

Large-scale forest simulations for the prediction of bird diversity in Central Europe

GreenFutureForest - BiodivERsA - EU Horizon 2020

Astor Toraño Caicoya, Norman Blanco, Pedro Leitão, Tord Snäll,
Hans Pretzsch

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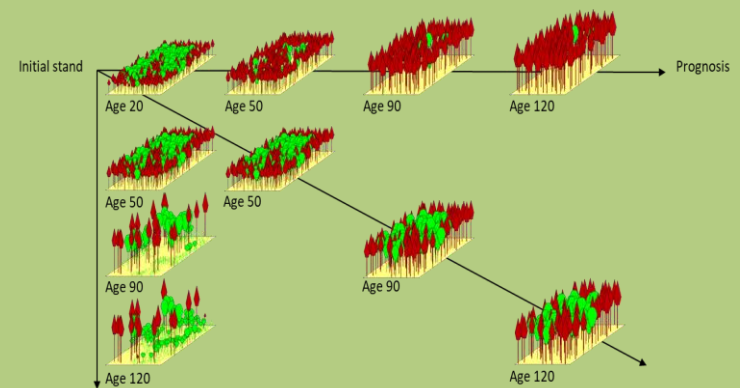
IUFRO World Congress – Curitiba

GreenFutureForest, Objectives

- Development of forest scenarios under the future global demand of wood products.
- Link between forest structures and biodiversity indicators
- Trade-off analysis

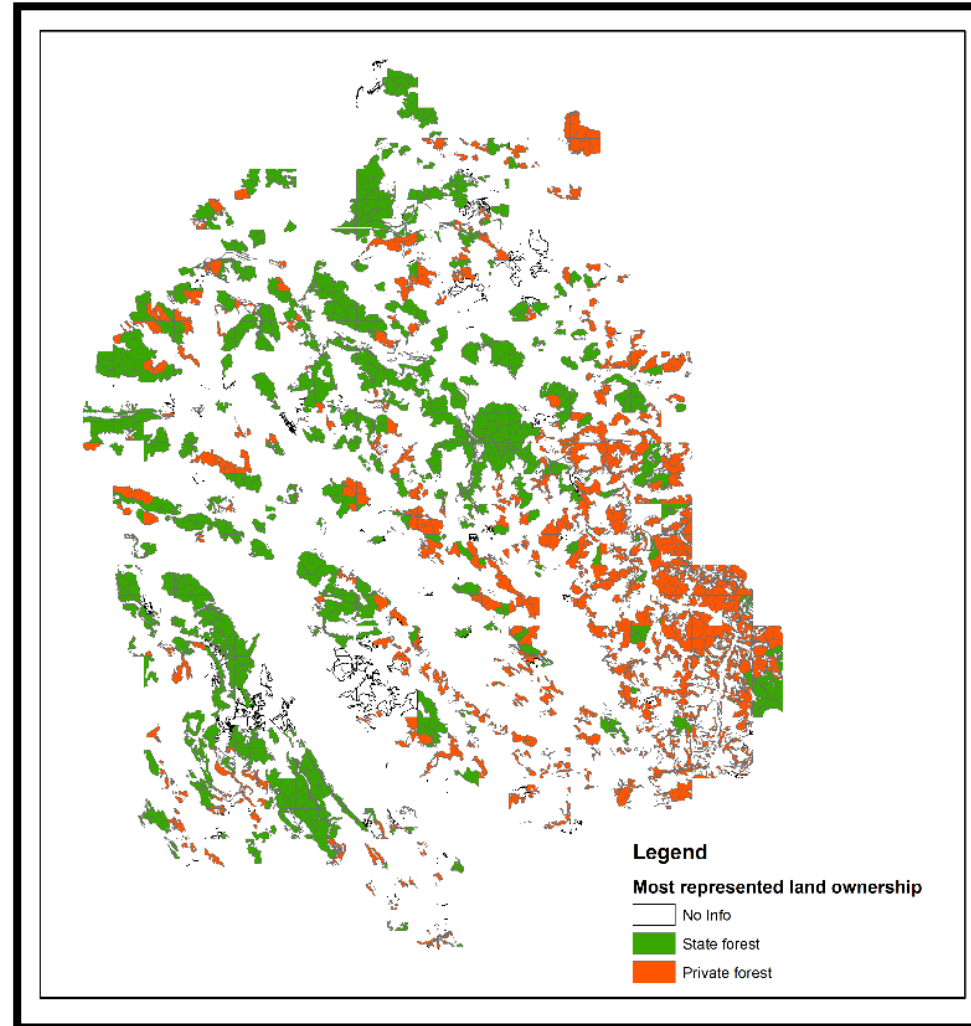
- Involvement of stakeholders: what do people want?

