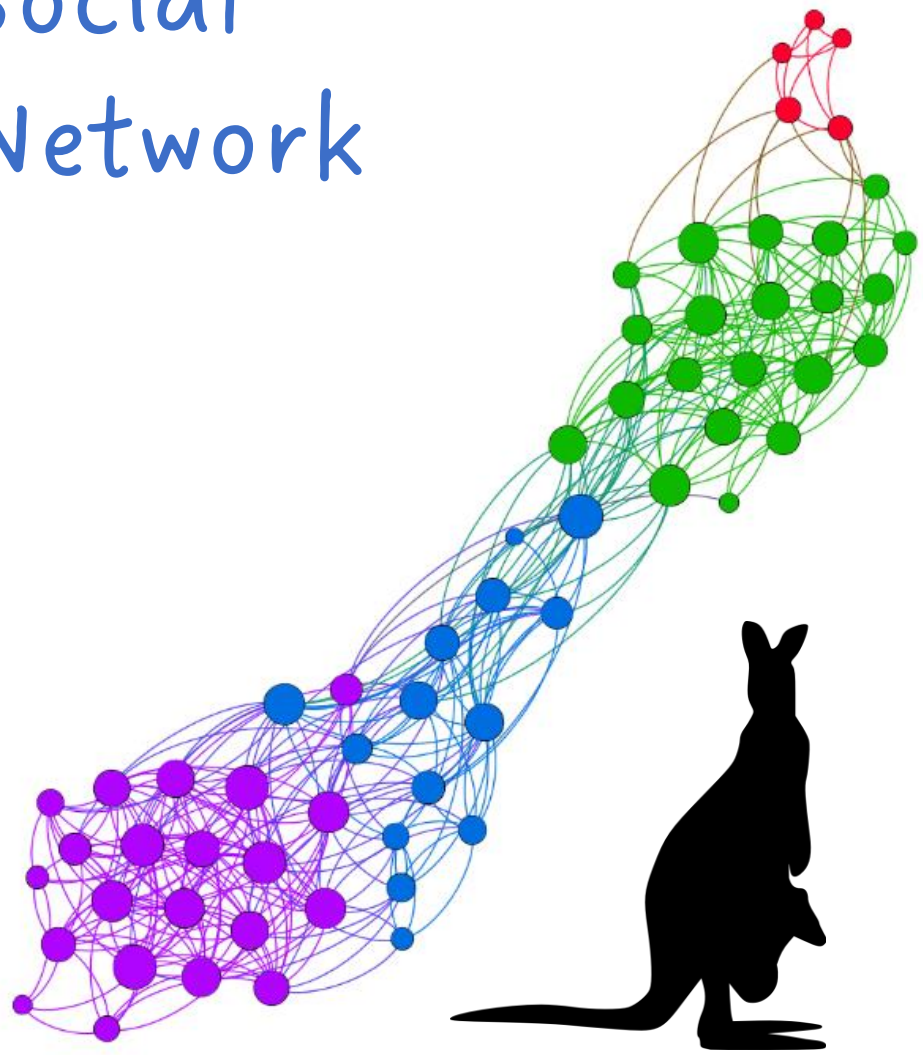
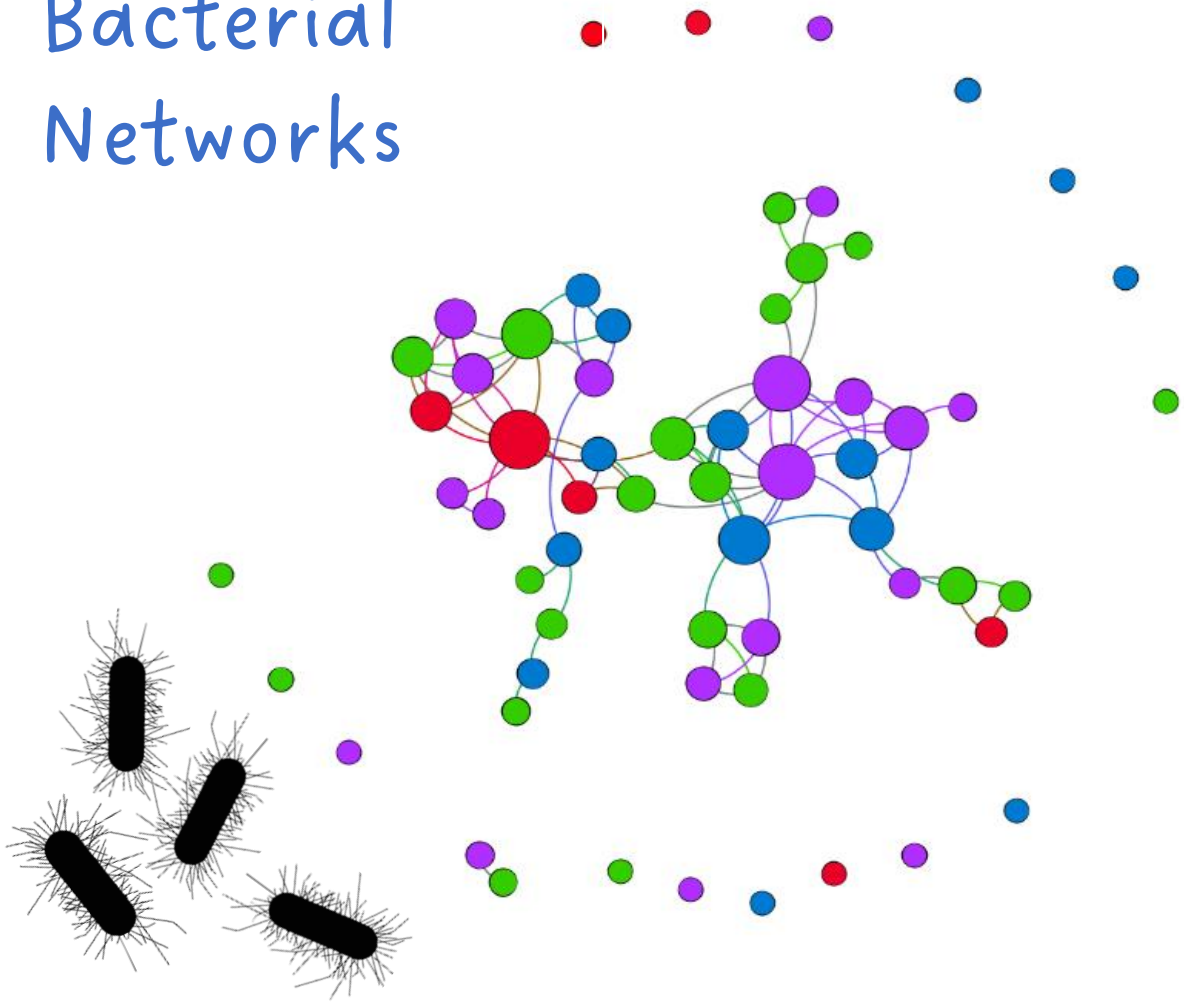
Hazel
Dot

