Free agents and social networkers:
modeling socio-ecological adaptation in fire-prone landscapes

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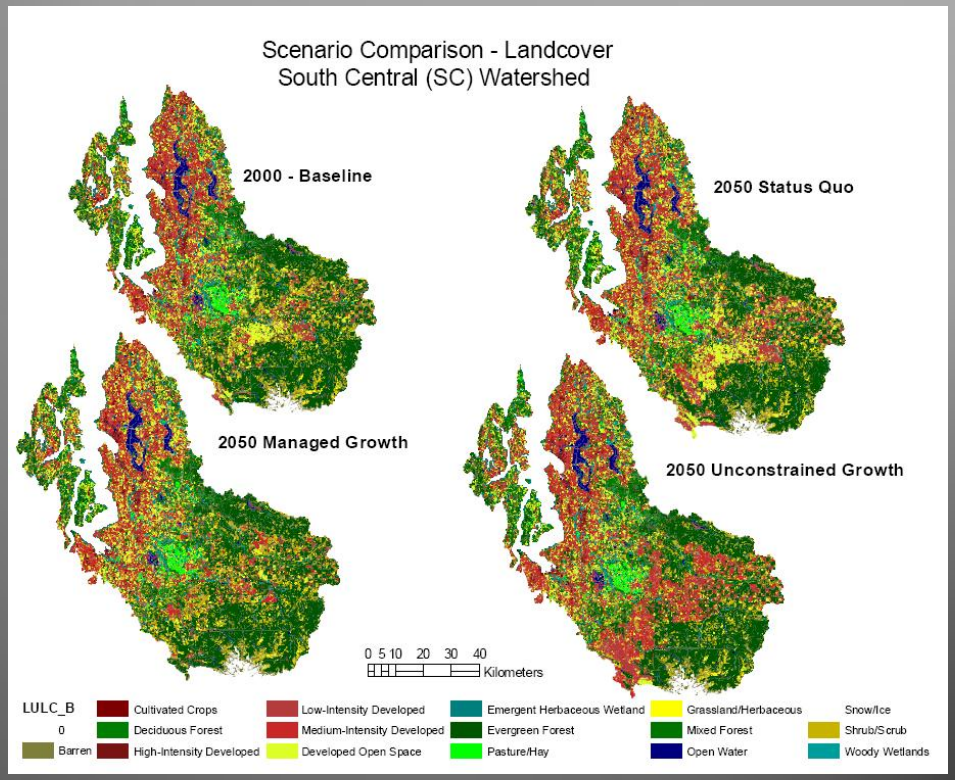
Socio-Ecological Systems

- Individual actions modify, connect or disconnect
- Flows of materials and information
- Mediated by social and cultural institutions