- Modelling horizon: 100 years
 - Climate change
 - Socio-economics situation





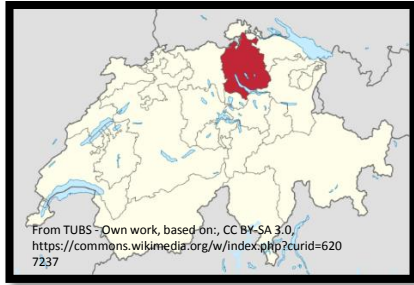
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<https://commons.wikimedia.org/w/index.php?curid=6207237>



	ha	%
Total area	172875	100
Forested forest	50000	29
State forest	26500	53
Private forest	23500	47

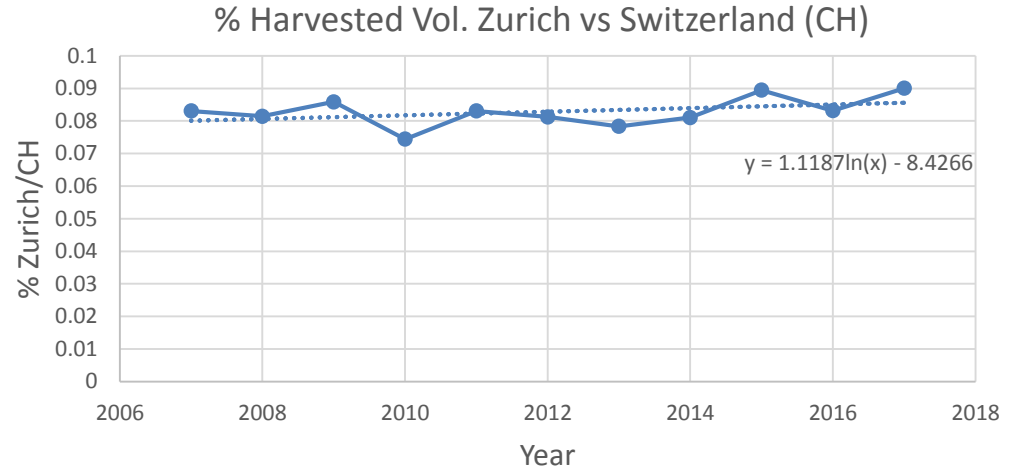
Schmider, P., et al, 1994: Die Waldstandorte im Kanton Zürich, vdf Hochschulverlag, Gesellschaft-Nr. nach Ellenberg und Klötzli. 287 pages.

GLOBIOM National Wood demand Downscaling

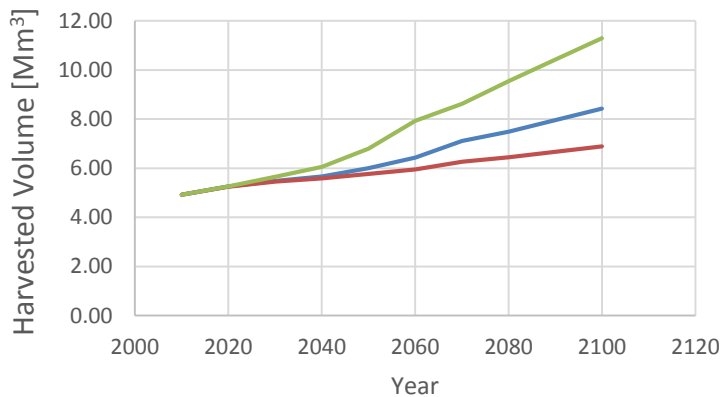


3 Socio-economic Pathways:

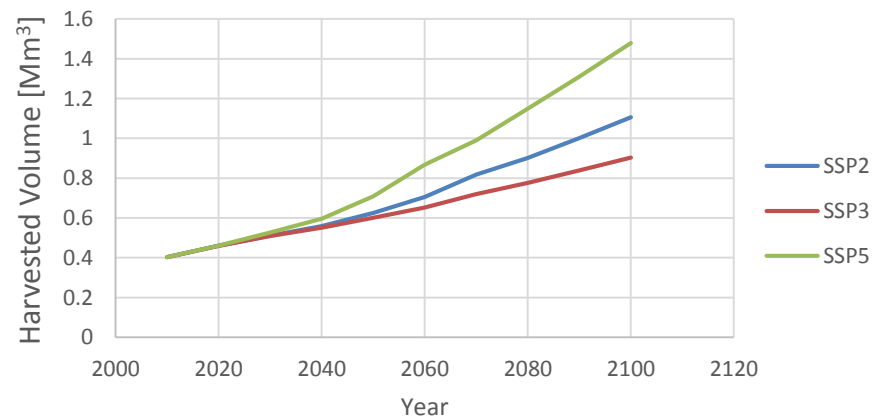
- SSP2: Middle of the road
- SSP3: Regional rivalry
- SSP5: Fossil fuel development



