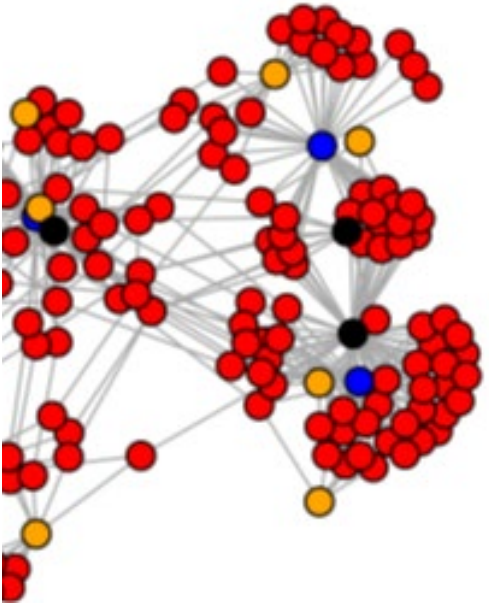
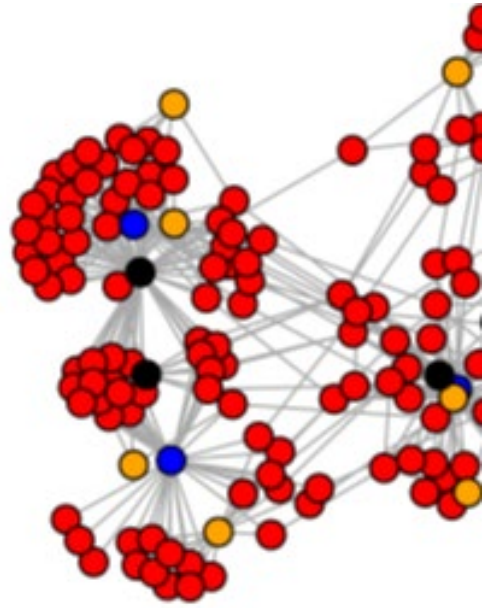


# Impact network analysis for guiding surveillance and mitigation



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FOOD SYSTEMS
INSTITUTE

# A couple main points

Scenario analysis to consider likely outcomes from potential mitigation strategies

Socioecological approach to integrate human decision-making in scenarios

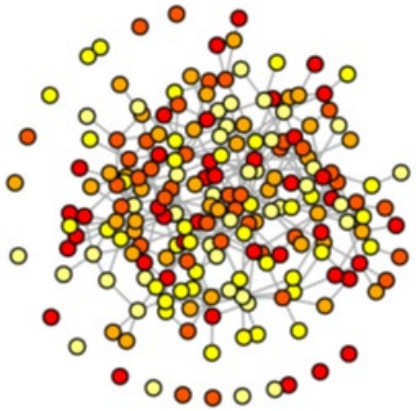
# Overview

- Introduction to networks
- Introduction to impact network analysis

# Overview

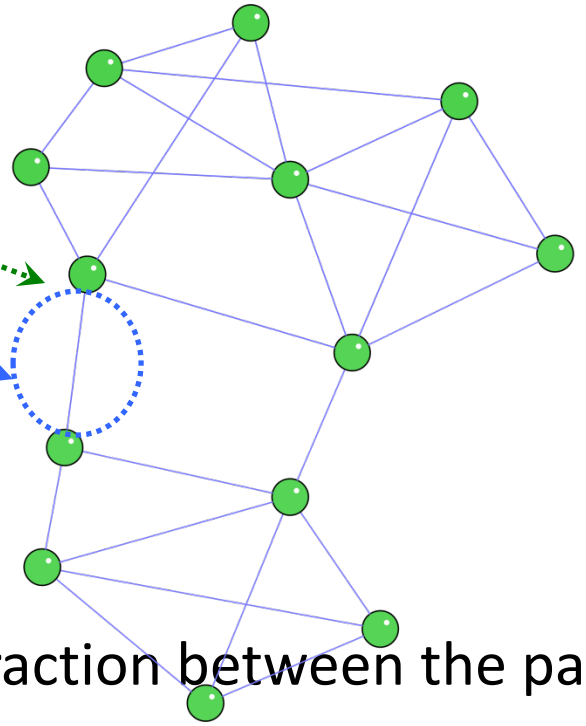
- **Introduction to networks**
- Introduction to impact network analysis

