PHD 2018-2021

Regeneration in uneven-aged forests: Detecting risks of abrupt community changes and adaptation of forest management to global change.

PhD supervisor: Benoit COURBAUD (Irstea - LESSEM)
PhD co-supervisor: Philippe BALANDIER (Irstea - EFNO)

Localisation:
Irstea Grenoble – UR LESSEM – Team Dynamics
Adress: 2 rue de la Papeterie, BP 76, 38402 Saint-Martin-d'Hères
Tel: 04 76 76 27 62 email : benoit.courbaud@irstea.fr

Doctoral school: EDCSV, Univ. Grenoble Alpes

Abstract:
Regeneration is a key process of forest dynamics especially difficult to pilot for a forest manager. Climate change increases the risk of an abrupt shift of seedling species composition or a blocking by understory vegetation due to the intensification of competition for resources. The objective of this thesis is to answer three key questions: how can we estimate whether the quantity of seedlings and saplings observed on the field at a given time is enough to renew an uneven-aged forest stand? What are the risks of abrupt composition change under climate change? How can we adapt forest regeneration management under climate change in uneven-aged stands? We will study these questions in two contrasted ecosystems: spruce-fir-beech mountain forests and oak-beech low-land forests. We will use field observations on forest sampling plots and the Approximate Bayesian Computation (ABC) method to calibrate a model of forest regeneration (tree fecundity, sapling growth and survival, competition with understory vegetation). This model will be used to analyze differences of strategies among tree species and estimate the effects of tree canopy, climate, understorey vegetation and soils conditions on regeneration demographic processes and regeneration fluxes. The simulation models Samsara (Individual based model of forest dynamics) and RReShar (model of regeneration and competition with understory vegetation) developed on the platform Capsis will be coupled and improved. Simulation experiments will then be conducted in order to identify the risk of abrupt changes of regeneration density and species composition because of climate change and competition with understory vegetation. We will then test a concept of "flexible management" making possible to adapt harvest type and intensity to disturbance and climate change.

Tools and methods:
Bibliography: sapling ecology, ecological regime shifts, demographic process modelling, estimation methods, experiment design, forest management strategies …
Filed measures: Regeneration measures on sampling plots along gradients of environment, and forest structure and management conditions.
Model calibration: Regeneration model calibration with Bayesian/ABC approaches.
Simulation model development: Coupling and improving Samsara2 and RReShar simulation models on the development platform Capsis.
Simulation experiments: Designing, performing and analyzing simulation experiments.
Publication: International journals in Ecology / Forestry / Modelling

Relevant competencies:
Forestry / Ecology / Statistics / Modelling / Programming / Numerical experiments / Science writing / Team-work / Curiosity / Creativity / Persistence / Rigor

References:

Balandier, P., Marquier, A., Casella, E., Kiewitt, A., Coll, L., Wehrlen, L. & Harmer, R. (2013). Architecture, cover and light interception by bramble (Rubus fruticosus): a common understorey weed in temperate forests. *Forestry* 86(1): 39-46.

Courbaud, B., Lafond, V., Lagarrigues, G., Vieilledent, G., Cordonnier, T., Jabot, F. & De Coligny, F. (2015). Applying ecological model evaludation: lessons learned with the forest dynamics model Samsara2. *Ecological Modelling* 314: 1-14.

Courbaud, B., Sardin, T., De Coligny, F., Cordonnier, T., Deleuze, C., François, D., Riond, C., Lafond, V. & Lagarrigues, G. (2016). Utilisation du modèle individu-centré Samsara2 pour analyser les sylvicultures en peuplement irrégulier. *Rendez-Vous Techniques de l'ONF* 53: 11-23.

Gaudio, N., Balandier, P., Perret, S. & Ginisty, C. (2011). Growth of understorey Scots pine (Pinus sylvestris L.) saplings in response to light in mixed temperate forest. *Forestry* 84(2): 187-195.

Gaudio, N., Gendre, X., Saudreau, M., Seigner, V. & Balandier, P. (2017). Impact of tree canopy on thermal and radiative microclimates in a mixed temperate forest: A new statistical method to analyse hourly temporal dynamics. *Agricultural and Forest Meteorology* 237: 71-79.

Lafond, V., Cordonnier, T., Mao, Z. & Courbaud, B. (2017). Trade-offs and synergies between ecosystem services in uneven-aged mountain forests: evidences using Pareto fronts. *European journal of Forest Research* 0: 1-16.

Laurent, L., Marell, A., Balandier, P., Holveck, H. & Said, S. (2017). Understory vegetation dynamics and tree regeneration as affected by deer herbivory in temperate hardwood forests. *Iforest-Biogeosciences and Forestry* 10: 837-844.

Perot, T., Marell, A., Korboulewsky, N., Seigner, V. & Balandier, P. (2017). Modeling and predicting solar radiation transmittance in mixed forests at a within-stand scale from tree species basal area. *Forest Ecology and Management* 390: 127-136.

Lagarrigues, G., Jabot, F. & Courbaud, B. (2014). Approximate Bayesian Computation to recalibrate individual-based models with population data: illustration with a forest simulation model. *Ecological Modelling* 306: 278-286.

Ligot, G., Balandier, P., Fayolle, A., Lejeune, P. & Claessens, H. (2013). Height competition between Quercus petraea and Fagus sylvatica natural regeneration in mixed and uneven-aged stands. *Forest Ecology and Management* 304: 391-398.

Simulation platform Capsis : http://capsis.cirad.fr/capsis/presentation