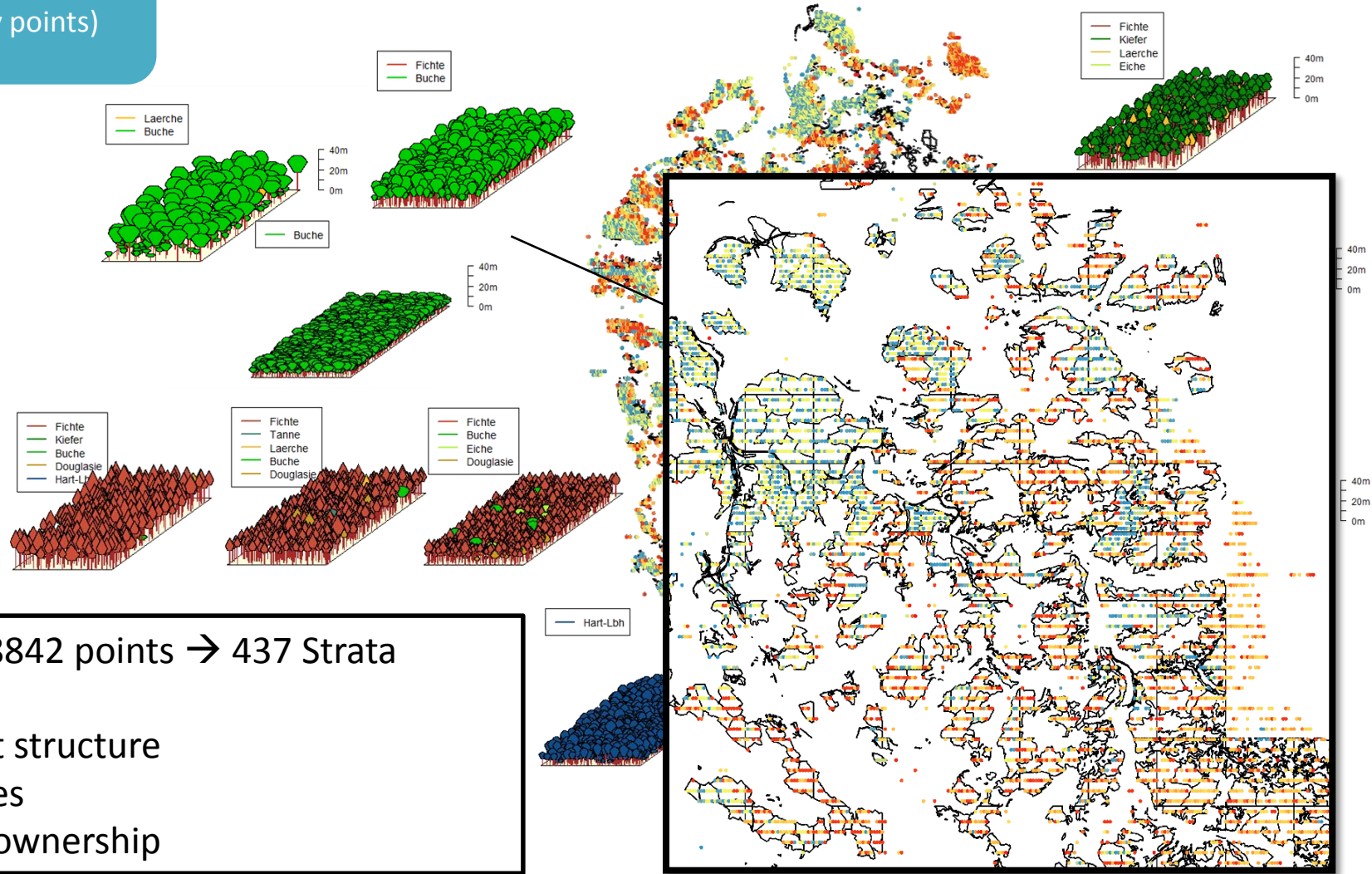
Wood Demand in Switzerland



Wood Demand in the Canton of Zurich



Stratification
(Inventory points)