Social Network

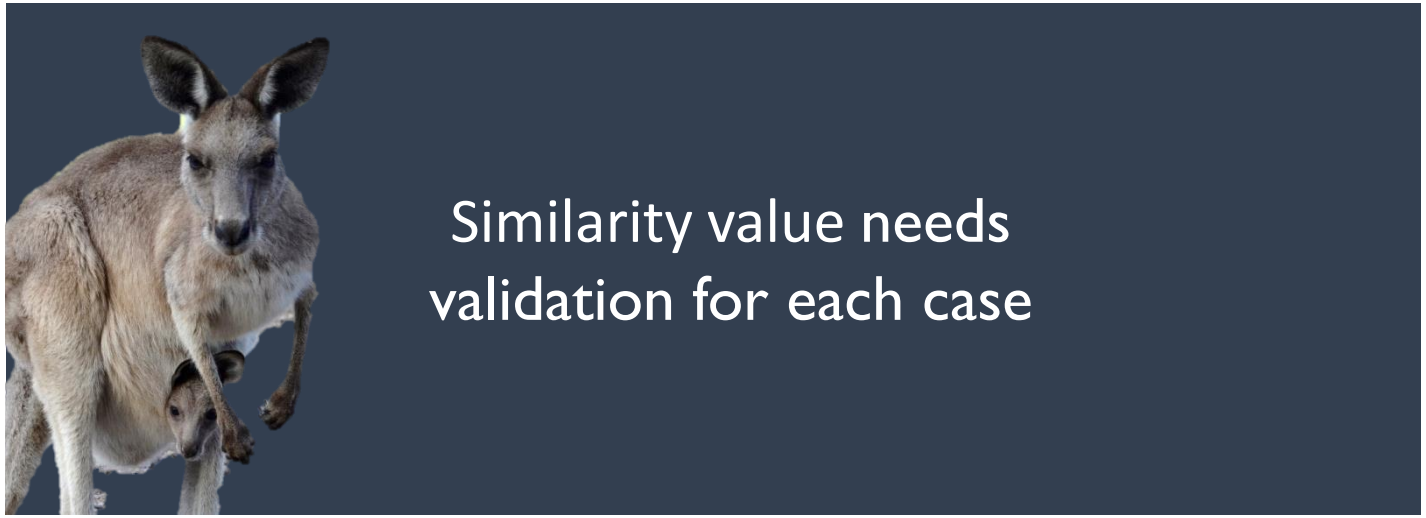


Commensal Bacterial Networks



CONCLUSION

MIXED SUPPORT for the use of commensal bacterial networks



Ejemplo 2 – Cerdos ferales

Cerdos ferales

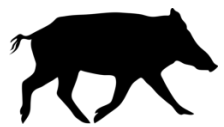
Objetivo: modelar interacciones potenciales para estimar rutas de tranmision de enfermedades.

Metodos:

Collares GPS

Cálculo de coocurrencias espacio-temporales y construcción de redes de contactos directos e indirectos.

Data management - Continuous time movement models (CTMMs)



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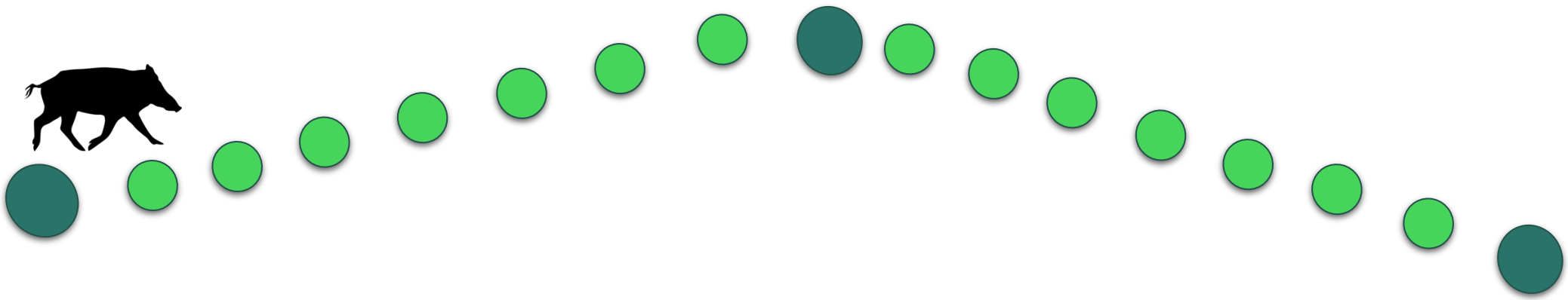

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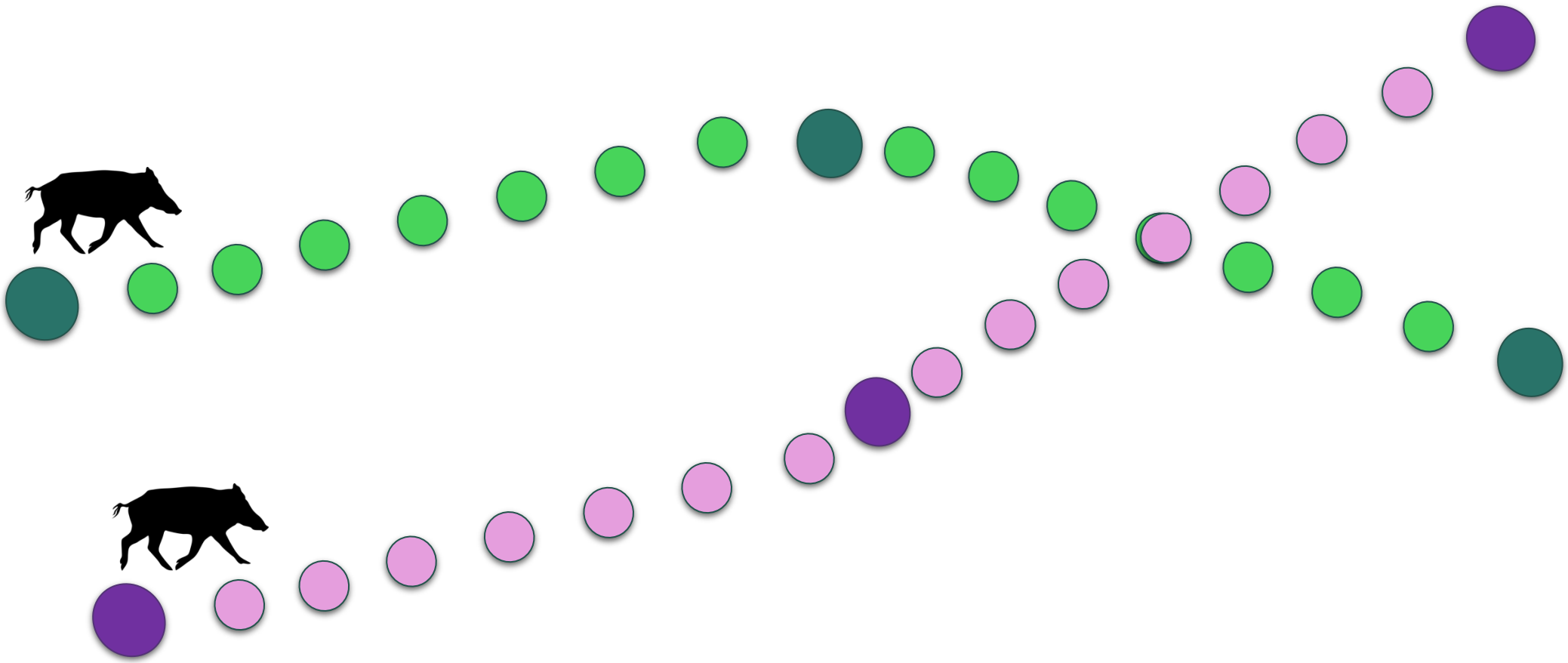
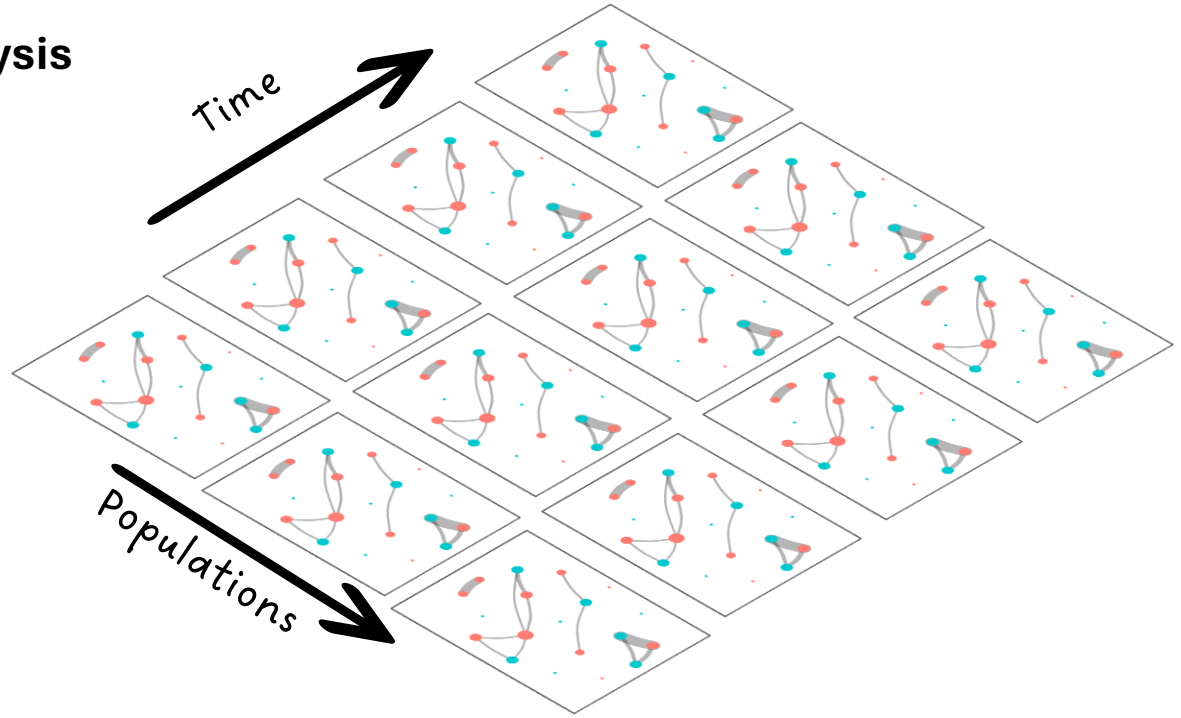


