Agent-Based Modelling for Human-Fire Interactions

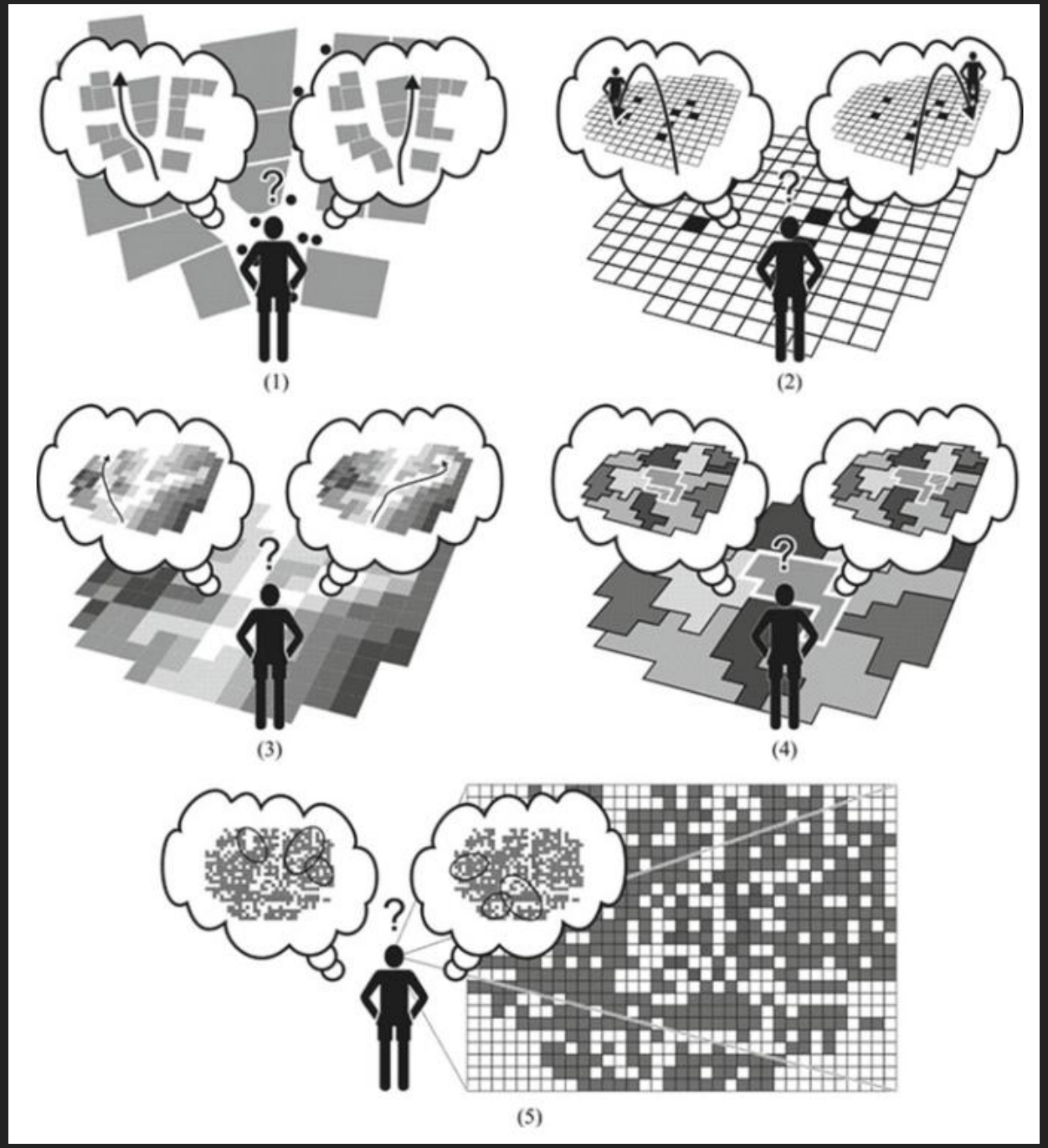
James Millington
King's College London
james.millington@kcl.ac.uk

What is an Agent-Based Model?