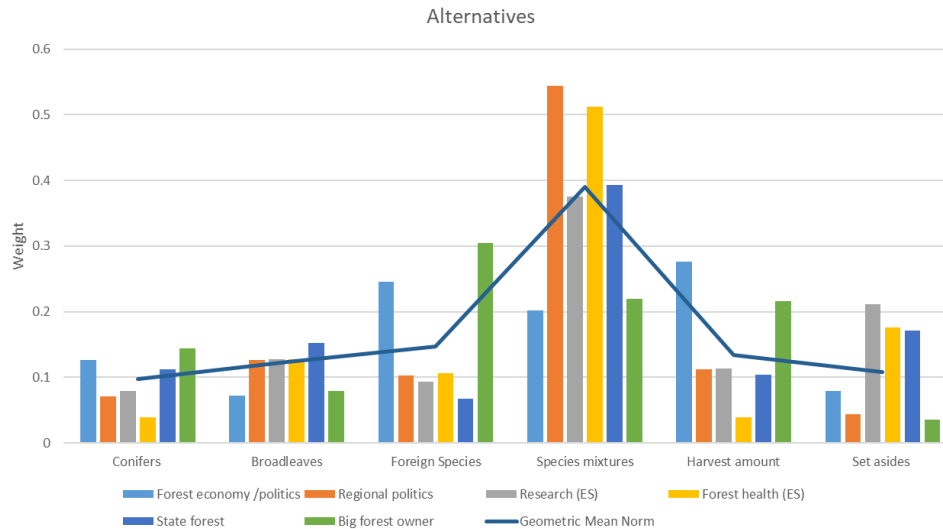


28842 points → 437 Strata

Criteria:

- Forest structure
- Species
- Land ownership

Stakeholders Survey (AHP-analysis)



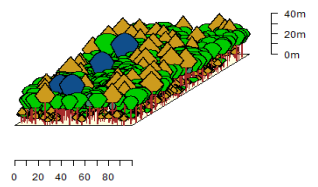
- **Production** oriented (intensive-use)
 - Short Rotation and conifer promotion
 - Small products, low target diameter felling
- **Multifunctionality** enhancement (multi-use)
 - Promotion of broadleaves
 - Permanent cover forestry
- **Business as Usual** variations:
 - State forest management concepts

- **Conversion** and introduction of Douglas fir
 - Future tree concept
 - Intensive plantation of Douglas fir and Norway spruce
 - Slight final harvest delay
- **Delay of harvest**, intensivation
 - Too much standing volume
 - Delay final harvest
 - Intensify

- **Habitat Tree Scenario:**
 - **Multifunctional** but
 - Enhancement of large trees
 - Especial promotion of soft broadleaves and oak sp.
 - Selective thinning
- **Set-asides:**
 - Natural mortality