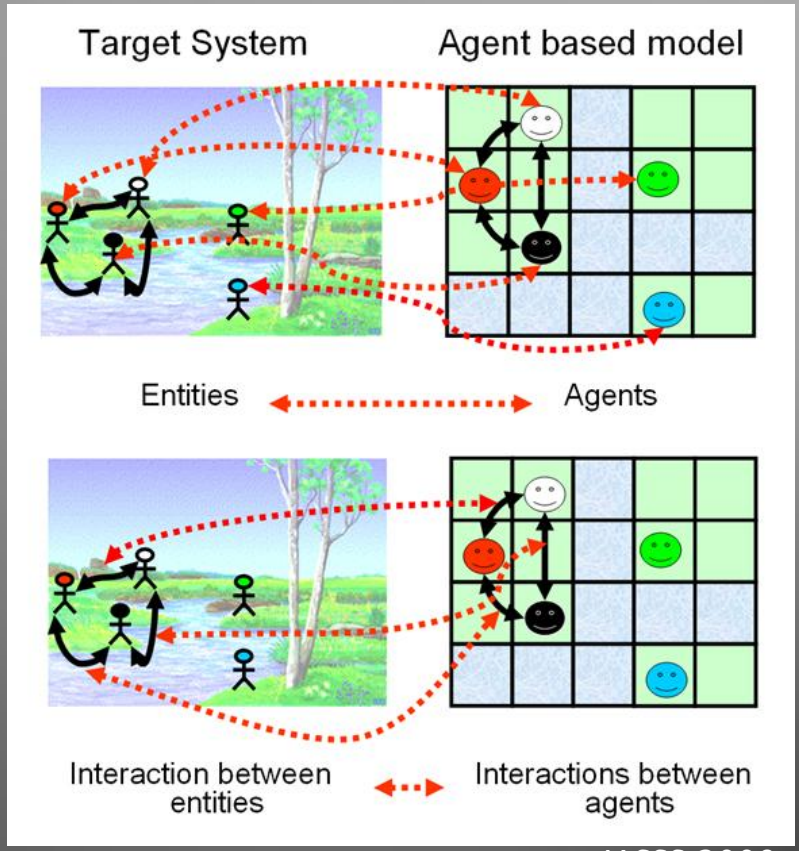
Landscape simulation models

- Incorporate critical system features
- Represent likely real-world outcomes with some accuracy
- Useful when
  - system is complex
  - relationships are poorly understood
  - uncertainties are high