Image: Sophie et Fred

ABM Types

1. Pedestrian Movement
2. Residential Locations
3. Hunting and Gathering
4. Land Use Change
5. Property Development



O'Sullivan *et al.* (2012) Fig. 1
http://doi.org/10.1007/978-90-481-8927-4_6

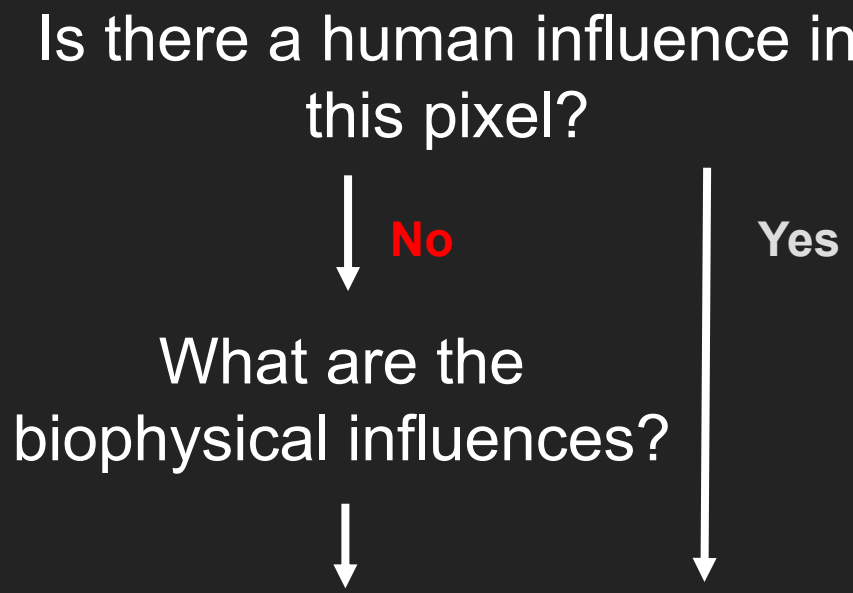
Possibilities of ABM

- Heterogeneity
  - Modelling of many interacting, discrete and heterogeneous entities
- Adaptation and Irrationality
  - Simulation of adaptive and/or rationally imperfect individual and group behaviour
- Versatility
  - Representation of multi-faceted entities across multiple spatial and temporal scales