- **Data management - Continuous time movement models (CTMMs)**
- **Temporal and spatial thresholds for direct and indirect contact**
- **Network analysis**



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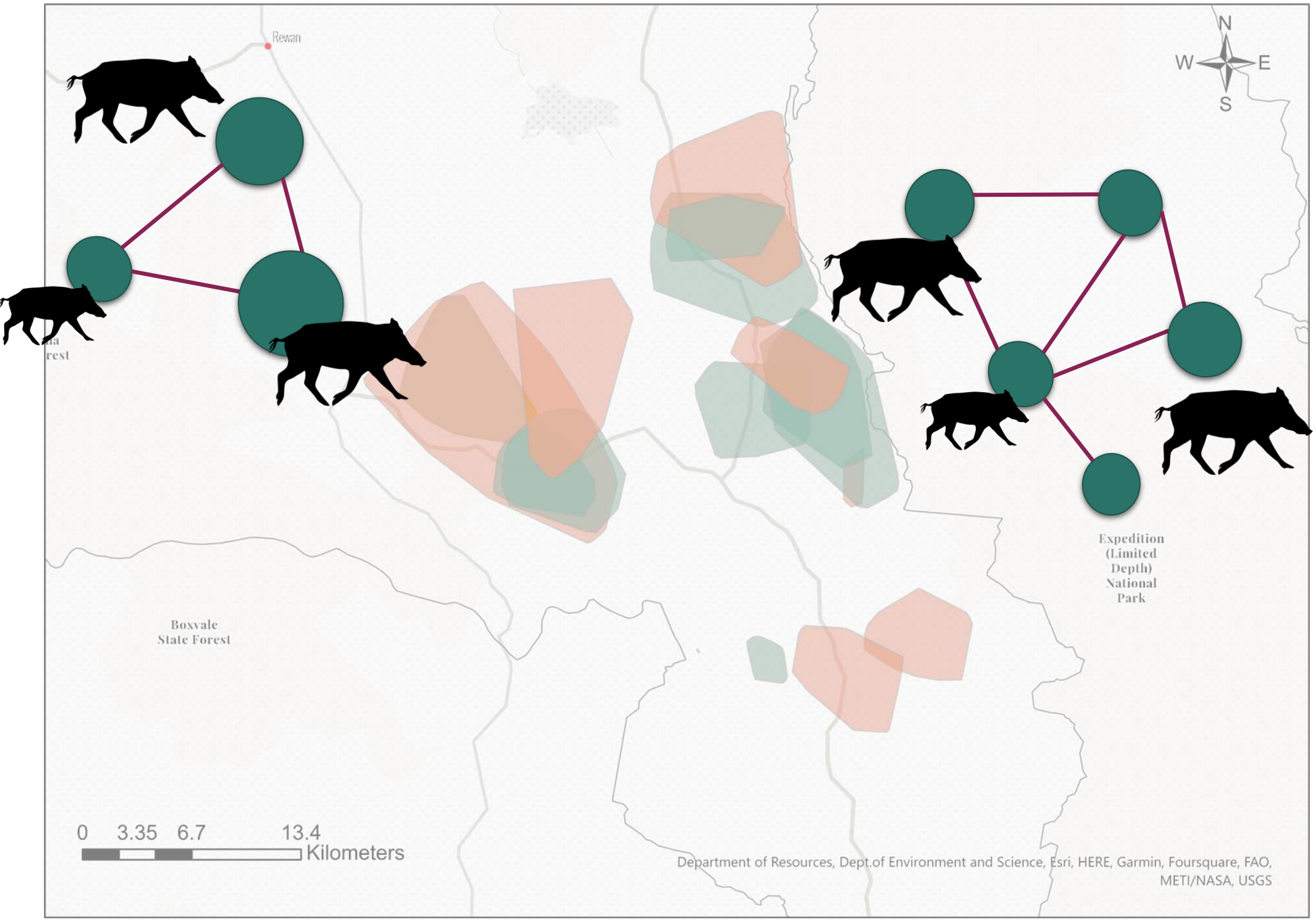
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Boxvale
State Forest
Expedition
(Limited
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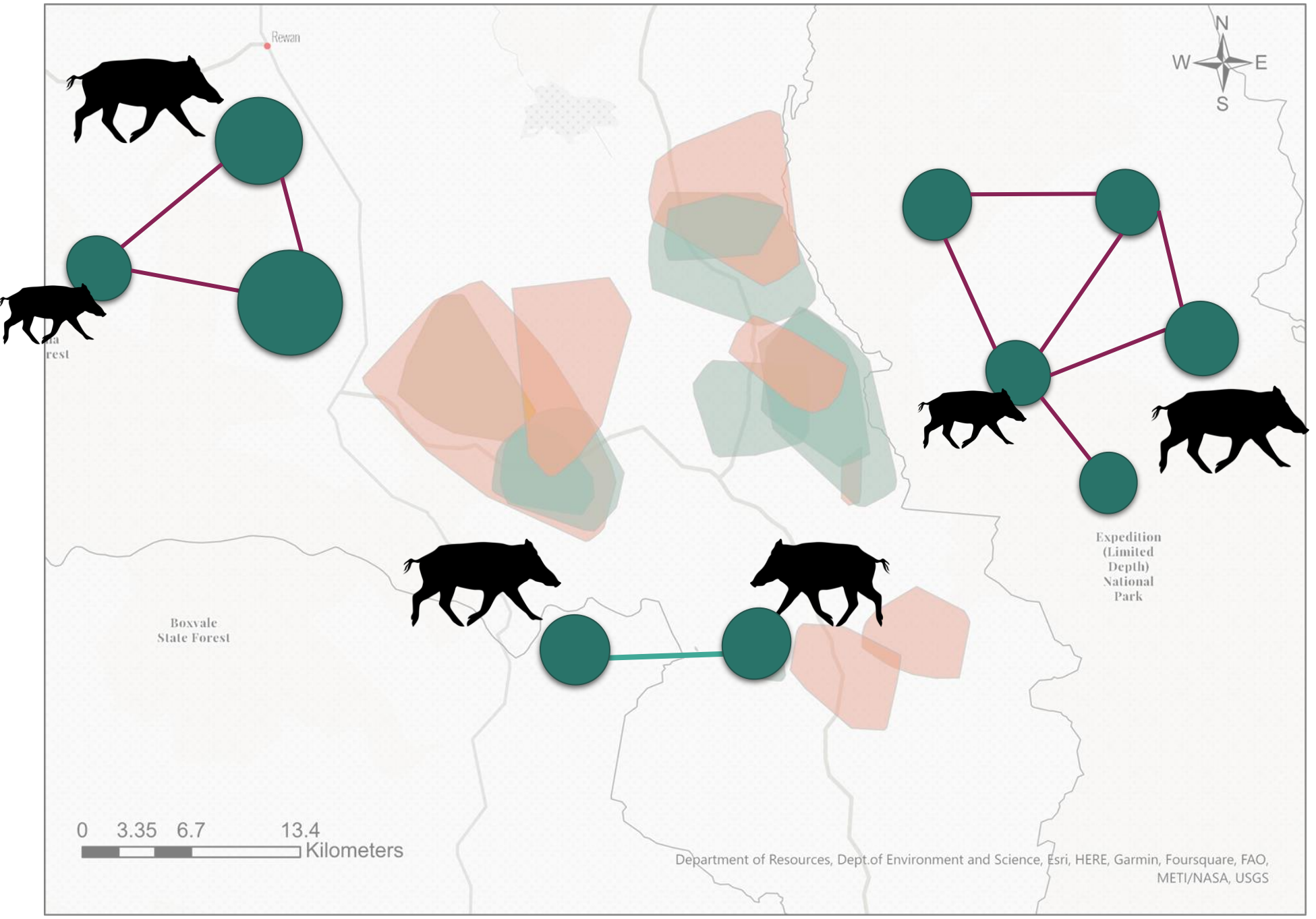
Kilometers
Department of Resources, Dept.of Environment and Science, Esri, HERE, Garmin, Foursquare, FAO,
METI/NASA, USGS