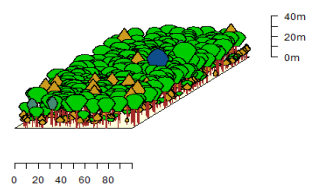
After 100 years

- Fir
- Beech
- Douglas fir
- Hard-BrdLv



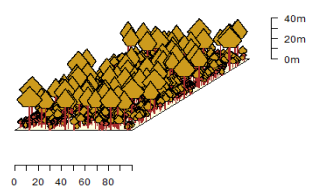
Habitat Tree

- Fir
- Beech
- Douglas fir
- Hard-BrdLv



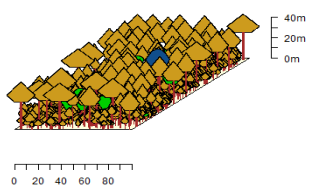
Multi-use

- Spruce
- Douglas fir



Intensive

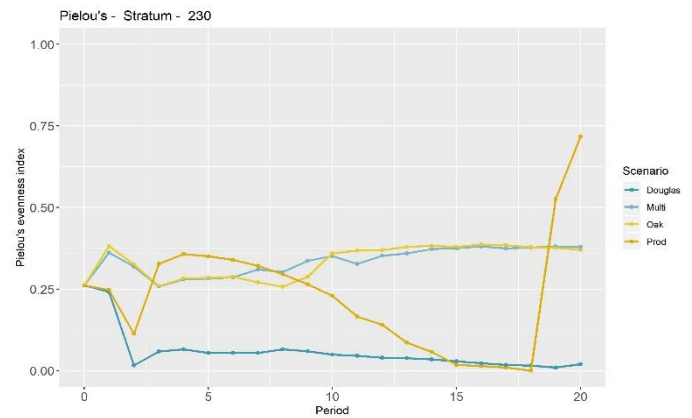
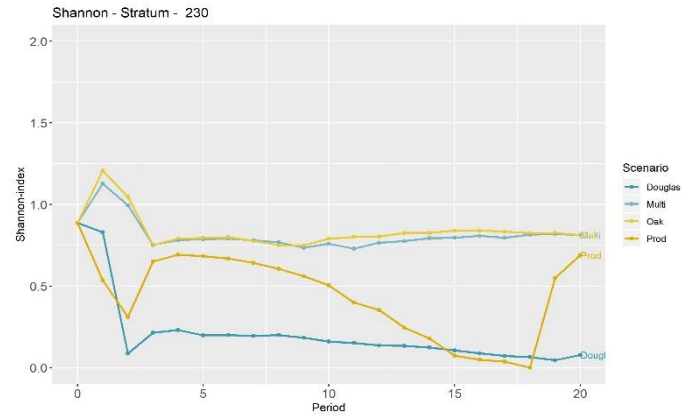
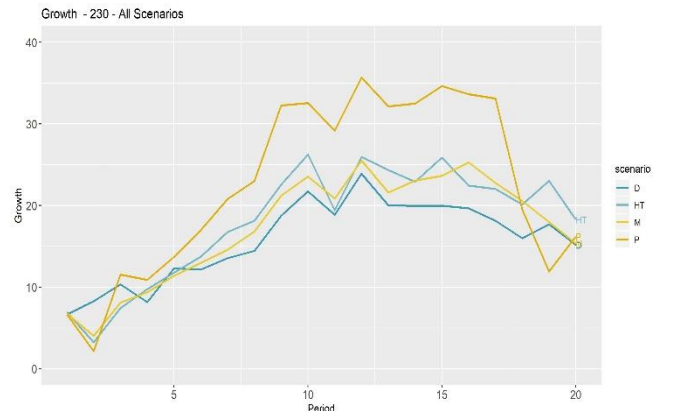
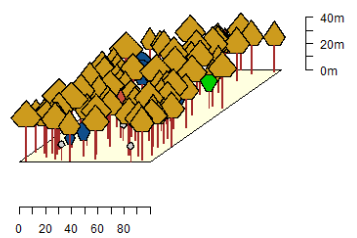
- Beech
- Douglas fir
- Hard-BrdLv
- Soft-BrdLv



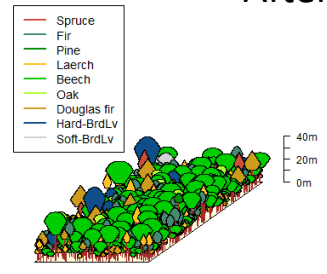
Conversion to Douglas/conifers

Present

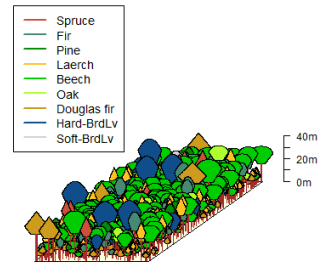
- Spruce
- Beech
- Douglas fir
- Hard-BrdLv
- Soft-BrdLv