SPASim - Integrated ABM & LFSM

Agent-Based Model

Landscape Fire-Succession Model



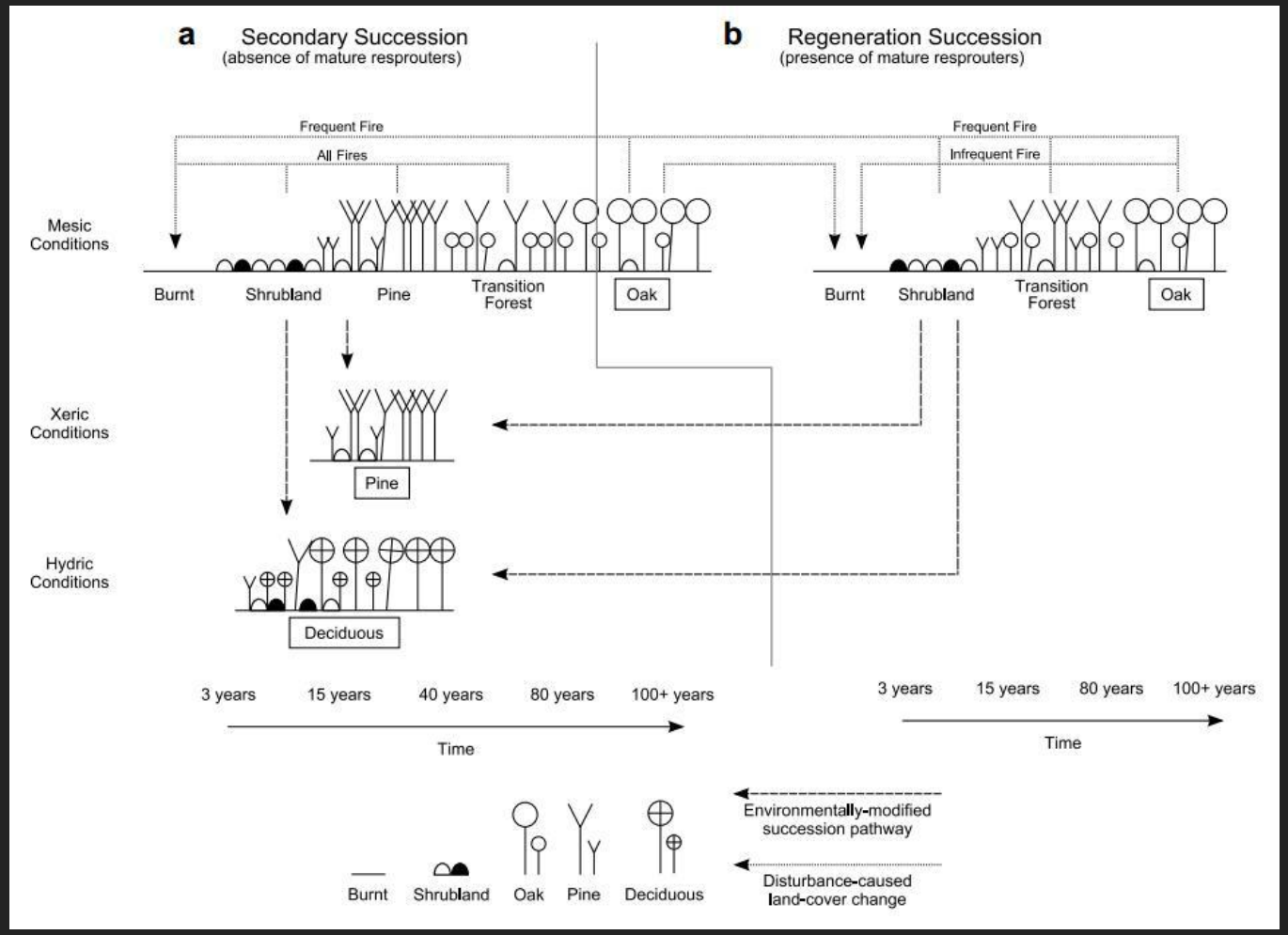
Land Use/Cover Change

Human activity constrains ‘natural’ veg change

SPASim - Landscape Fire-Succession

Succession

- Climate
- Moisture
- Seed Sources

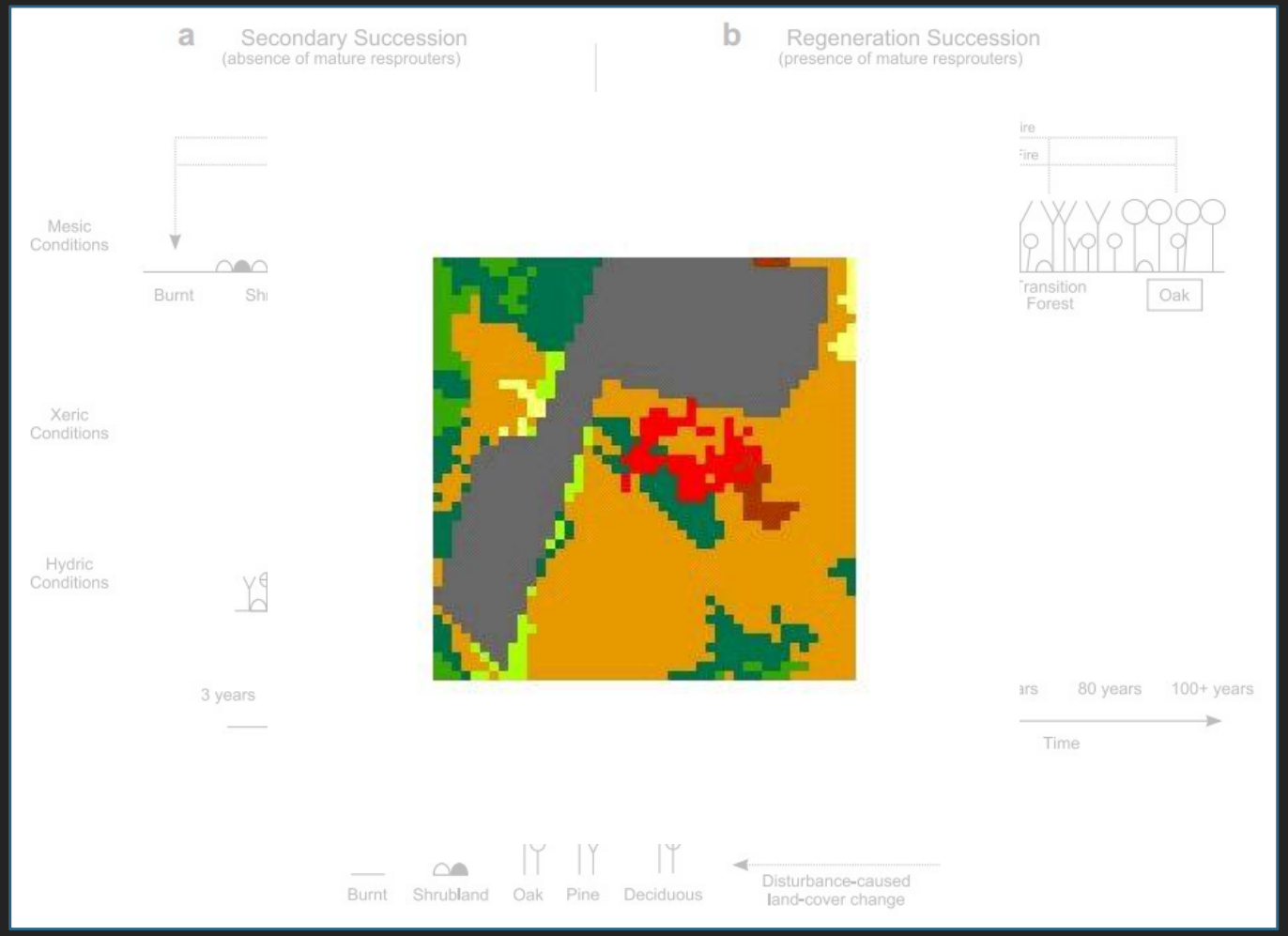


Millington *et al.* (2009) Fig. 2
https://doi.org/10.1016/j.envsoft.2009.03.013

SPASim - Landscape Fire-Succession