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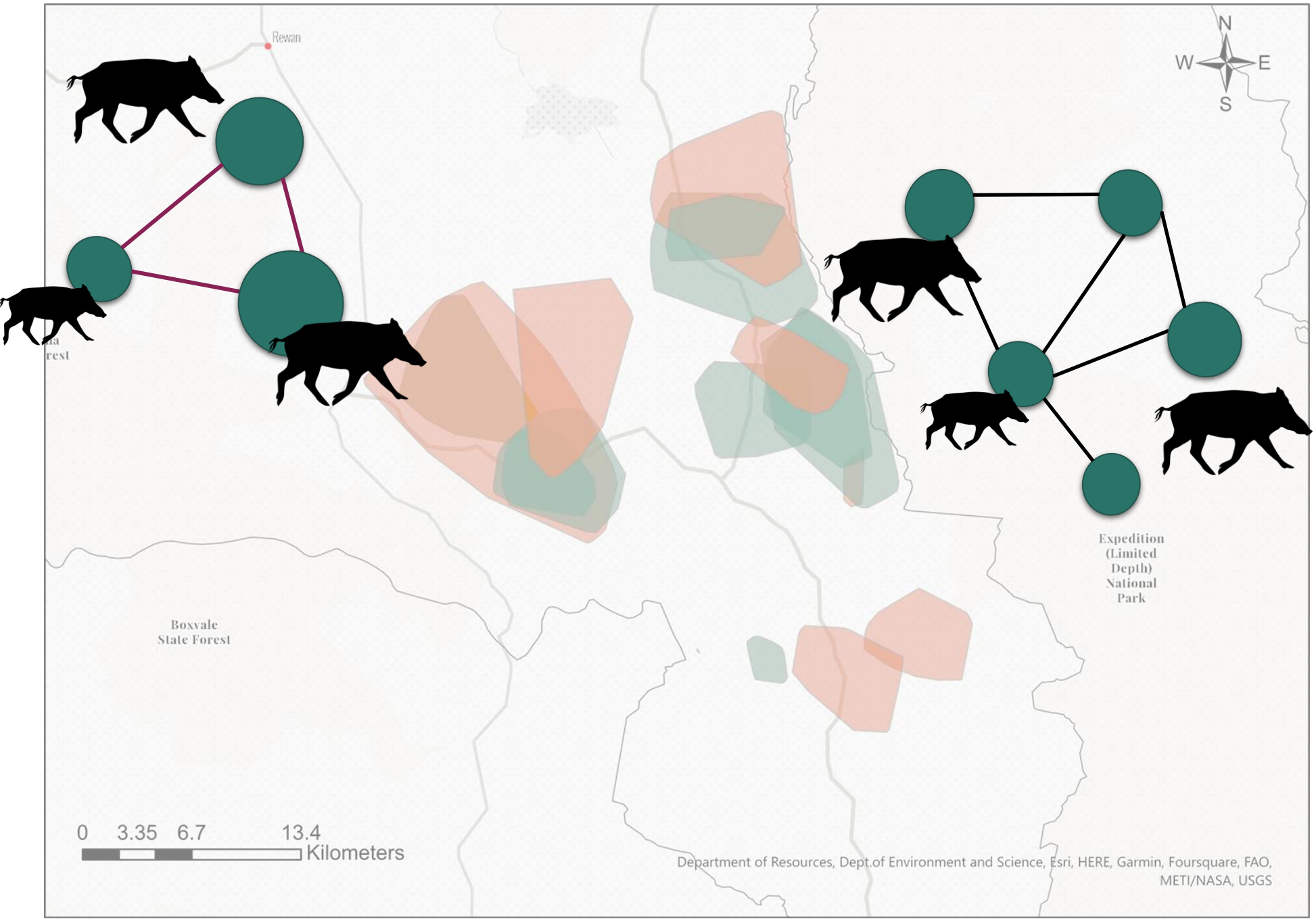
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- Data management - Continuous time movement models (CTMMs)
- Temporal and spatial thresholds for direct and indirect contact
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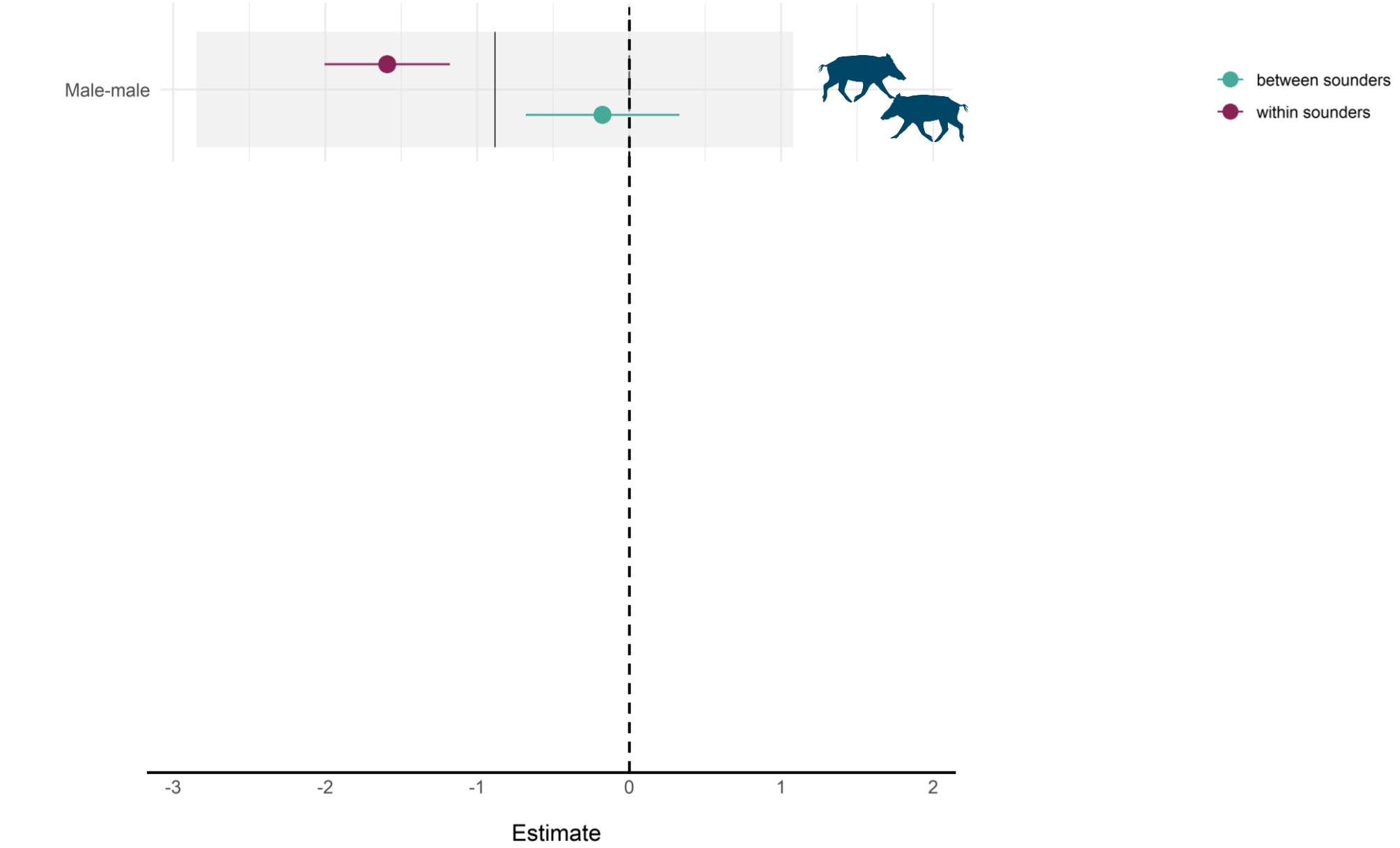
- Contact rate