# Dynamic network models



Node (Vertex)

Link (Edge)

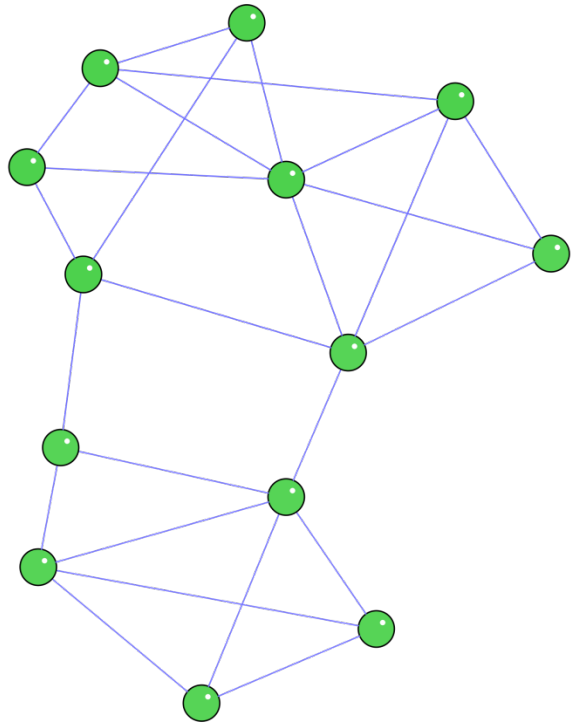


**Link weight:** Level of interaction between the pair of nodes

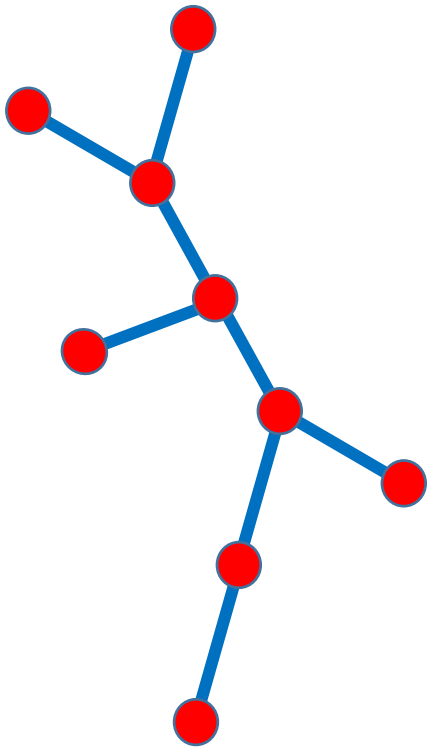
**Dynamic nature:** Link weights change over time

# Infinite possibilities for network model structures

- Nodes could be
  - Locations in spatial networks (counties, fields, plants, leaves, cells, organelles, microbes, …)
  - Entities
    - Individual people
    - Species (perhaps in food webs or the phytobiome)
    - Genes
    - Molecules
- Links could be
  - Strength or likelihood of influence, triggering, information flow, …
  - Dependent on environmental variables



# Traits of network nodes



- In a socioeconomic network, nodes are people or human institutions (managers/farmers, extension agents, scientists, …)
- In a biophysical network, nodes are geographic locations (individual plants, farms, storage facilities, wildlands, …)

- Degree centrality – number of links
- Closeness centrality – measure of how readily other nodes can be reached
- Betweenness centrality – importance as a bridge between other nodes
- Centrality of neighbors – importance in terms of importance of neighbors