Fire

- Vegetation
- Slope
- Wind



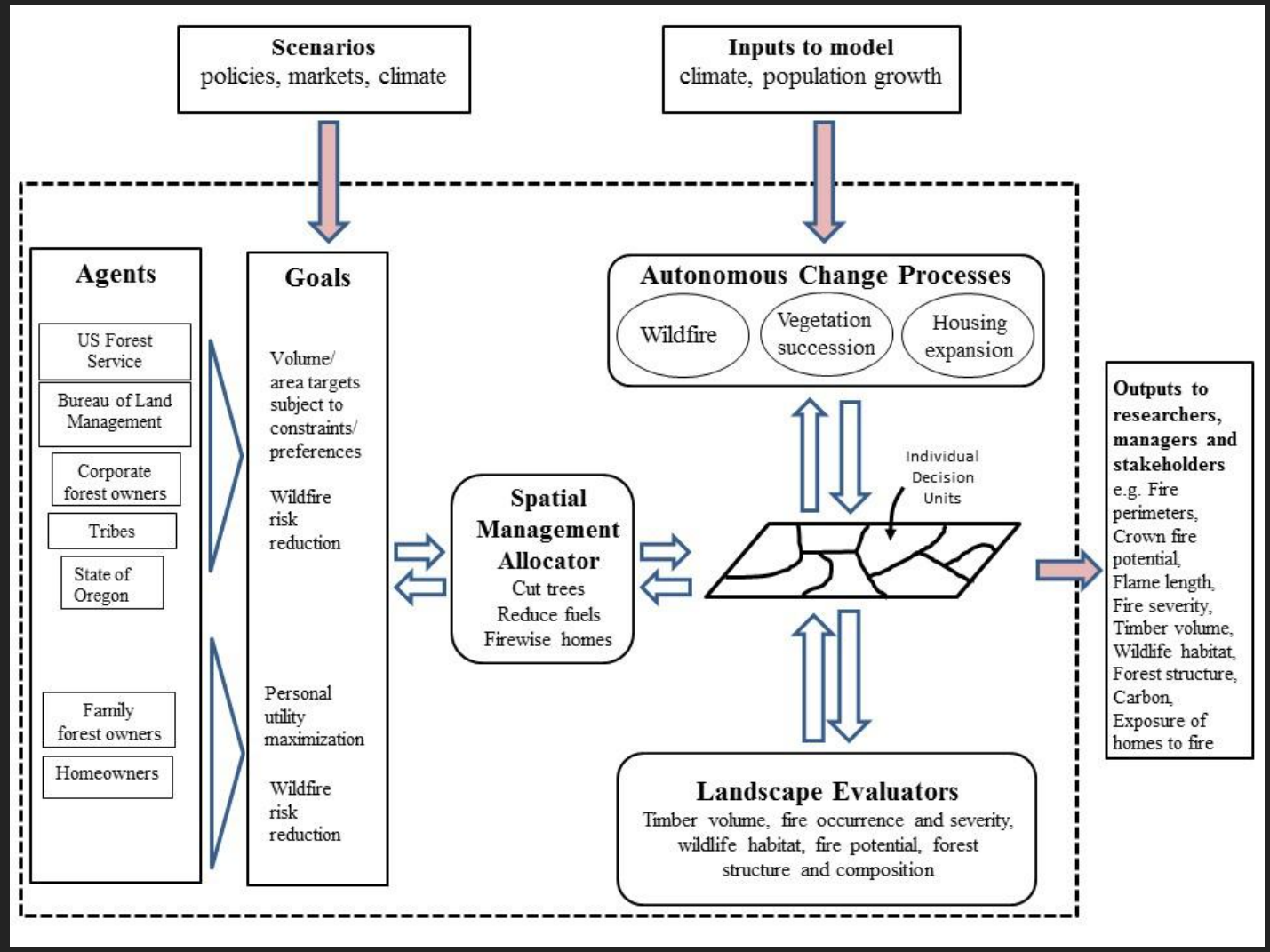
Millington *et al.* (2009)
https://doi.org/10.1016/j.envsoft.2009.03.013

SPASim - Agent-Based Model

- Agent Types
  - Traditional
  - Commercial
- Decision-Making Criteria
  - Crop yields (values)
  - Land fragmentation (costs)
- Generational Change
  - Probability of farm inherited by child
  - New' farms may establish on abandoned land