Contacto Directo



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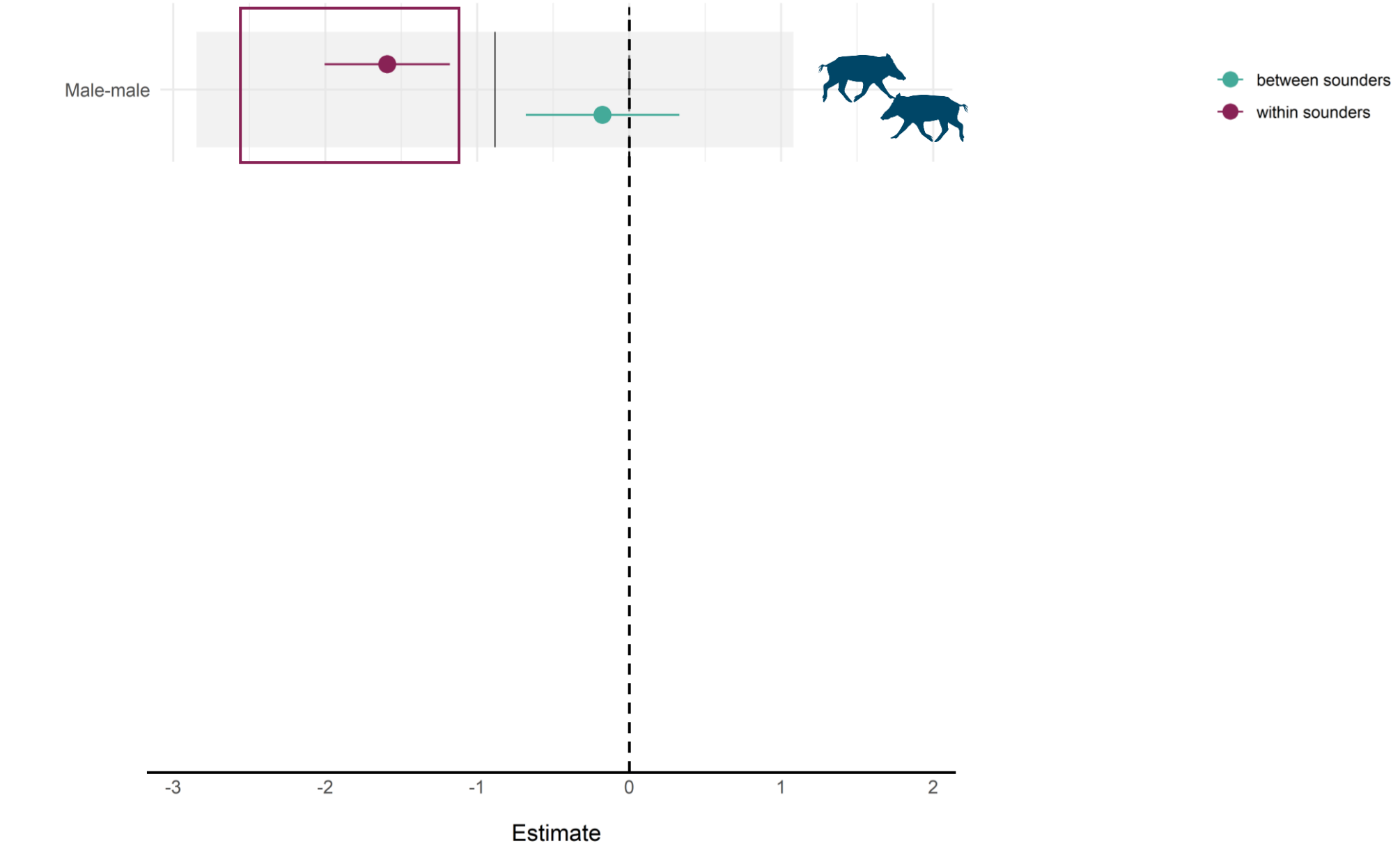

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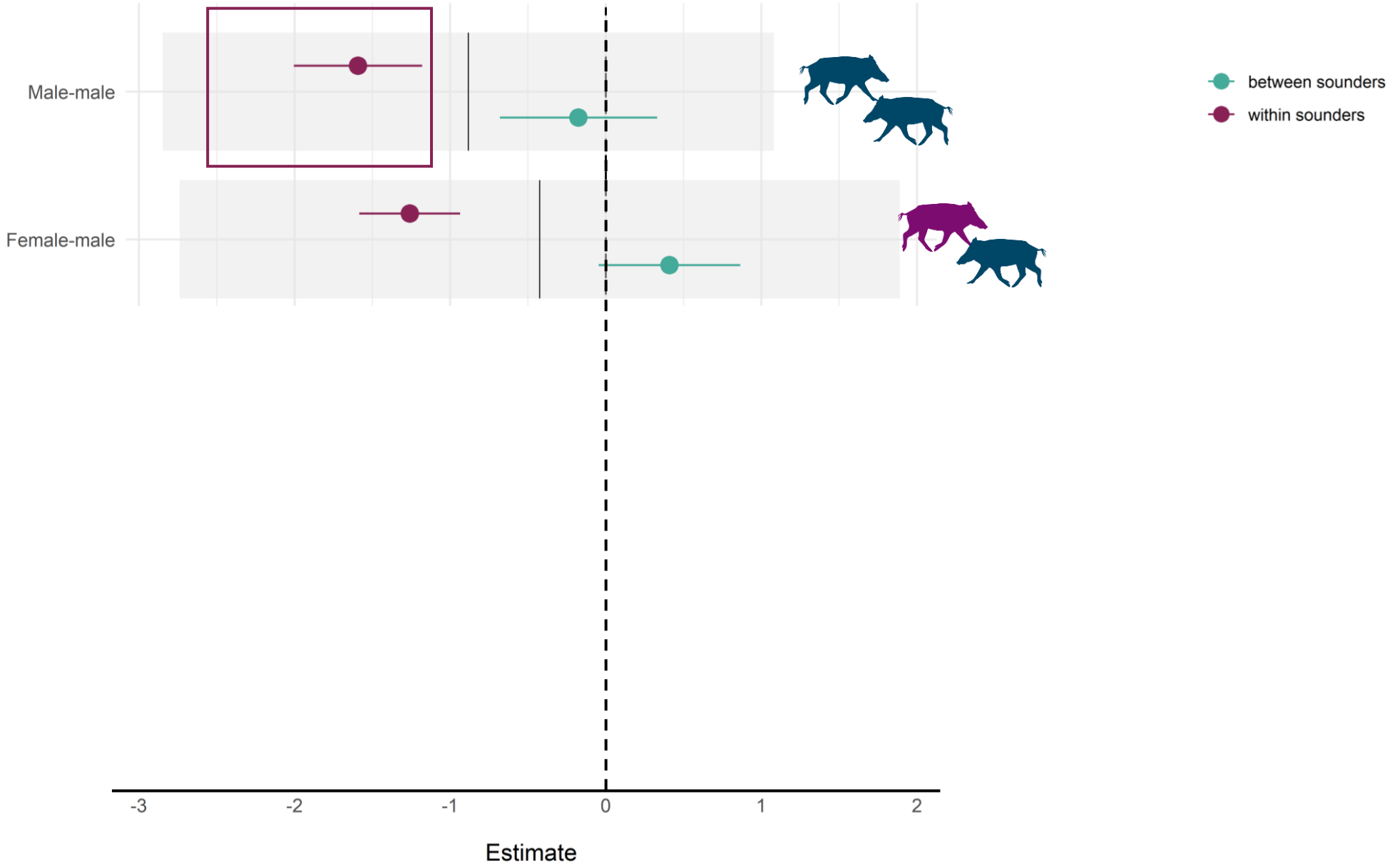