# Ecological Networks in Stored Grain: Key Postharvest Nodes for Emerging Pests, Pathogens, and Mycotoxins

JOHN F. HERNANDEZ NOPSA, GREGORY J. DAGLISH, DAVID W. HAGSTRUM, JOHN F. LESLIE, THOMAS W. PHILLIPS, CATERINA SCOGLIO, SARA THOMAS-SHARMA, GIMME H. WALTER, AND KAREN A. GARRETT

John Hernandez Nopsa



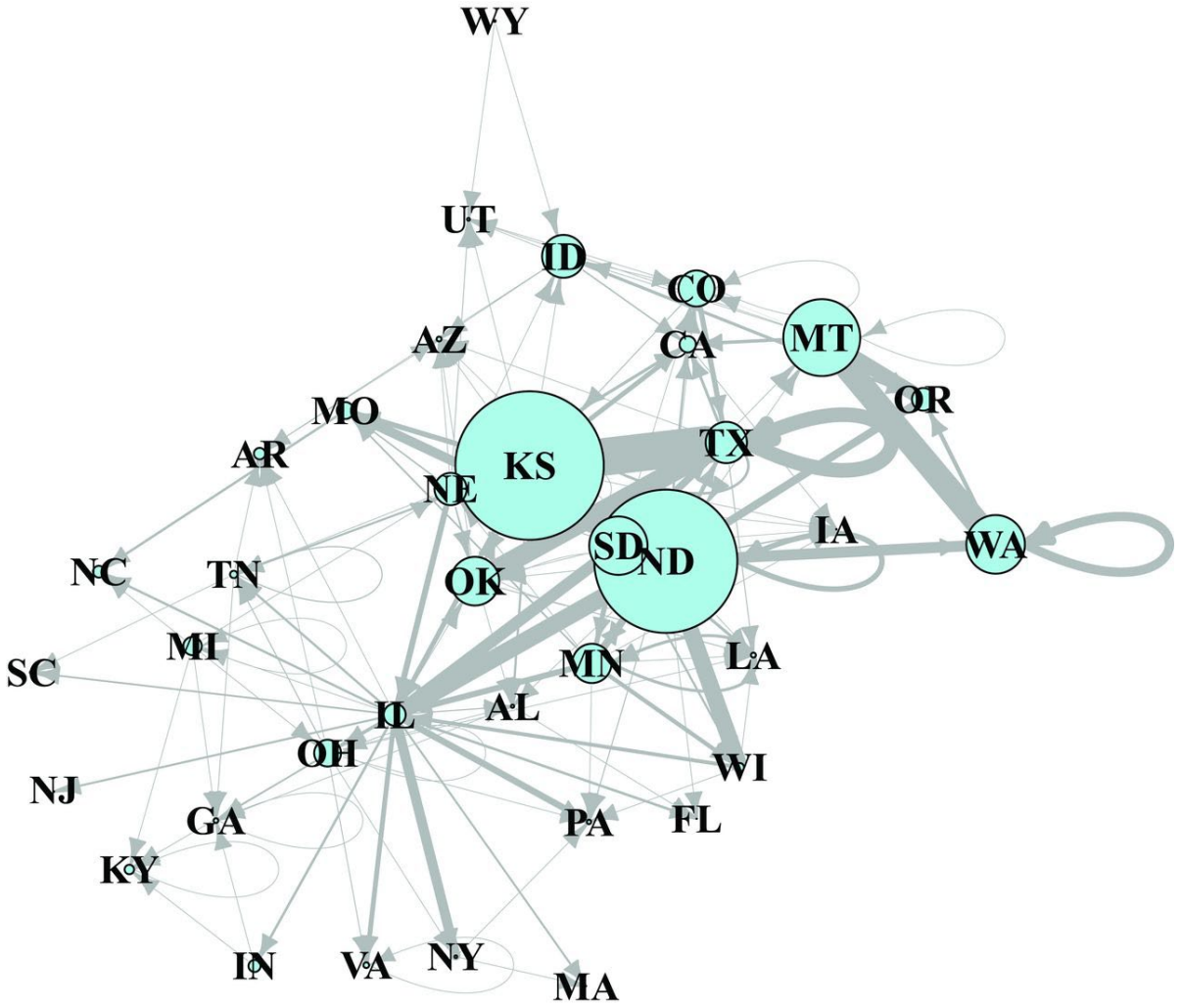
BioScience

An Australian Government Initiative

CRC AUSTRALIA

2015

# Wheat rail movement in US 2006-2010



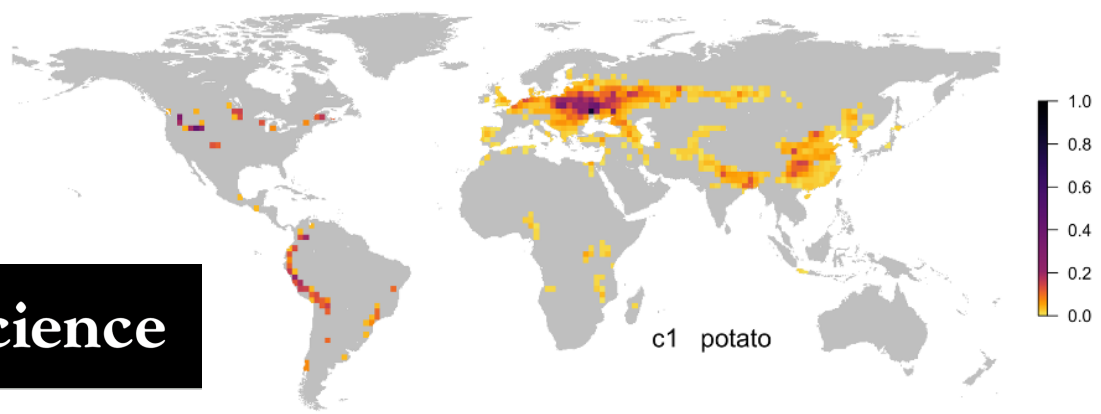