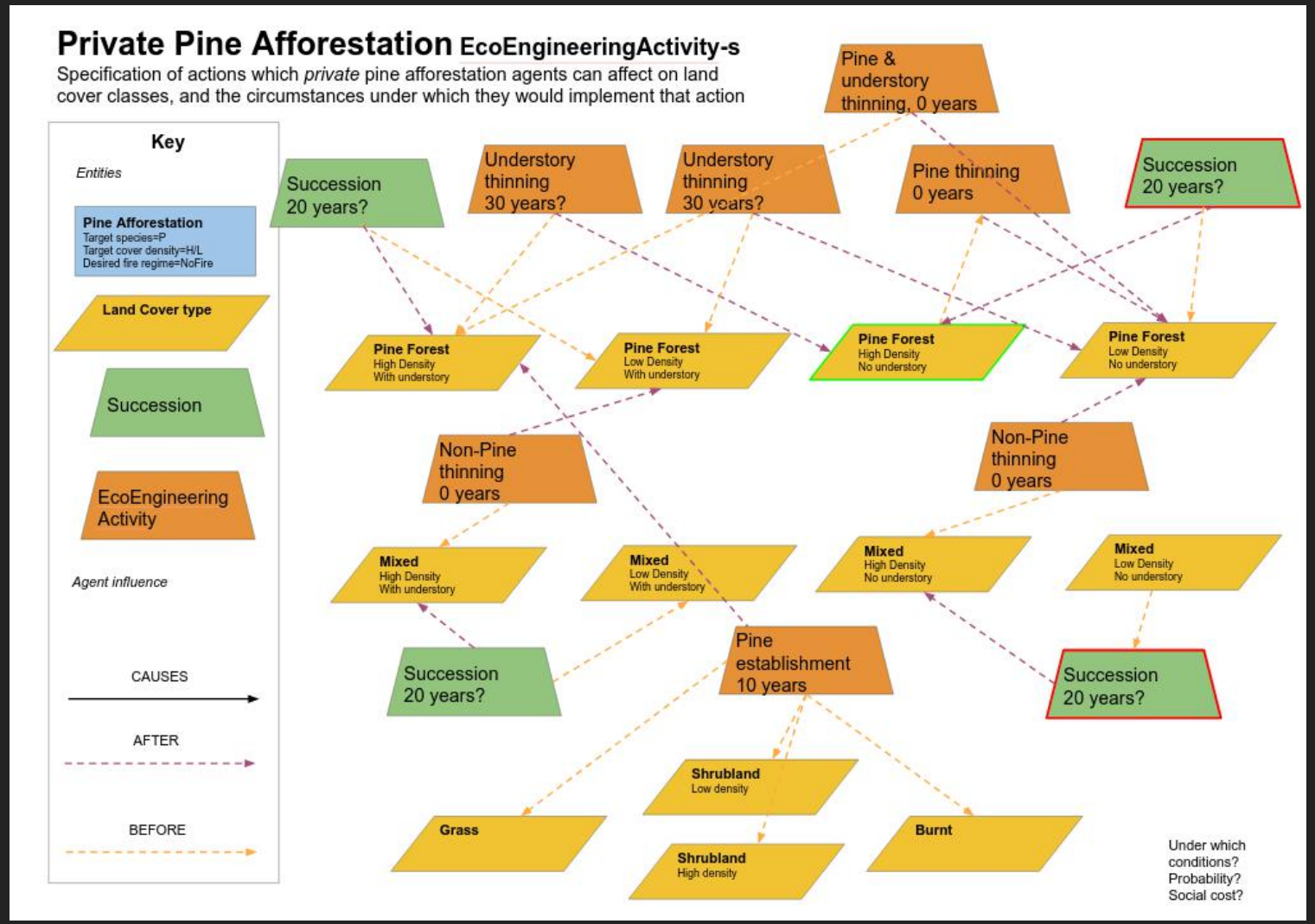
Millington *et al.* (2008)
http://jasss.soc.surrey.ac.uk/11/4/4.html