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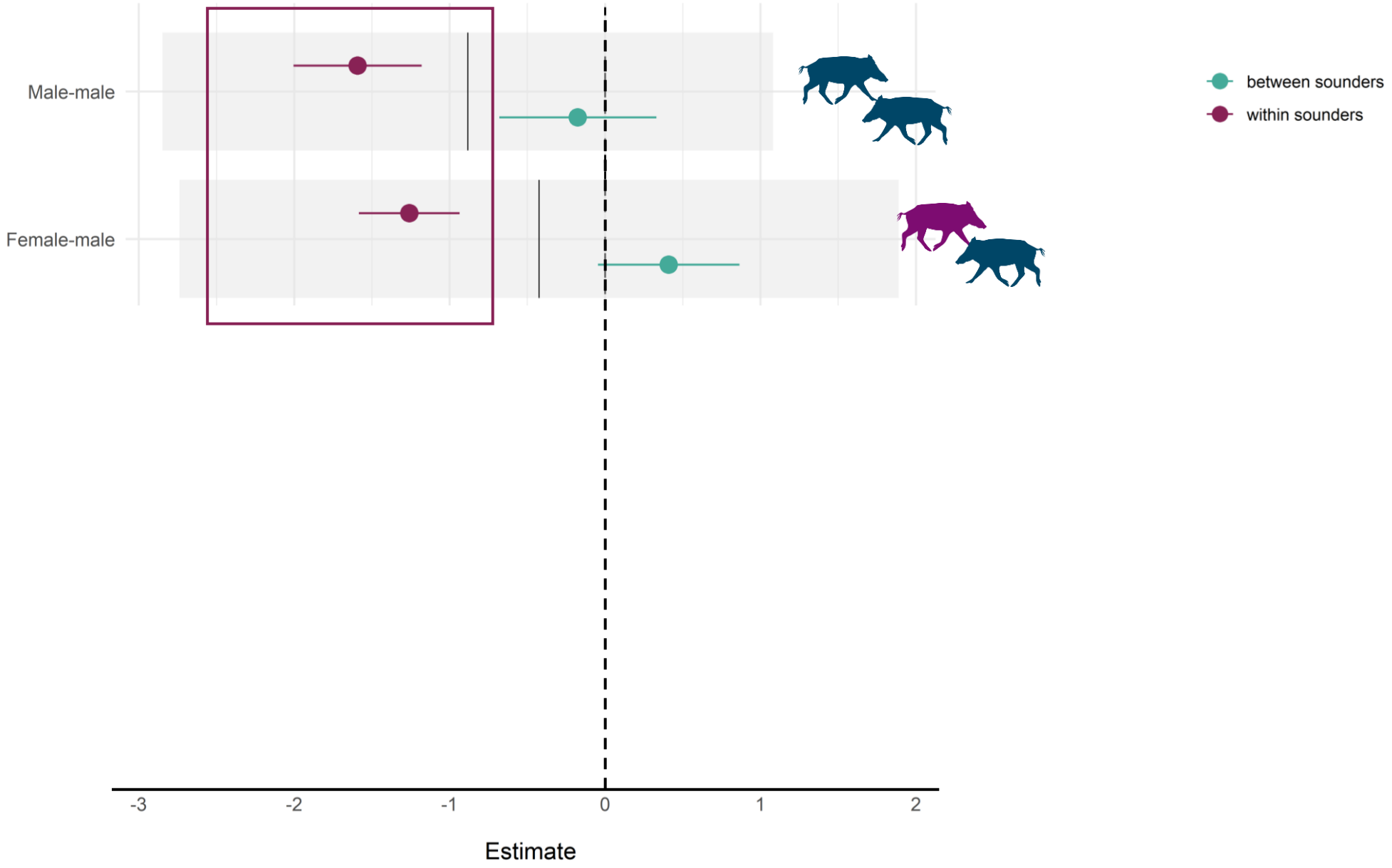

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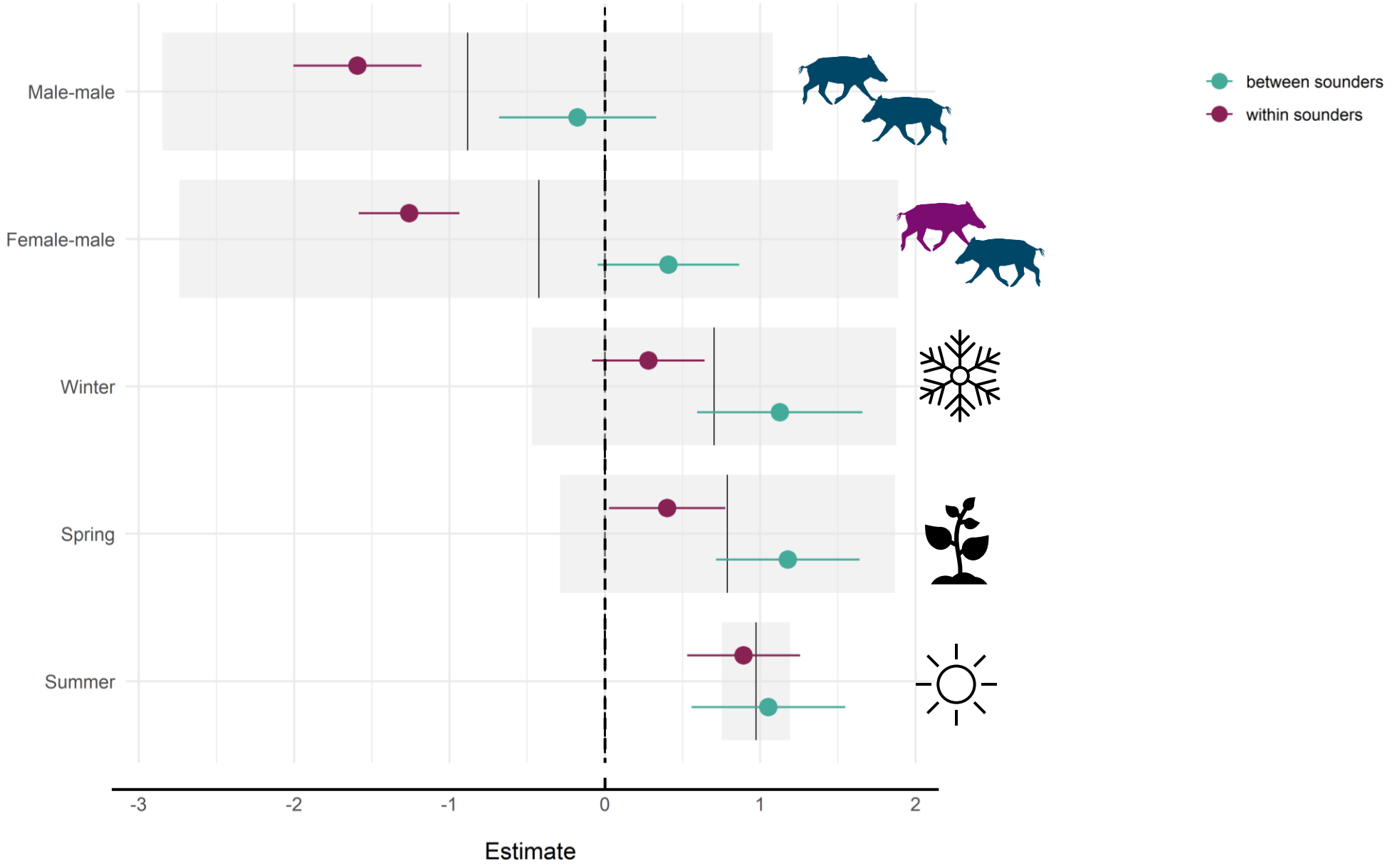

