# Uses of Agent-Based Models in the Framework of Biodiversity Conservation

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**Mission Biodiversity: Choosing new paths for conservation**

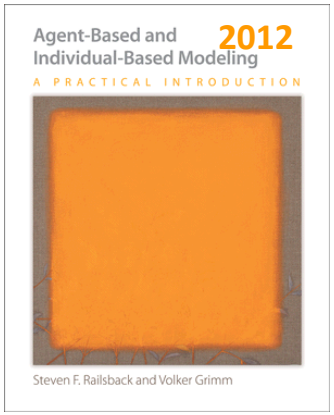
# IBM versus ABM

- **IBM** and **ABM** both base on a modeling paradigm which simulates the global characteristics of a dynamic system on the basis of interacting systems' components (*agents* or *individuals*). In both cases these basic entities can be equipped with a large number of variables describing their states and with a set of rules describing how these variables are updated.
  - **"IBMs** are simulations based on the global consequences of local interactions of members of a population" *Craig Reynolds*
  - "**ABM** begins with assumptions about agents and their interactions and then uses computer simulation to reveal the dynamic consequences of these assumptions" *Leigh Tesfatsion*

- **IBM**: individuals represent animals
  => Behavioral Ecology
  - Duriez et al., 2009
    What decision rules might pink-footed geese use to depart on migration?
    An individual-based model
  - Mosser et al., 2015
    Landscape heterogeneity and behavioral traits drive the evolution of lion group territoriality
    => a spatially explicit, agent-based simulation model

- **ABM**: agents represent human stakeholders (humans), social groupings
  => Environmental assessment and management

- **IBM** and **ABM**, more and more used synonymously,
  are suitable tools to test decision rules under various scenarios