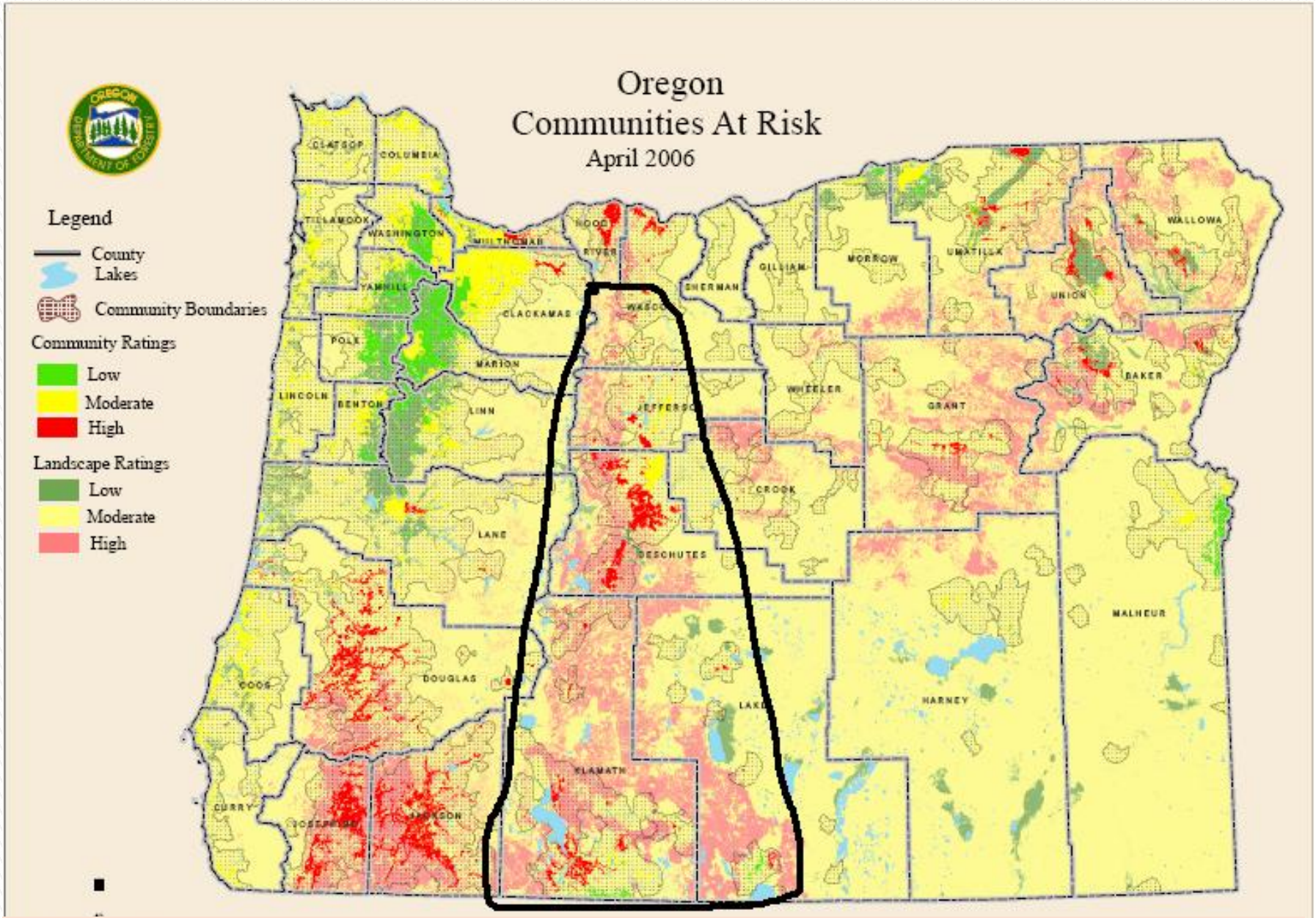


Agent-based modeling

- Actors have rules (i.e., policies, norms) that guide and constrain actions
- Actors are autonomous and adaptive agents
- Can interact through persuasion, imitation, sanctioning



JASSS 2009



Central Oregon's fire-prone landscape

patterns
complex
influences
scientists
effects
factors
adaptation
example
e.g
model
values
federal
approach
Spies
range
vegetation
policies
including
severity
increase
managers
area
conditions
set
resources
new
groups
potential
study
wildfires
fire
change
management
Envision
fuel
models
agencies
actor
lands
used
landscapes
decision
treatment
fire-prone
forest
biodiversity
learning
include
communities
large
activities
work
developed
high
services
forests
wildlands
behaviors
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time
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development
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may
goals