**John F. Hernandez Nopsa et al. BioScience 2015;biosci.biv122**

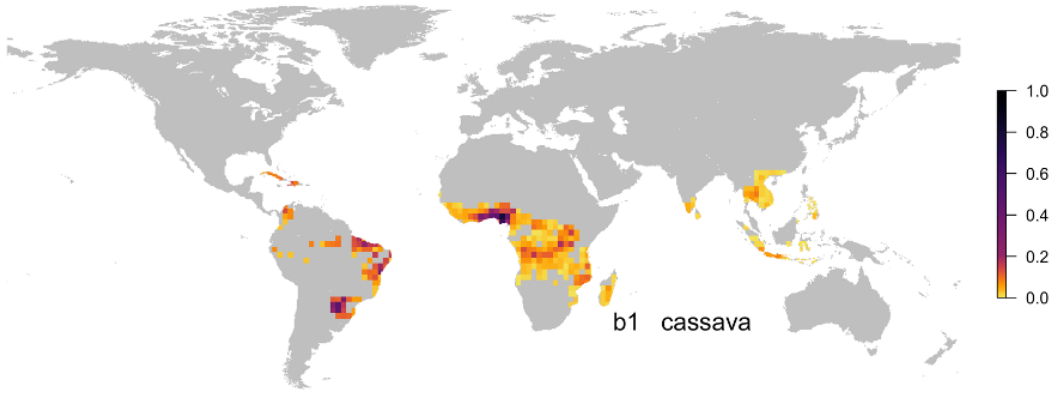


BioScience

# Global Cropland Connectivity: A Risk Factor for Invasion and Saturation by Emerging Pathogens and Pests

YANRU XING, JOHN F. HERNANDEZ NOPSA, KELSEY F. ANDERSEN, JORGE L. ANDRADE-PIEDRA, FENTON D. BEED, GUY BLOMME, MÓNICA CARVAJAL-YEPES, DANNY L. COYNE, WILMER J. CUELLAR, GREGORY A. FORBES, JAN F. KREUZE, JÜRGEN KROSCHEL, P. LAVA KUMAR, JAMES P. LEGG, MONICA PARKER, ELMAR SCHULTE-GELDERMANN, KALPANA SHARMA, AND KAREN A. GARRETT