Oregon ABM - Forests, Fire, People

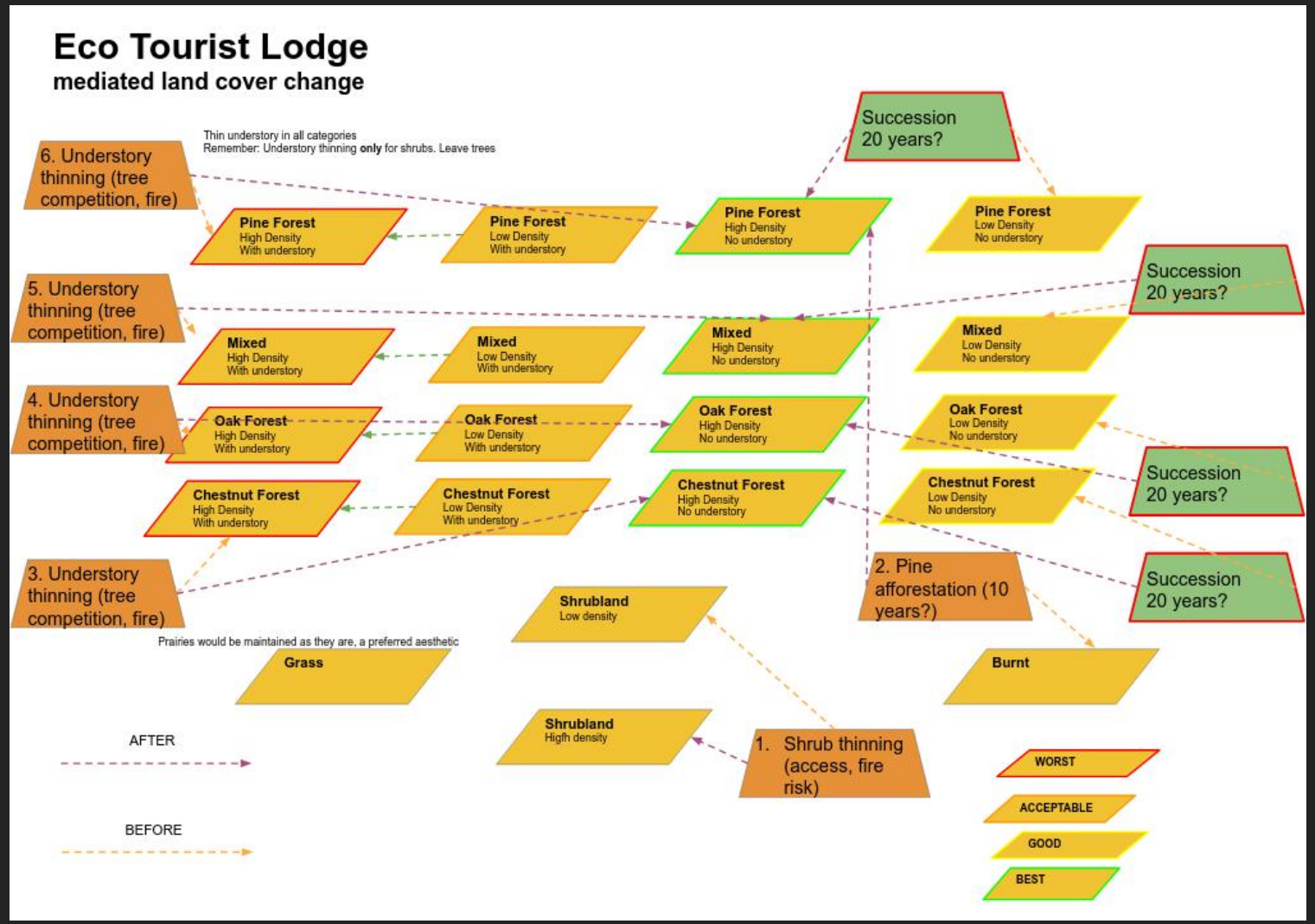


Spies *et al.* (2017) Fig. 2
https://doi.org/10.5751/ES-08841-220125

Gredos ABM

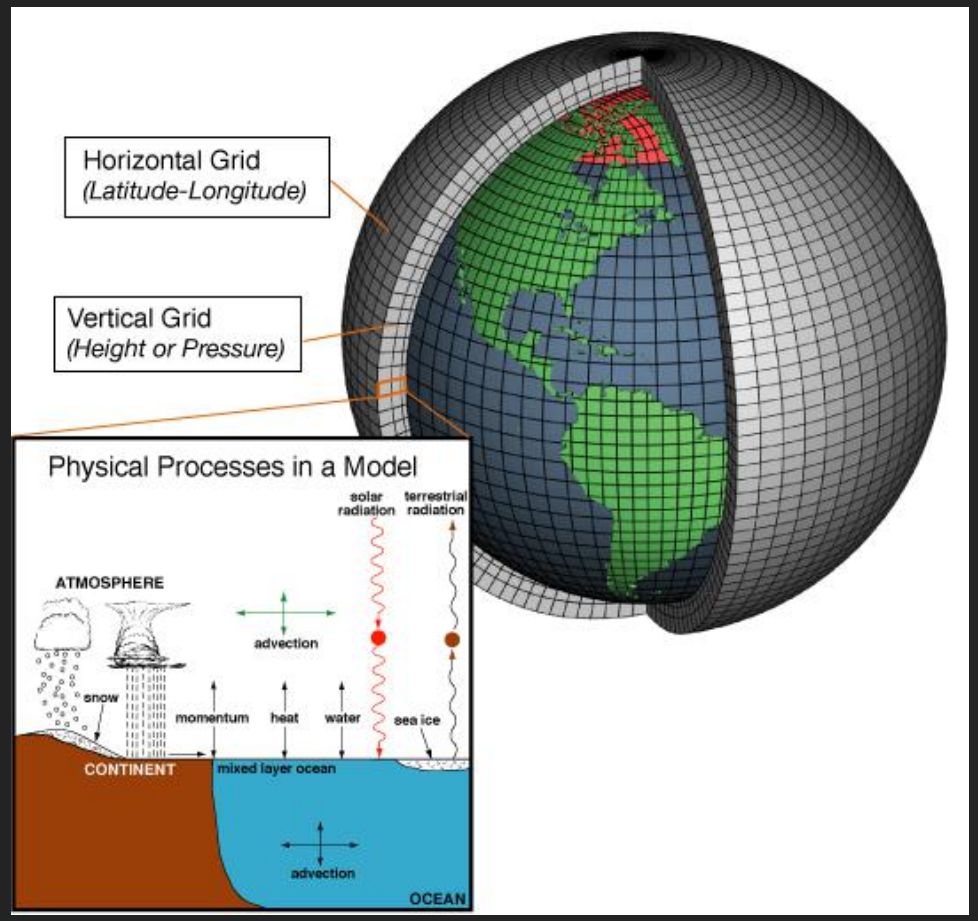

Private Pine Afforestation EcoEngineeringActivity-s
Specification of actions which private pine afforestation agents can affect on land cover classes, and the circumstances under which they would implement that action
Key
Entities
Pine Afforestation
Target species=P
Target cover density=H/L
Desired fire regime=NoFire
Land Cover type
Succession
EcoEngineering Activity
Agent influence
CAUSES
AFTER
BEFORE
Pine & understory thinning, 0 years
Succession 20 years?
Understory thinning 30 years?
Understory thinning 30 years?
Pine thinning 0 years
Succession 20 years?
Pine Forest High Density With understory
Pine Forest Low Density With understory
Pine Forest High Density No understory
Pine Forest Low Density No understory
Non-Pine thinning 0 years
Non-Pine thinning 0 years
Mixed High Density With understory
Mixed Low Density With understory
Mixed High Density No understory
Mixed Low Density No understory
Succession 20 years?
Pine establishment 10 years
Succession 20 years?
Shrubland Low density
Grass
Shrubland High density
Burnt
Under which conditions? Probability? Social cost?