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WUI
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role
CNHS
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suppression
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landscape
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Fire
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treatments
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fires
ecosystem
regimes
system
dynamics
population
networks
risk
carbon
land
et
ecological
wildfire
policy
focus
data
disturbance
responsible
structures
succession
habitat
private
region
information
research
actors
using
future
types
also
climate
influence
community
well
behavior
decisions
scenarios
within
modeling
economic
feedbacks
decision-making
develop
resource
examine
human
spatial
workshop
species
project
scenario
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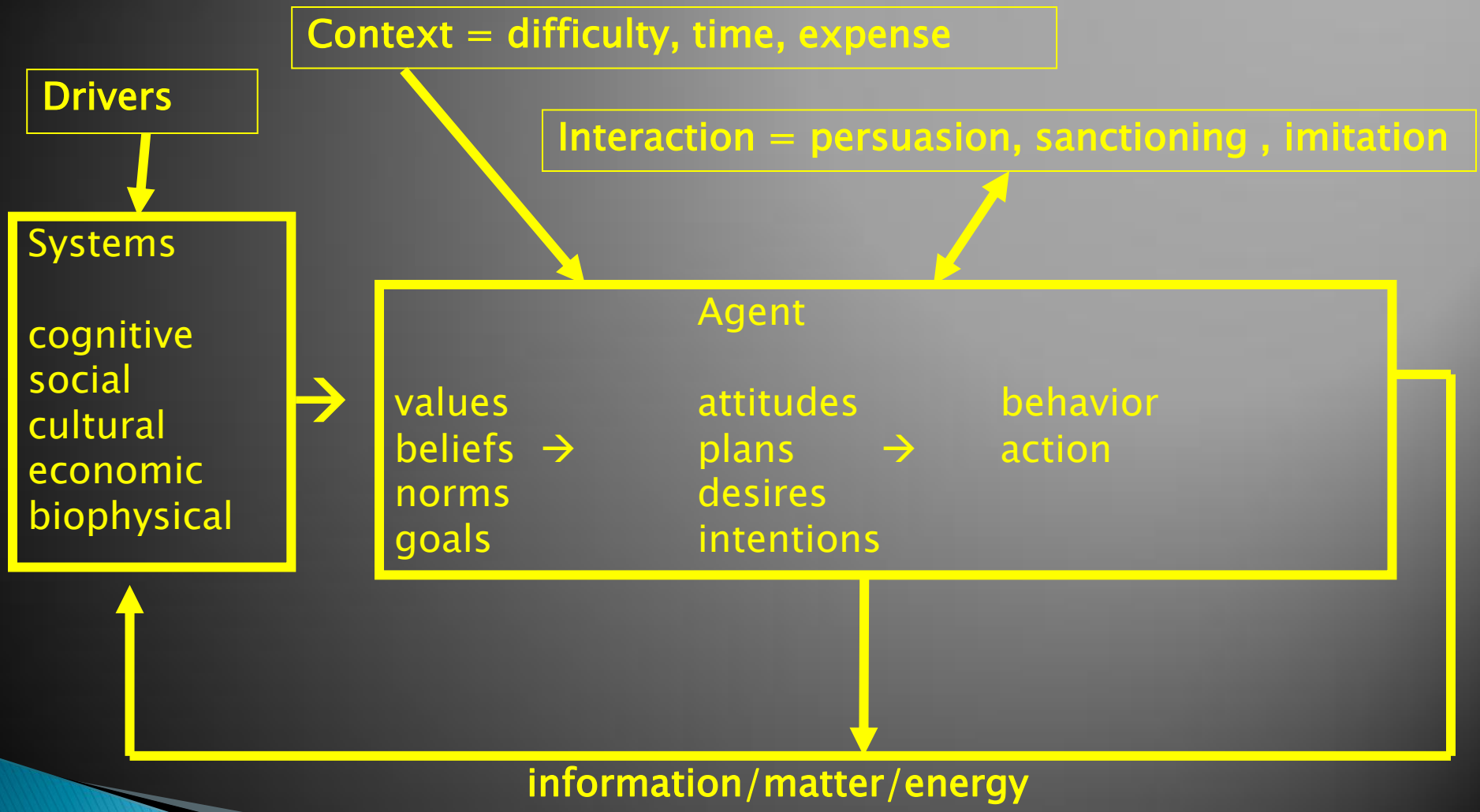
Theory of individual action in Envision