BioScience

2020

# Overview

- Introduction to networks
- **Introduction to impact network analysis**

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DOI: 10.1111/2041-210X.13655

RESEARCH ARTICLE

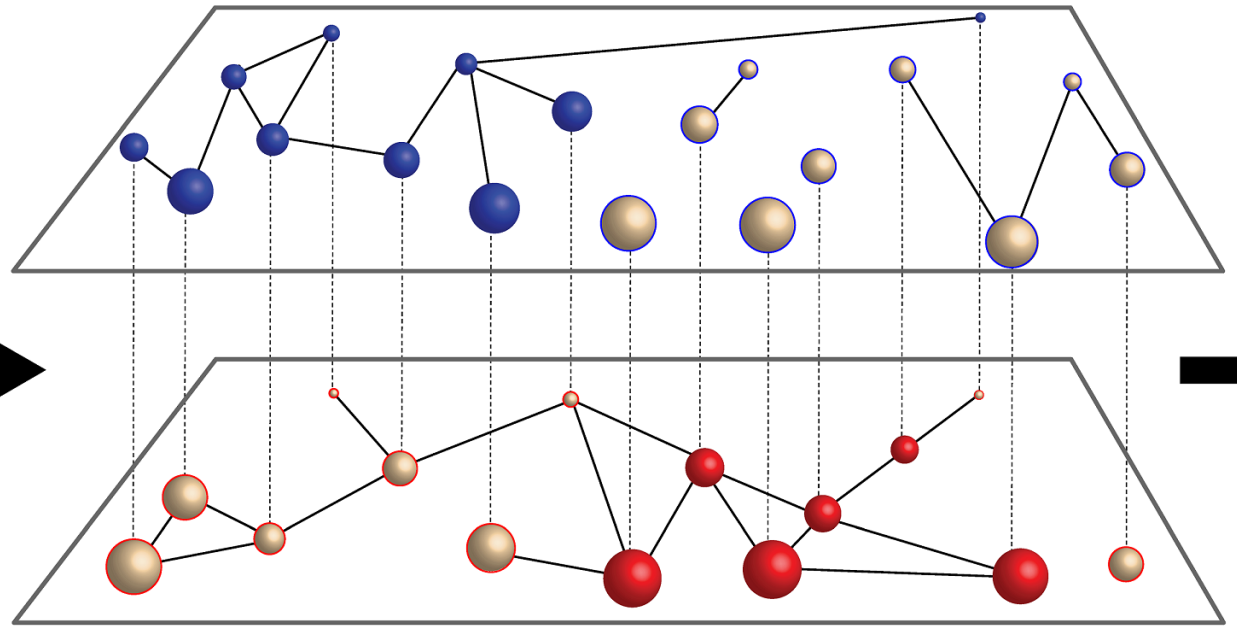
Methods in Ecology and Evolution BRITISH ECOLOGICAL SOCIETY

# Impact network analysis and the INA R package: Decision support for regional management interventions

Karen A. Garrett

# Impact network analysis

**Socioeconomic network**
Exchange of information among decision makers, affecting management adoption



**Management technologies**
Available for adoption

**Outcomes**
Bioentity establishment, productivity, sustainability, resilience

**Biophysical network**
Dispersal of a focus bioentity, with establishment influenced by management adoption

Garrett 2021

# Key types of questions in INA scenario analysis

- What locations are particularly important for system management?
- How are the benefits of the system distributed by gender and age?
- How could subsidies and policies influence system outcomes?
- Are observations over time in line with goals for project monitoring and evaluation?