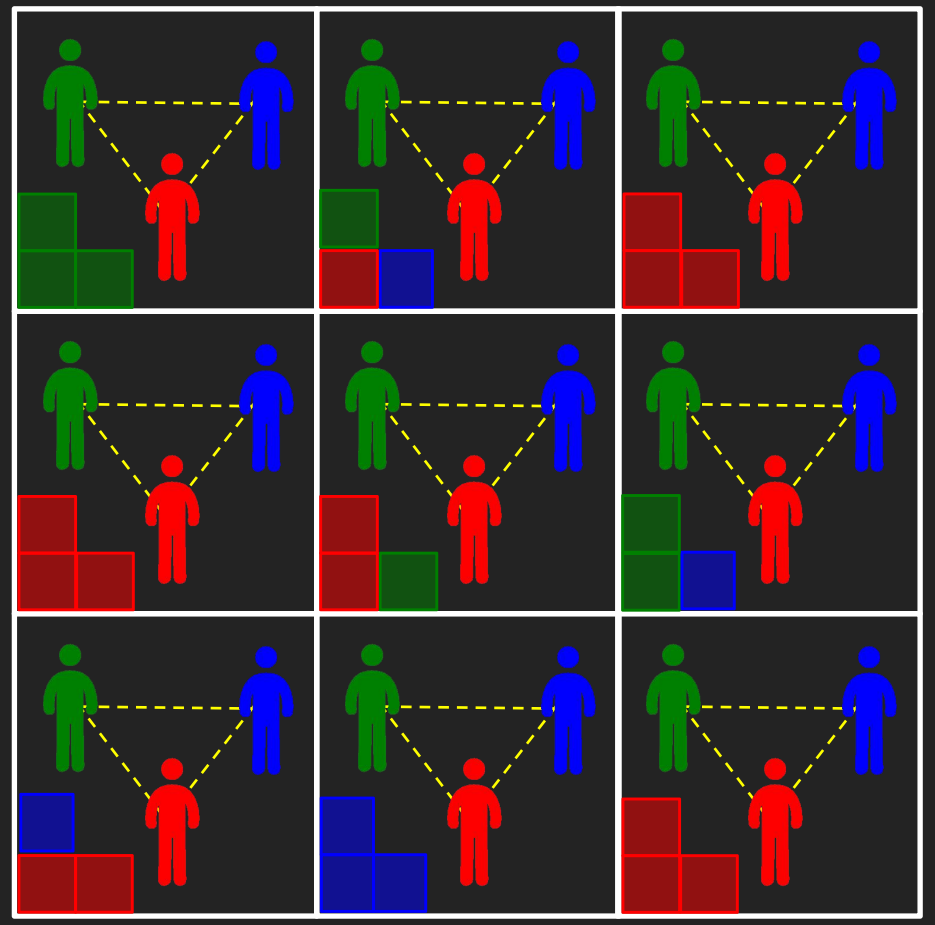
Gredos ABM


Eco Tourist Lodge
mediated land cover change
Thin understory in all categories
Remember: Understory thinning only for shrubs. Leave trees
6. Understory thinning (tree competition, fire)
5. Understory thinning (tree competition, fire)
4. Understory thinning (tree competition, fire)
3. Understory thinning (tree competition, fire)
Pine Forest High Density With understory
Pine Forest Low Density With understory
Pine Forest High Density No understory
Pine Forest Low Density No understory
Mixed High Density With understory
Mixed Low Density With understory
Mixed High Density No understory
Mixed Low Density No understory
Oak Forest High Density With understory
Oak Forest Low Density With understory
Oak Forest High Density No understory
Oak Forest Low Density No understory
Chestnut Forest High Density With understory
Chestnut Forest Low Density With understory
Chestnut Forest High Density No understory
Chestnut Forest Low Density No understory
Succession 20 years?
Succession 20 years?
Succession 20 years?
Succession 20 years?
2. Pine afforestation (10 years?)
Burnt
Shrubland Low density
Shrubland Higfh density
1. Shrub thinning (access, fire risk)
Prairies would be maintained as they are, a preferred aesthetic
Grass
AFTER
BEFORE
WORST
ACCEPTABLE
GOOD
BEST