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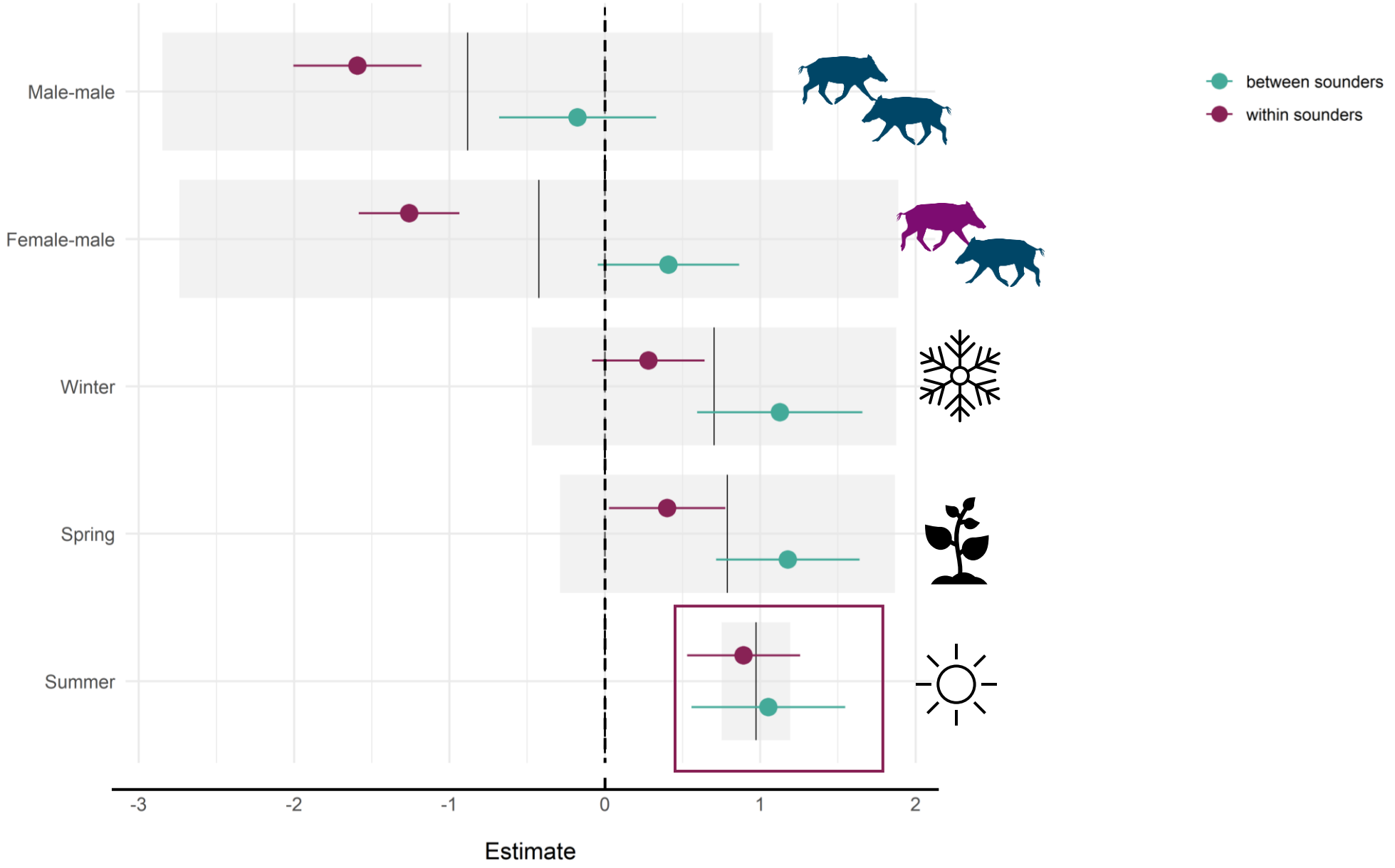

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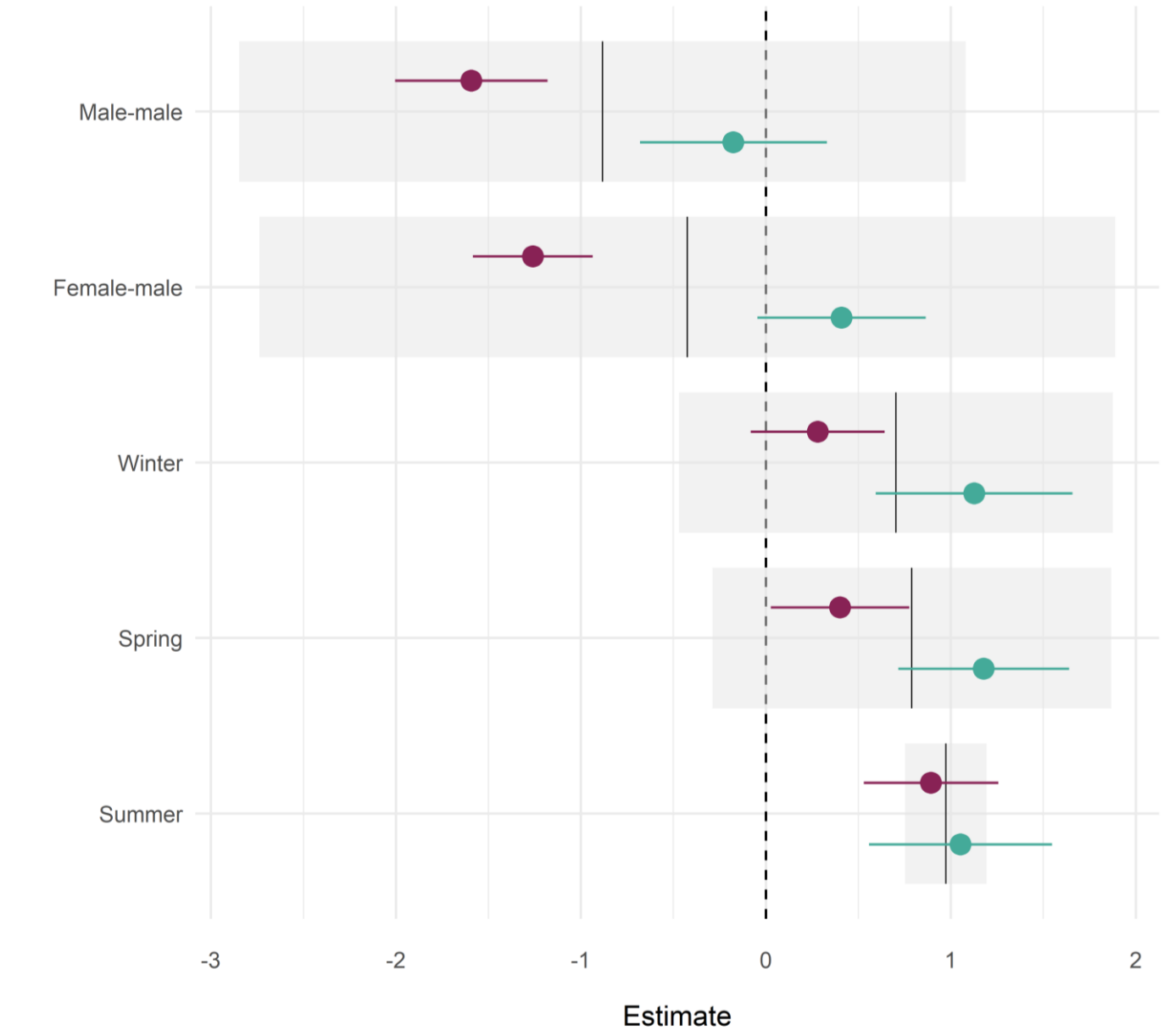
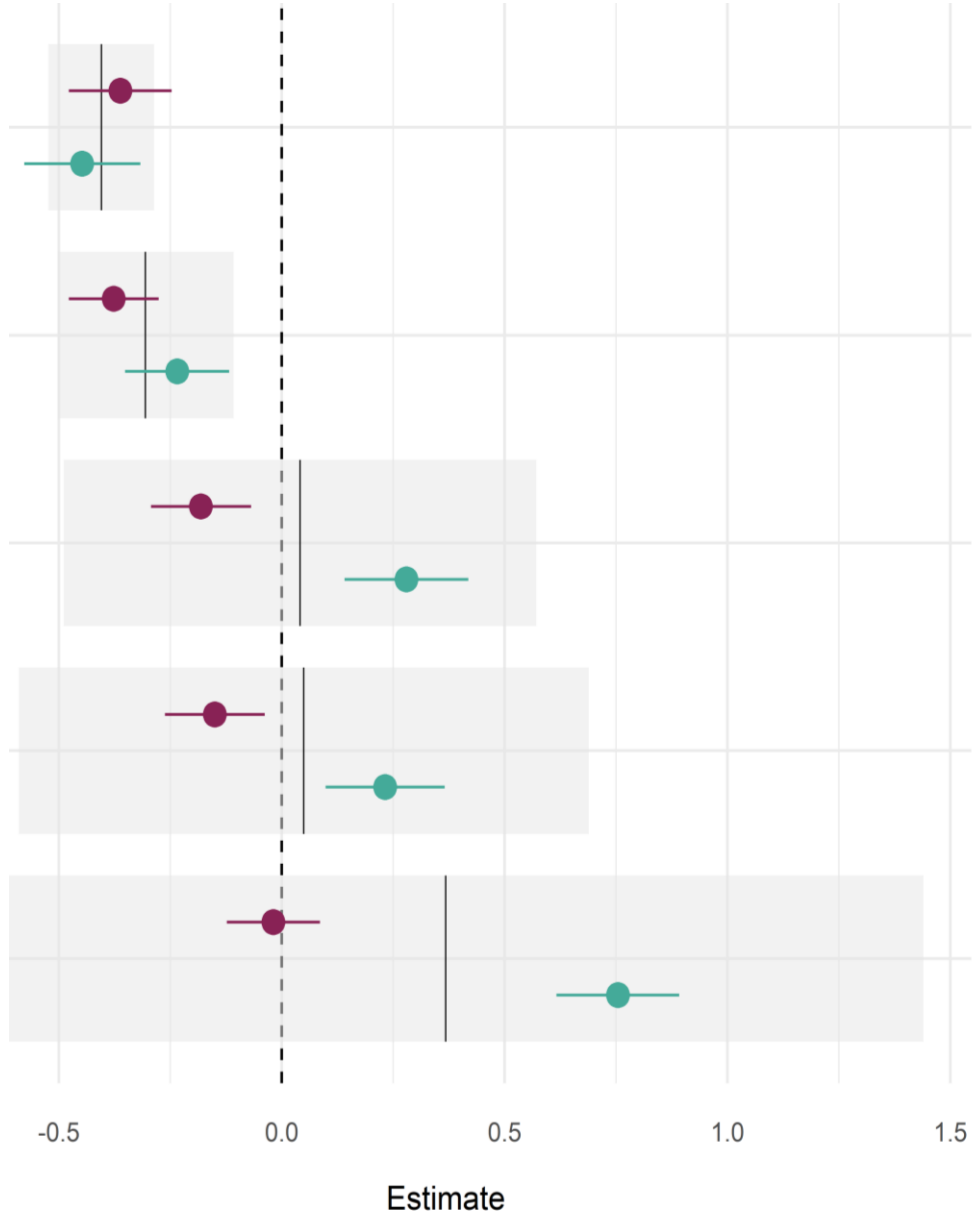
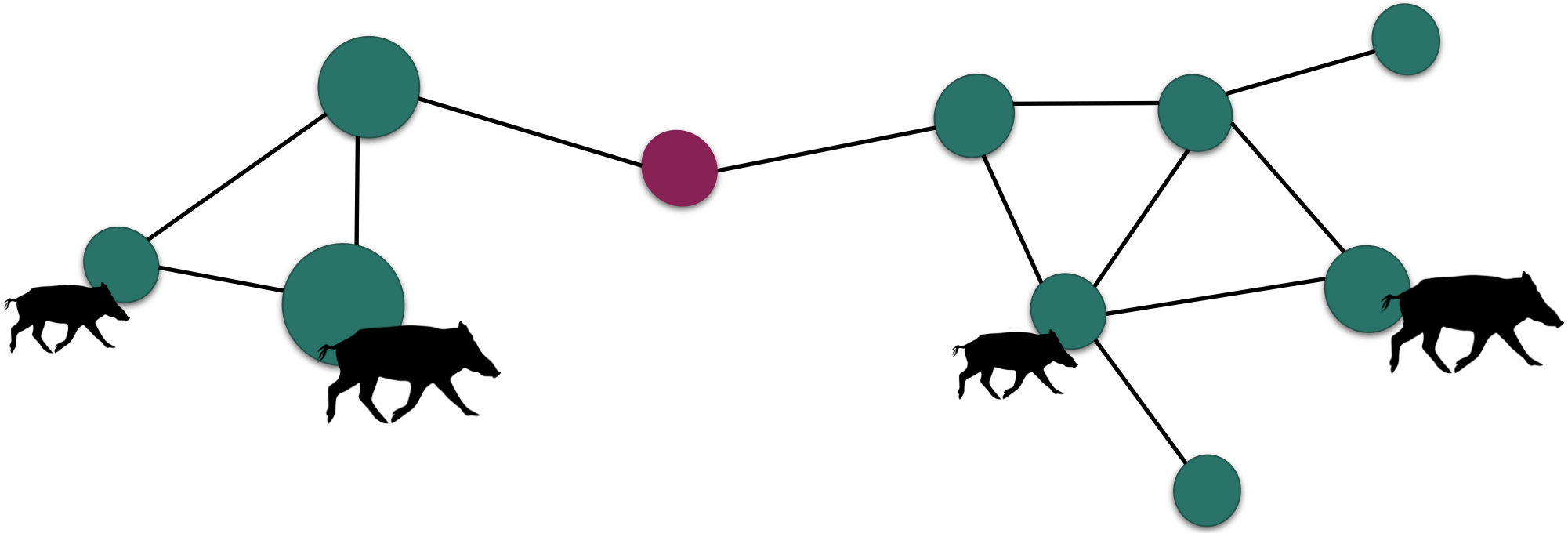