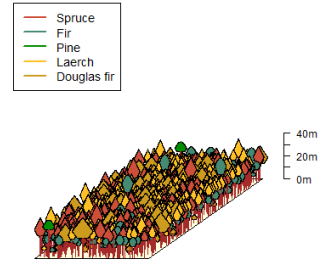
After 100 years



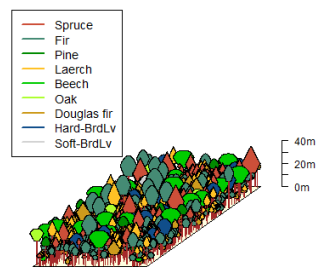
Habitat Tree



Multi-use

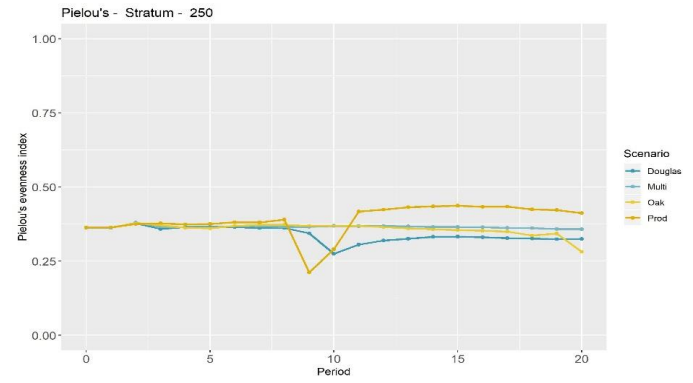
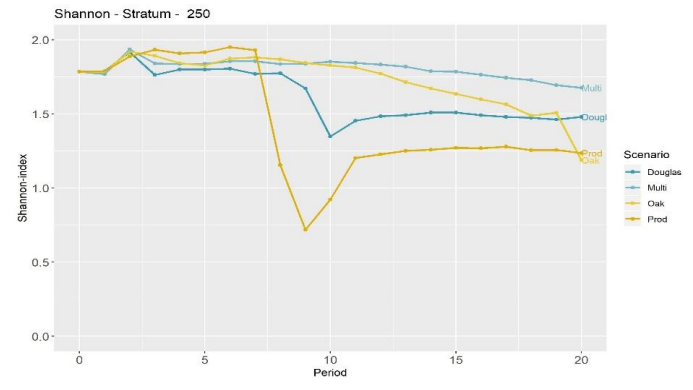
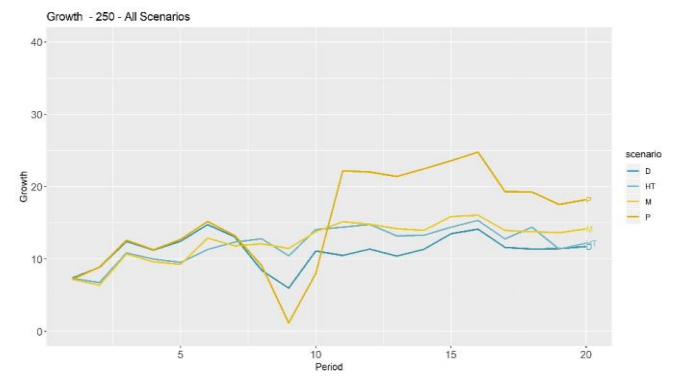
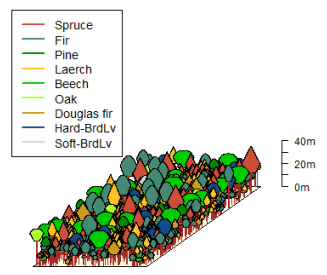
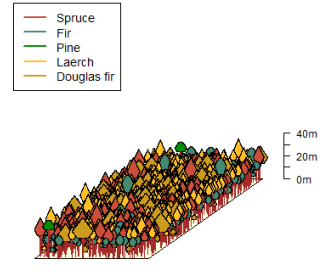
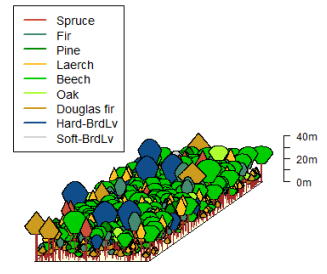
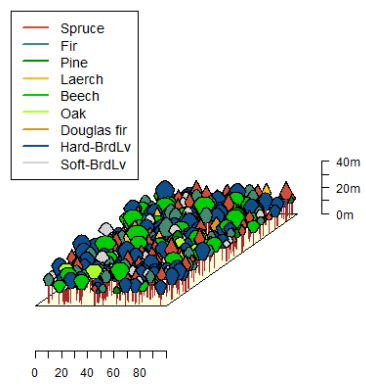