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One type of question for surveillance: where to prioritize efforts

# Surveillance value of nodes

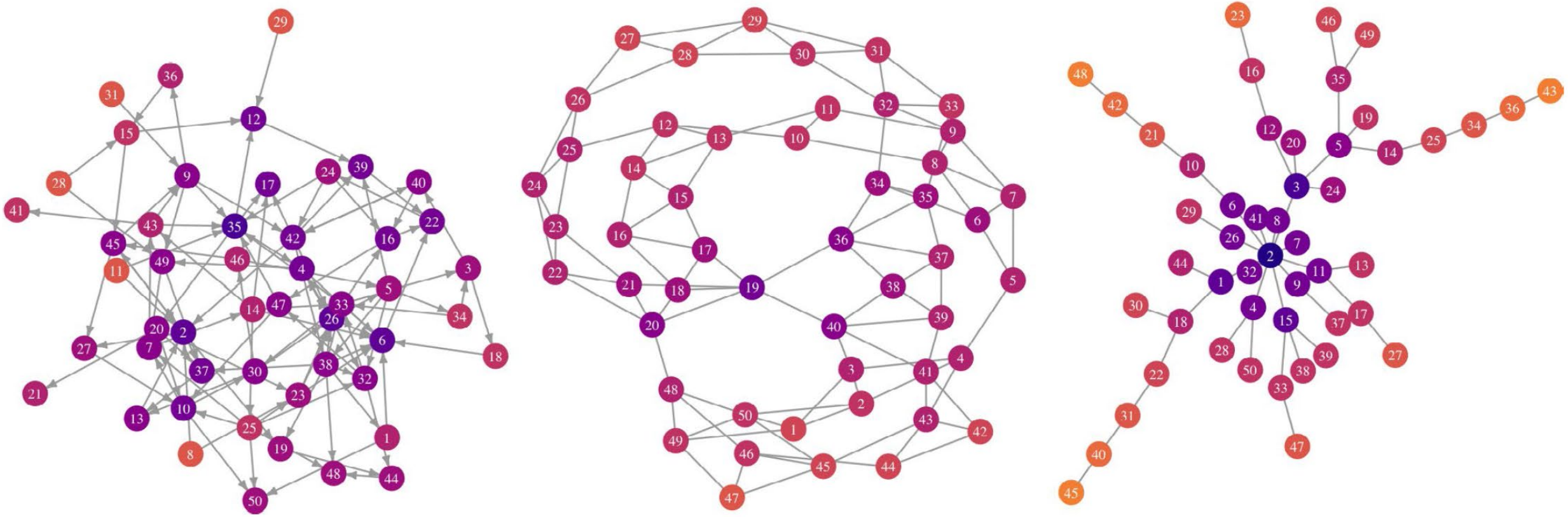

**FIGURE 2** Identifying key nodes for sampling for an invasive 'bioentity' as part of a smart surveillance strategy (experiment 1). This