Global ABM

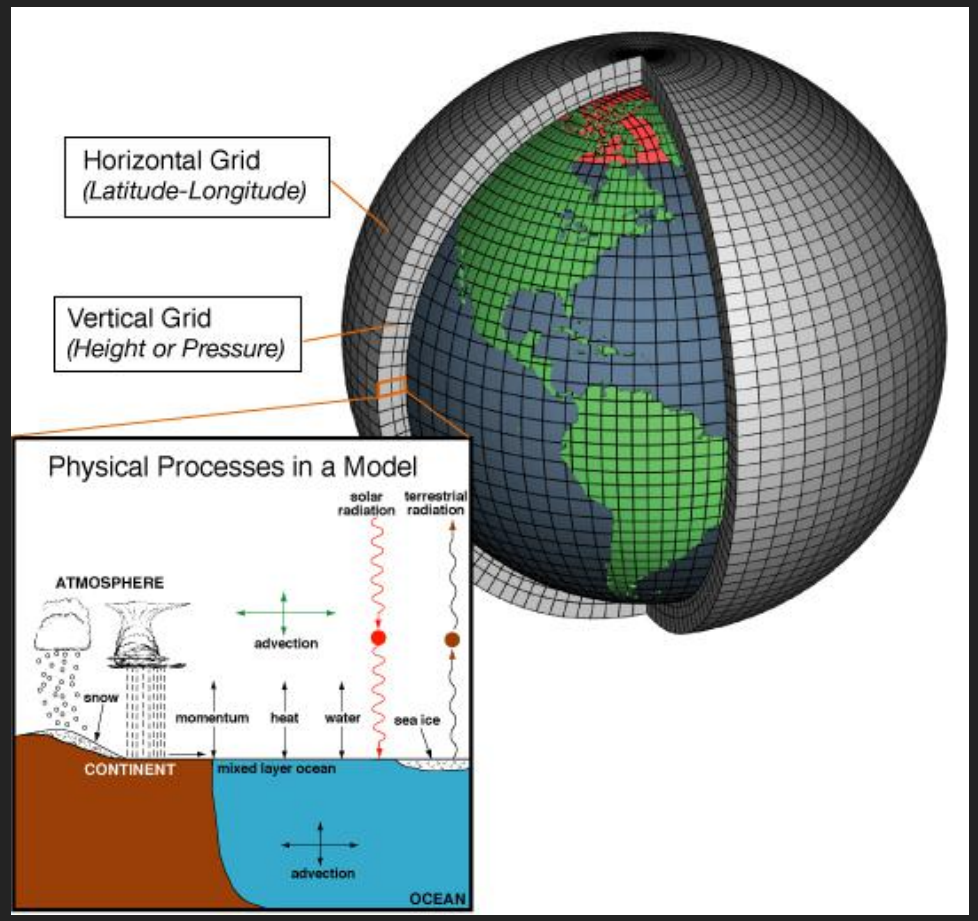
Agents on a 0.5° Grid → Multi-agent interactions?

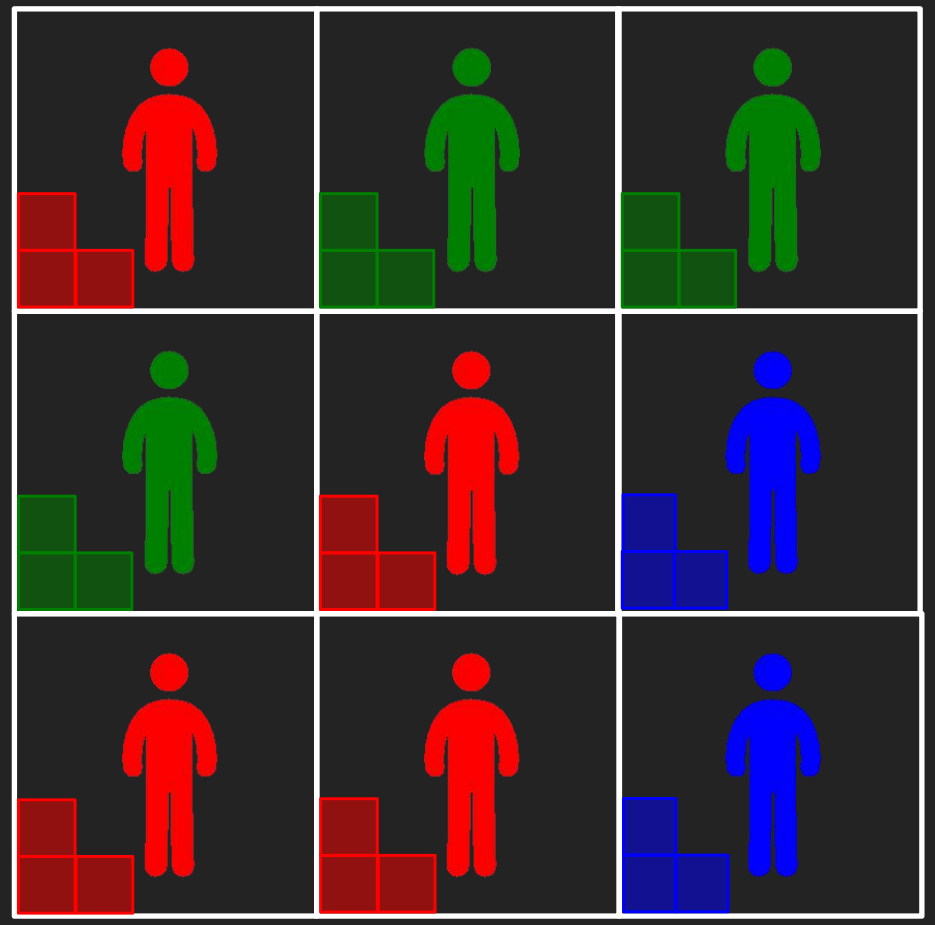




Global ABM

Agents on a 0.5° Grid ⟶ Single Agents?





What could ABM do for you?

James Millington
King's College London
james.millington@kcl.ac.uk