Contacto Indirecto



Quien es el mas popular?
Betweenness



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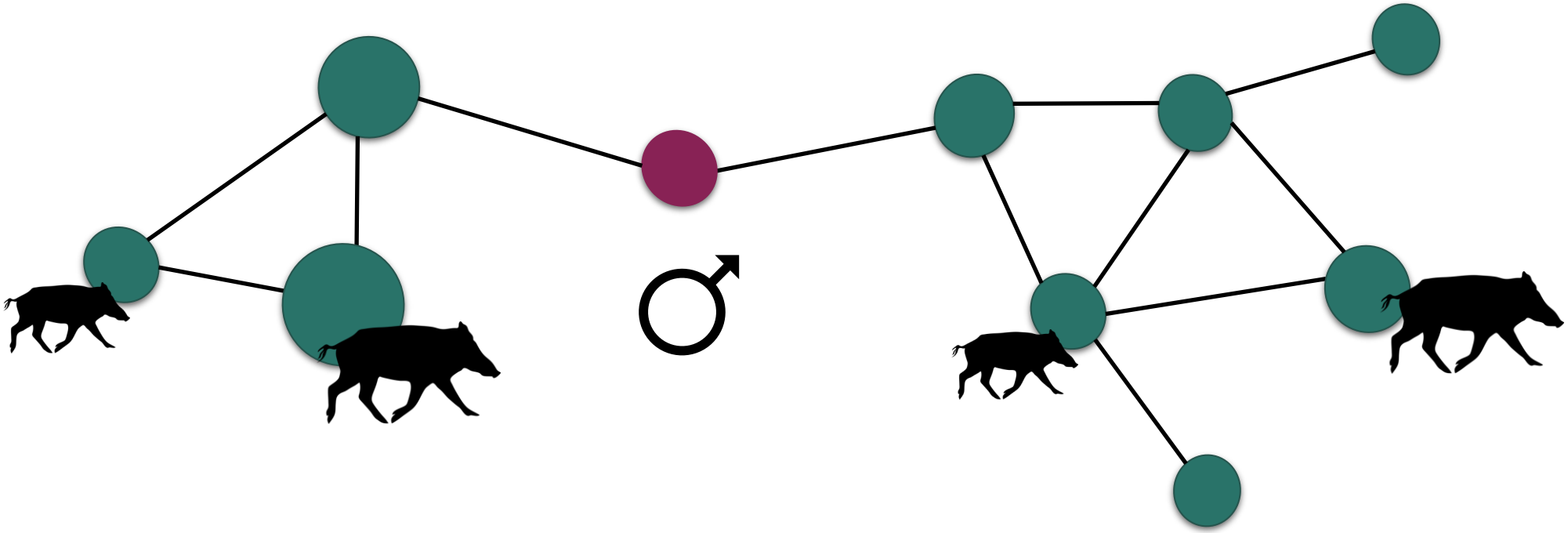
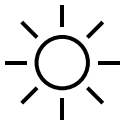


Porque es importante?

Target males to stop a disease's spread

In summer they have more contact, so potentially an outbreak in summer is worse than in another season



We now have information from Australia to update disease models

Comparacion de los casos

Aspecto	Canguros	Cerdos ferales
Tipo de contacto	Social directo / microbiano indirecto	Co-ocurrencia espacial
Fuente de datos	Observación + microbioma	GPS
Implicancias	Red bacteriana ≠ red social	Redes útiles para optimisar modelos de transmision de enfermedades

Conclusiones

- Las redes pueden revelar patrones ocultos de tramision
- Es clave definir correctamente los nodos y vinculos o links
- Entender patrones de movimientos

Y en aves silvestres?

- Que dato podemos utilizar
- Redes de moviemto migratorio? Redes de contacto interespecificas?
- Potencial para modelar transmision de influenza aviar en aves