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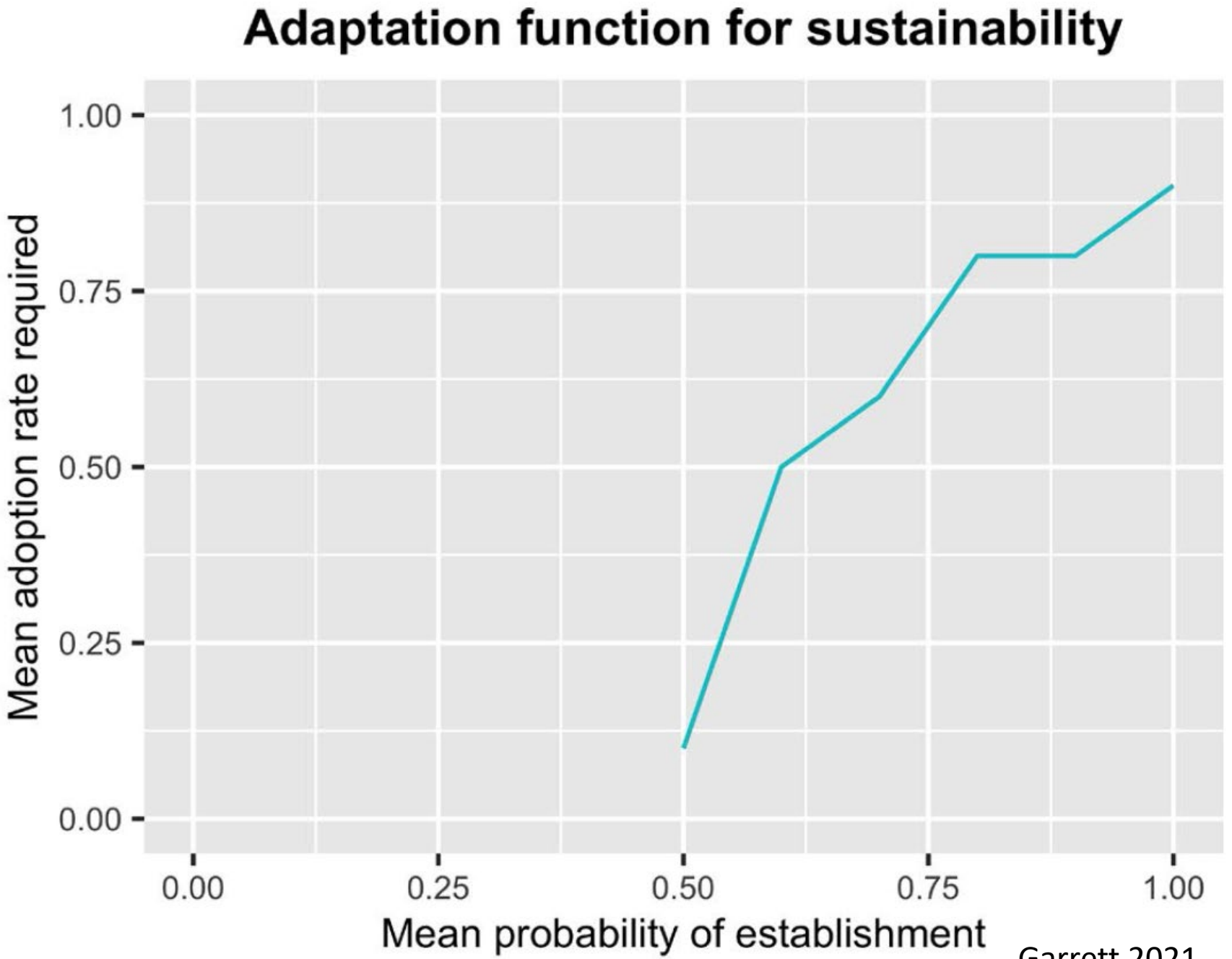
**Example of an adaptation scenario**: suppose the probability of resistance gene establishment becomes higher – How much does the adoption rate for a good management practice have to go up, to keep risk the same as in the past?