Simulating individual behavior: private land owners

Management approaches

Factor group	Practices with factor loadings of ≥0.4	Eigenvalue	Proportion Explained	Cronbach's alpha
Timber harvesting	Harvest timber for profit Sell logs or other wood products	2.397	14.980	0.935
Defensible space creation	Prune or limb trees Thin by hand or with chainsaw Pull by hand Clear around structures Make structures more fire-proof Create fuel breaks	5.732	35.823	0.886
Mechinized thinning	Thin with mechanized equipment Mow, crush, grind or chip	1.151	7.195	0.718
Cultivation	Plant fire-adapted trees Shade out vegetation	1.205	7.531	0.754
Grazing	*Grazing cattle* *Applying herbicides*	*1.020*	*6.375*	*0.464*

Manager types

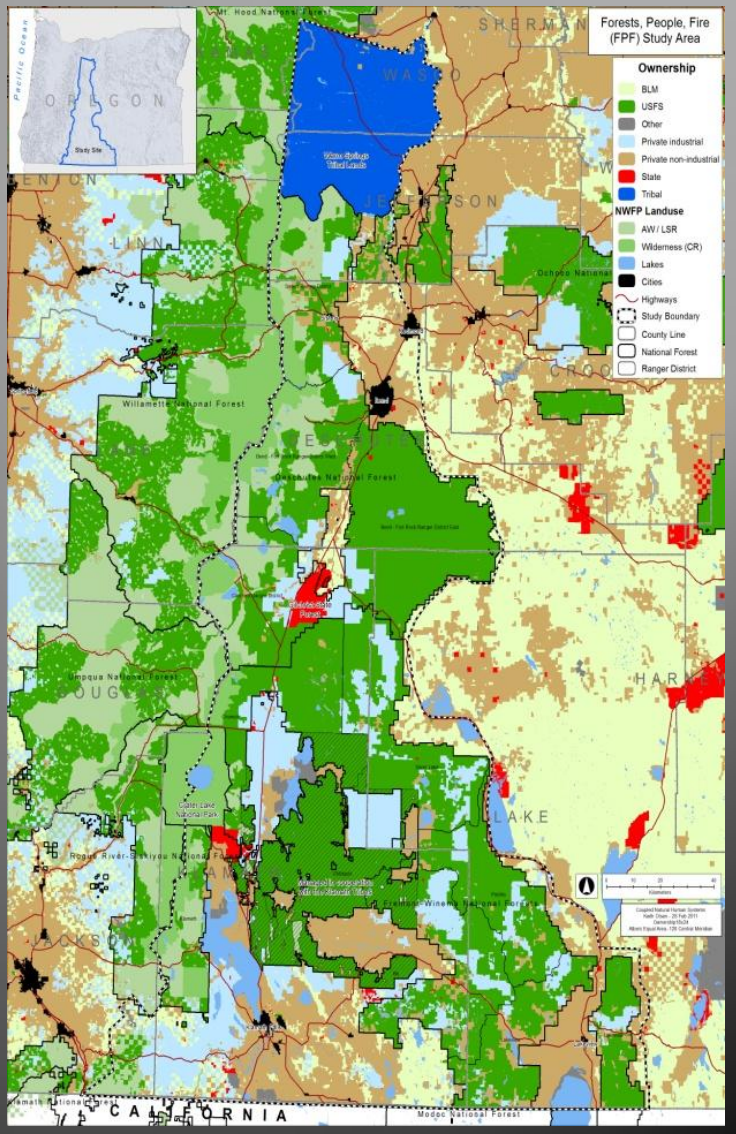
Characteristics	Sample	Fuel manager cluster group: Commodity-oriented	Amenity-oriented	Non-committal	Unlikely	
Percentage of sample	100	26.5	21.1	27.8	24.6	
						X^2
Treated acres to reduce fire risk (%)	68.9	49.3	83.8	82.6	53.5	66.106***
Very concerned about fire (%)	44	52.6	59.3	43	25.5	62.729***
Primary residents (%)	22.5	22.8	44.6	25.2	12.7	27.477***
Timber most important goal (%)	9.6	22.9	3.2	2.4	9.1	34.1***
Grazing most important goal (%)	14.6	20.3	7.4	11.3	18.2	9.636*
Residence most important goal (%)	16.8	5.1	27.7	21.8	14.5	24.533***
Real estate most important goal (%)	7.8	5.1	3.2	11.3	10.9	9.074*
Earn some income from forestry (%)	33.0	61.0	25.5	18.5	25.5	57.08***
More likely to manage with incentives (%)	73.2	85.6	83.7	76.6	48.1	45.768***
						F
Acres treated to reduce fire risk (mean)	186.9	324.6^{a}	146.4	174.9	89.9^{a}	3.964**
Parcel acreage (mean)	1240.4	1973.1^{ab}	735.6^{a}	1225.4	899.4^{b}	6.147***
Ownership acreage (mean)	2584.3	4031.2^{a}	1225.4^{a}	2405.9	2510.6	5.279**

$*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$

Means with same superscripts are significantly different at $p \leq 0.05$ based on Games-Howell method

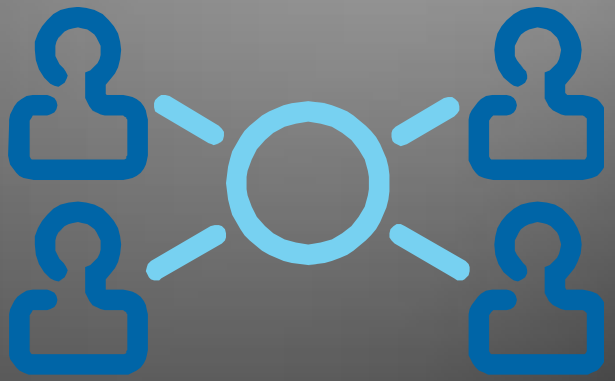
Representing agents spatially

- Assign probability parcel belongs to each agent type
- Represent practices that the agent group is most likely to conduct
- Simulate resulting changes in conditions on parcel
- Simulate effects on other parcels