Intensive

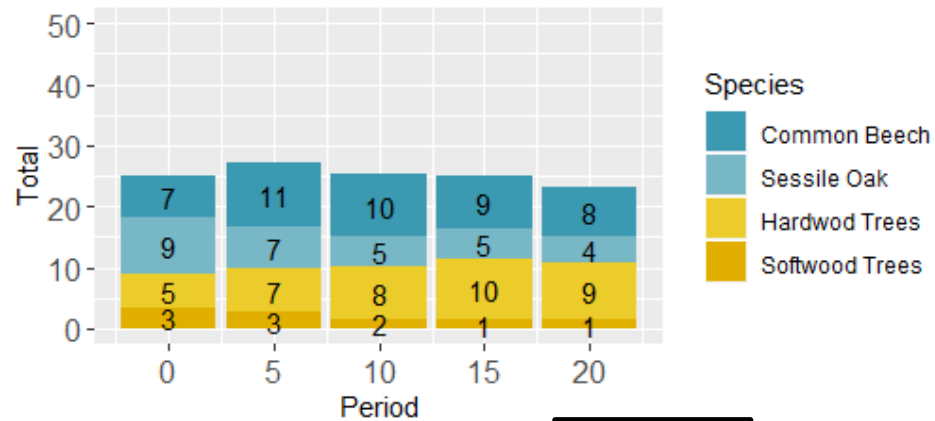


Conversion to Douglas/conifers

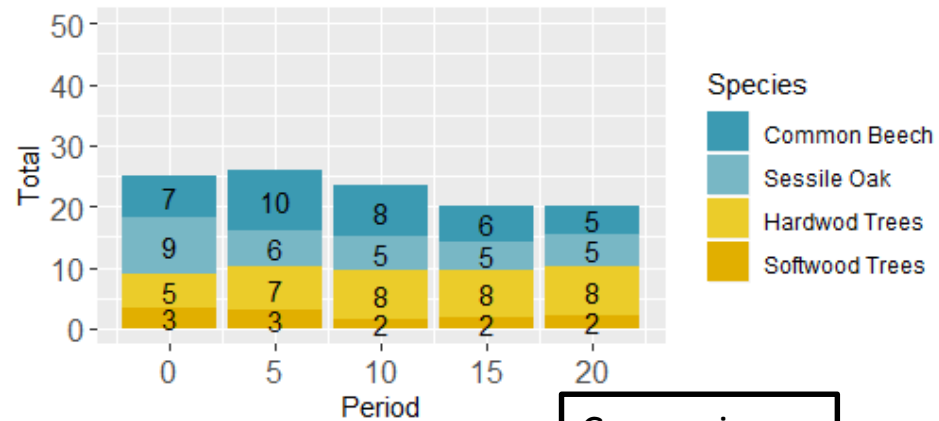
Present



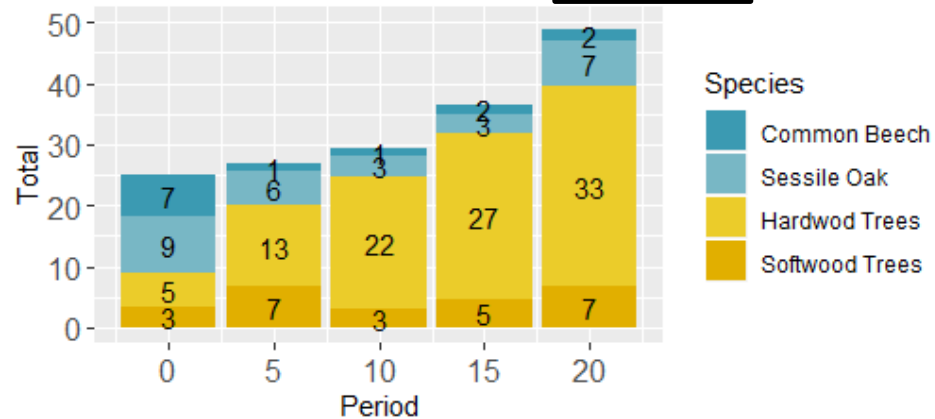
Number of Trees - Dbh >= **Habitat Tree**



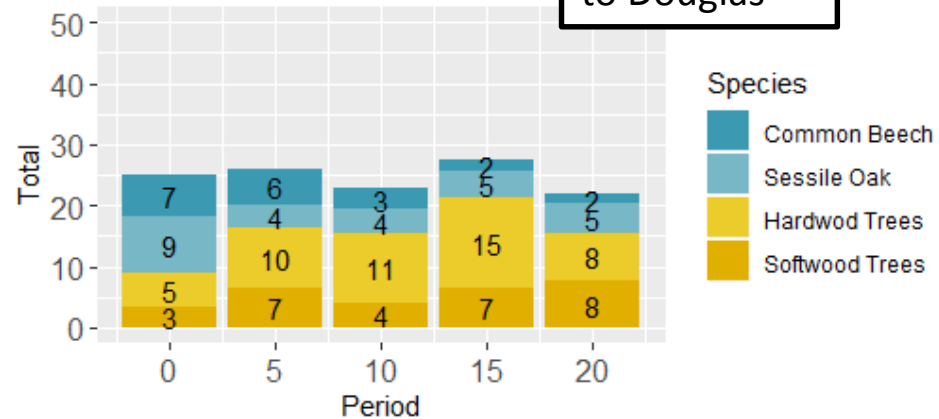
Number of Trees - Dbh >= 60 **Multi-use**



Number of Trees - Dbh >= 60 **Intensive**



Number of Trees - Dbh >= 60 **Conversion to Douglas**



Distance minimization of alternatives to a set of objectives

Objectives

- Maximize harvested volume AND
- Maximize tree diversity (Shannon index) after 100 years

Mahalanobis distance:

- Decisions-Distance for correlated variables

Constraints

- Private Land ownership
 - Only Maximization of harvested vol.