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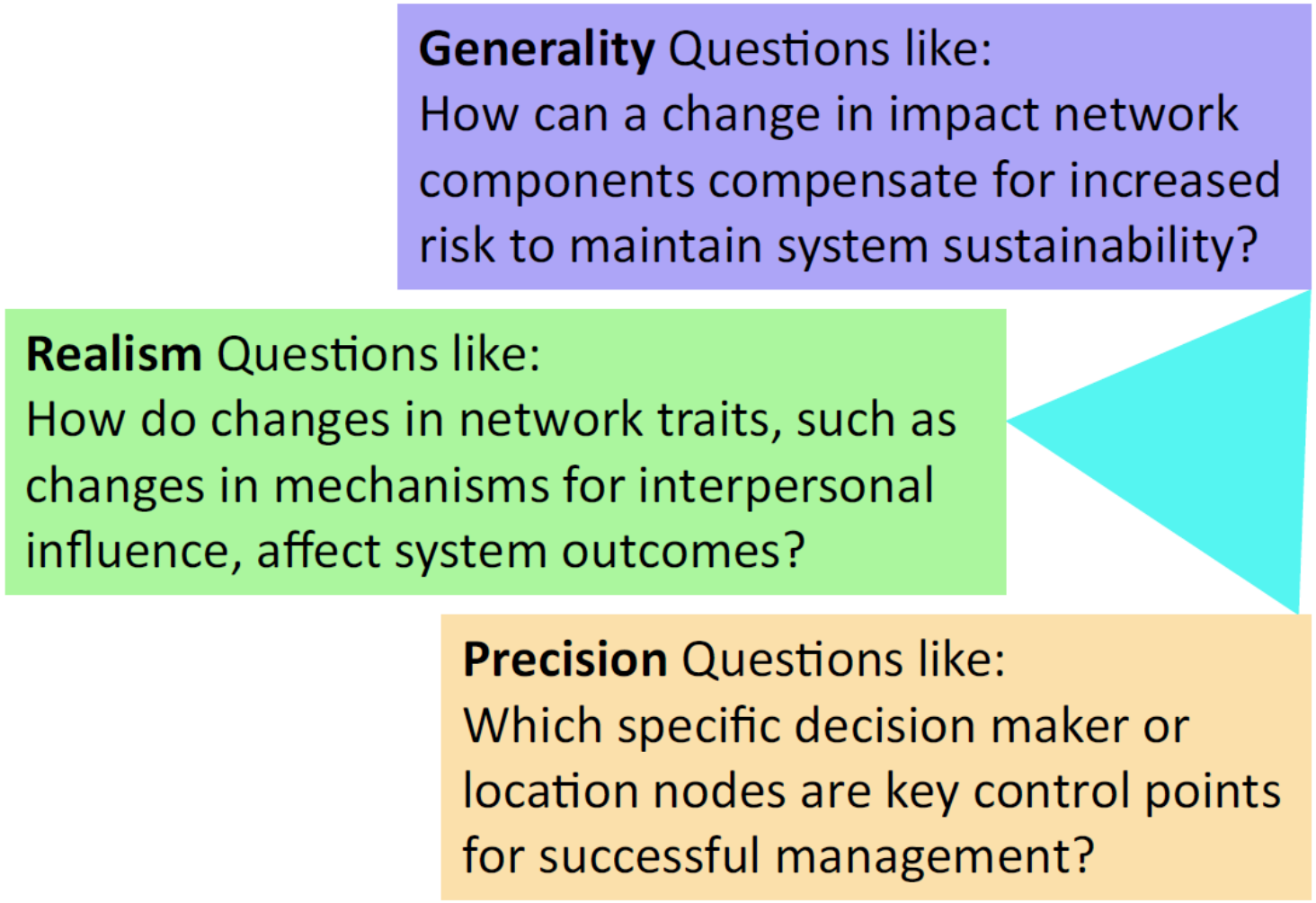


**FIGURE 7** Three potential priorities in impact network analysis, and examples of the types of questions that might be asked in each context. As more information about a system is available, questions can address greater realism and precision

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| Experiment | Component | Question |
| --- | --- | --- |
| 1A | Explicit biophysical network | What locations selected for sampling are likely to allow detection of an invasive bioentity before many other locations are invaded? |
| 1B | Added implicit socioeconomic network | How is the selection of sampling locations likely to change if the probability the invasive bioentity enters the region at each location is determined by socioeconomic traits of locations? |

# Evaluating adaptation outcomes

| Experiment | Type of stressor | Question |
|---|---|---|
| 3A | Press | To adapt for sustainability in the face of increased establishment risks, what level of change is needed in manageable system components? |
| 3B | Press | What is the adaptation function for sustainability, describing the needed system change to keep the system failure rate below a threshold, as establishment risks increase? |

# Evaluating adaptation outcomes

| Experiment | Type of stressor | Question |
|---|---|---|
| 3A | Press | To adapt for sustainability in the face of increased establishment risks, what level of change is needed in manageable system components? |
| 3B | Press | What is the adaptation function for sustainability, describing the needed system change to keep the system failure rate below a threshold, as establishment risks increase? |
| 3C | Pulse | To adapt for resilience in the face of a rapid change in bioentity establishment, what level of change is needed in manageable system components? |
| 3D | Pulse | What is the adaptation function for resilience, describing the needed system change to keep the failure rate below a threshold, if there is a rapid change in establishment? |