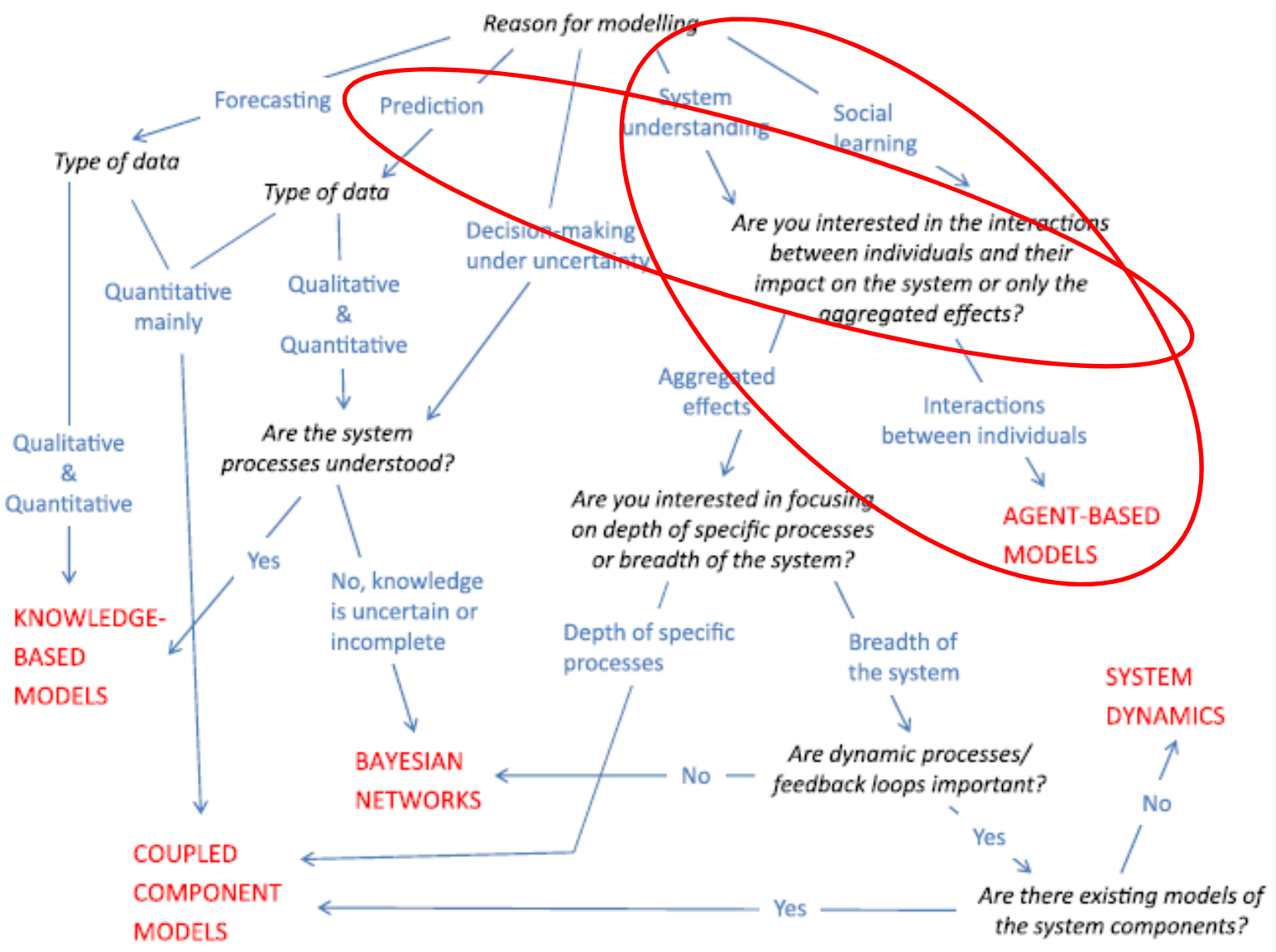


# Common modelling approaches for integrated environmental assessment and management

- **Systems dynamics**
  stocks and flows
- **Bayesian networks**
  probabilistic relationships among system variables
- **Coupled component models**
  nodes represent detailed component models (biophysical, economic, social), while links correspond to data passing between models
- **Agent-based models**
  interactions between autonomous decision-making entities representing most often humans
- **Knowledge-based models** (also referred to as **expert systems**)
  knowledge is encoded into a knowledge base and then an inference engine uses logic to infer conclusions

Kelly R.A., Jakeman A.J., Barreteau O., Borsuk M.E., ElSawah S., Hamilton S.H., Henriksen H.J., Kuikka S., Maier H.R., Rizzoli A.E., van Delden H. 2013. Selecting among five common modelling approaches for integrated environmental assessment and management. *Environmental Modelling & Software* 47: 159-181

# Decision tree for selecting the most appropriate integrated modelling approach



# Species conservation based on the simulation of population dynamics in a changing heterogeneous environment

- Topping et al. (2003)
  ALMaSS (*Animal Landscape and Man Simulation System*)
  A generic agent-based model for animals in temperate European landscapes.

- Carter N., Levin S., Barlow A., Grimm V. (2015).
  Modeling tiger population and territory dynamics using an agent-based approach. *Ecological Modelling* 312: 347-362.

- Tambe M., Yadav A., Lyet A. (this session)
  PAWS (*Protection Assistant for Wildlife Security*):
  Randomized Patrols for Wildlife Security
  A decision-support tool for security resource optimization
  (Green Security Game)

# Species conservation based on population dynamics and the simulation of harvesting decisions or disturbances

- Bishop I.D., Gimblett H.R. 2000. Management of recreational areas: GIS, autonomous agents, and virtual reality. *Environment and Planning B: Planning and Design* 27 (3): 423-435.

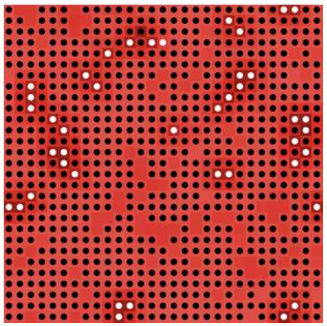
- Le Page C., Bobo K.S., Kamgaing T.O., Ngahane B.F., Waltert M. (this session) Participatory agent-based simulation to foster dialogue and build trust between local communities and researchers: a case study on bushmeat hunting in the periphery of Korup National Park (South-West Cameroon) [http://jasss.soc.surrey.ac.uk/18/1/8.html]

# The issue of conservation through the interactions between ecological and social dynamics (Simulating areas of biodiversity)

- Li An, Guangming He, Zai Liang, Jianguo Liu (2006). Impacts of demographic and socioeconomic factors on spatio-temporal dynamics of panda habitat. Biodiversity and Conservation 15 (8): 2343-2363.

- Mathevet R., Poulin B., Lefebvre G. (this session)
  Wetland social-ecological dynamics, biodiversity conservation and dialogue process: lessons-learned from the ButorStar computer-based role-playing game

# Teaching different aspects of biodiversity conservation : learning about theoretical and practical aspects of biodiversity with “virtual labs”



- Novak M., Wilensky U. 2006. NetLogo Daisyworld model. http://ccl.northwestern.edu/netlogo/models/Daisyworld. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL
- Jones T., Laughlin T. 2009. Learning to measure biodiversity: 2 agent-based models that simulate sampling methods & provide data for calculating diversity indices. *American Biology Teacher* 71 (7): 406-410.
- Etienne M. (this session). Teaching biodiversity conservation through companion modelling: an original way to tackle social and ecological dynamics
- García-Barrios L., Perfecto I., Vandermeer J., Speelman E., Garcia C. (this session). AZTECA CHESS and AGRODIVERSITY: Educational Tools to Explore the Emergence of Functional Biodiversity in Agroecosystems
- Becu N., Frascaria N., Latune J. (this session). NEWDISTRICT training tool: A distributed simulation to integrate biodiversity issues in periurban development projects

# Companion modelling to improve social learning and participation of stakeholders (thinking collectively about areas of biodiversity)

- Briot J.-P., Guyot P., Irving M. (2007). Participatory simulation for collective management of protected areas for biodiversity conservation and social inclusion. *AIS-CMS*, 7, 183–188.
- Perrotton A. (this session). Tackling issues of coexistence between protected areas and communal lands: From a Role Playing Game to an Agent-Based Model
- Bommel P., Bonnet M.-P., Coudel E., Haentjens E., Nunes Kraus C., Laques A.E., Melo G., Nasuti S., de Souza Nogueira I. (this session). From scientific models to Companion Modelling: engaging a dialogue with local actors in an Amazonian floodplain about biodiversity management at a territorial level