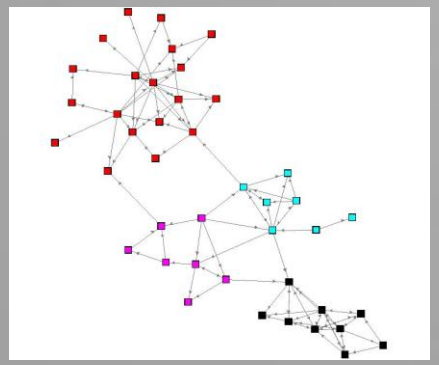
Simulating social influences

- How to account for changes in determinants of agent behavior that result from social influences (e.g., membership to different types of organizations)?
- What influences who agents interact with and what they take away from those interactions?

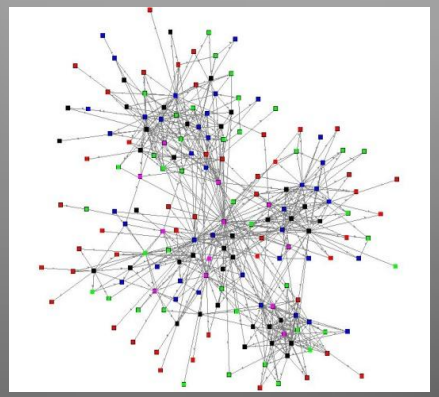


Social structure and adaptation

- Can represent types of social structure that have bearing on adaptation:
  - Diffuse information (Granovetter 1973, Berger 2001)
  - Promote local cooperation (Granovetter 1973, Bodin 2006)
  - Foster learning (Bodin 2006)
  - Foster innovation (Valente 1996)
  - Reflect social capital (Adger 2003, Mandarano 2009, Janssen et al. 2006)



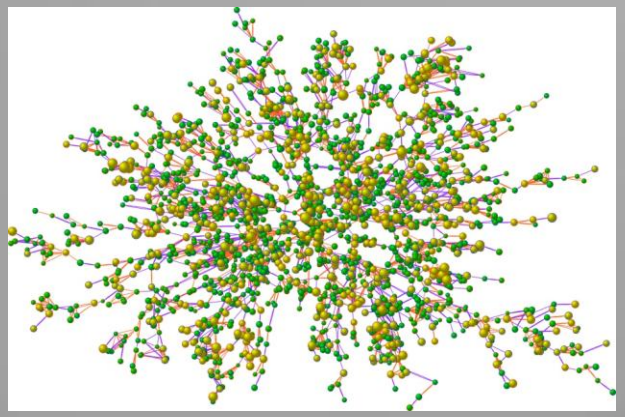
Information communication network



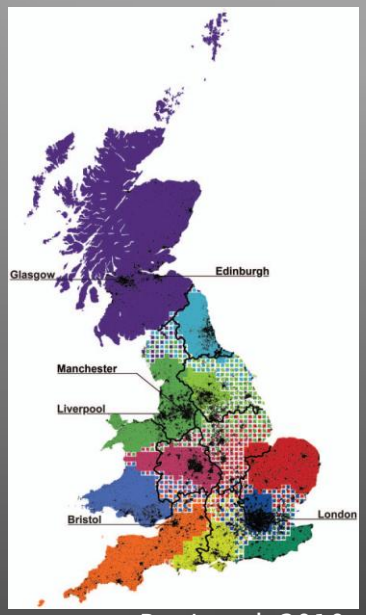
Learning network

Social network analysis

- Sets of individuals or organizations and the ties between them
- Ties facilitate exchange of information, attitudes, norms, material and non-material resources
- Measures of tie density, distribution, strength, function



James Fowler



Ratti et al. 2010

Hypotheses

- Participants in social networks related to natural resources management are more likely to reduce fuels
- Characteristics of social networks are important in explaining the variability in management actions of actor groups
  - **Homophilous**: common behaviors, common ideas, frequent local cooperation
  - **Heterophilous:** diversity of behaviors, nuanced understandings, innovative approaches
  - **Weak ties among otherwise unconnected groups:** balance power, build social capital, cooperation across subgroups
- Network structure is associated with local material conditions, e.g., a community's exposure to biophysical risk and socio-economic vulnerability

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