$$V_{harv_{str}} = \begin{pmatrix} V_{sc_1str_1} & \cdots & V_{sc_nstr_1} \\ \vdots & \ddots & \vdots \\ V_{sc_1str_n} & \cdots & V_{sc_nstr_n} \end{pmatrix}$$

$$Sh_{mean_{str}} = \begin{pmatrix} Sh_{sc_1str_1} & \cdots & Sh_{sc_nstr_1} \\ \vdots & \ddots & \vdots \\ Sh_{sc_1str_n} & \cdots & Sh_{sc_nstr_n} \end{pmatrix}$$

$$Obj_{str} = \begin{pmatrix} V_{harv_{str_1}} & Sh_{mean_{str_1}} & Sh_{stdv_{str_1}} \\ \vdots & \vdots & \vdots \\ V_{harv_{str_n}} & Sh_{mean_{str_n}} & Sh_{stdv_{str_n}} \end{pmatrix}$$

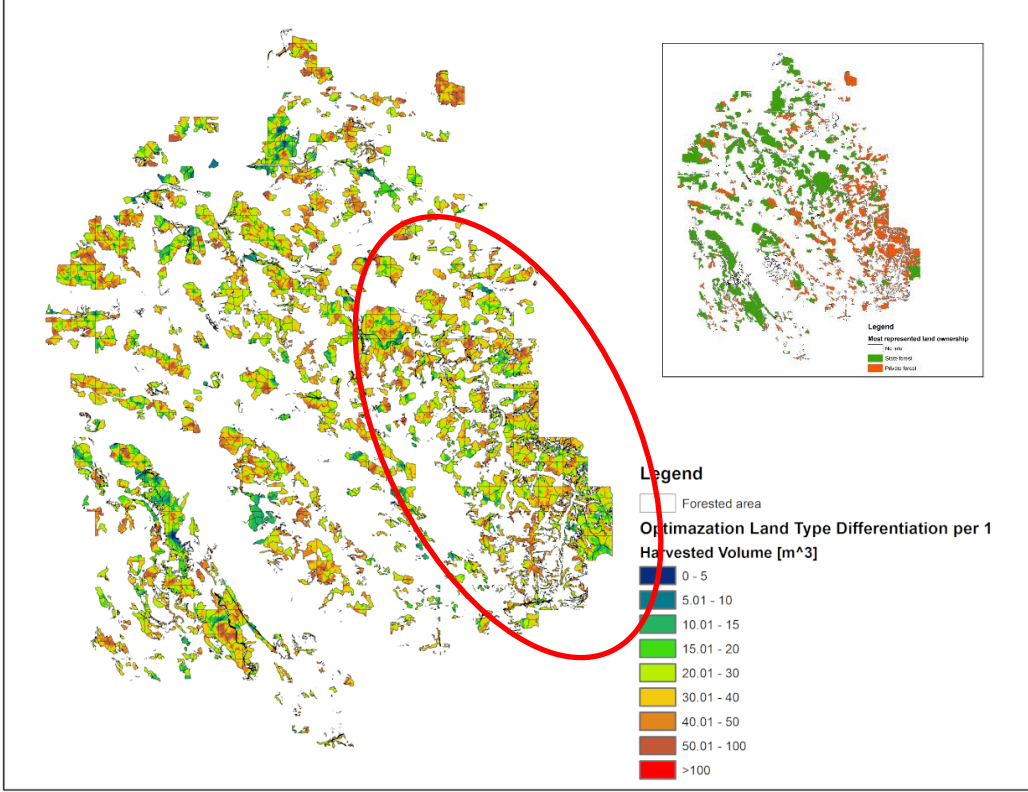
$$d_{str}(Mahalanobis) = [(x_b - Obj_{str})^T C^{-1} (x_b - Obj_{str})]^{1/2}$$

Optimization results

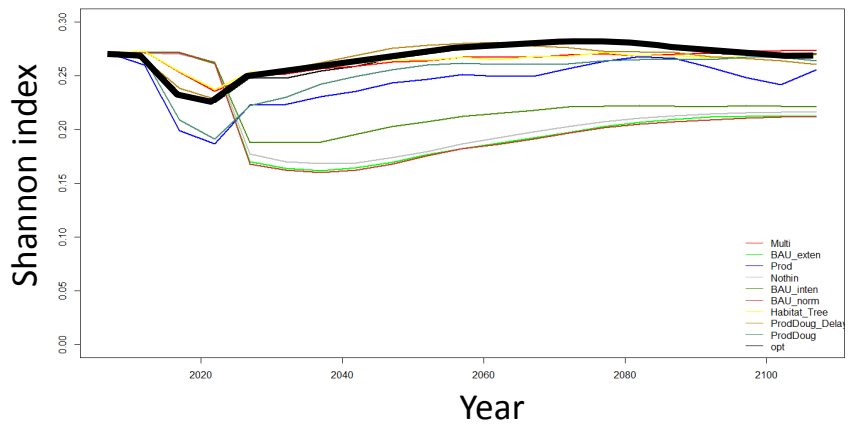
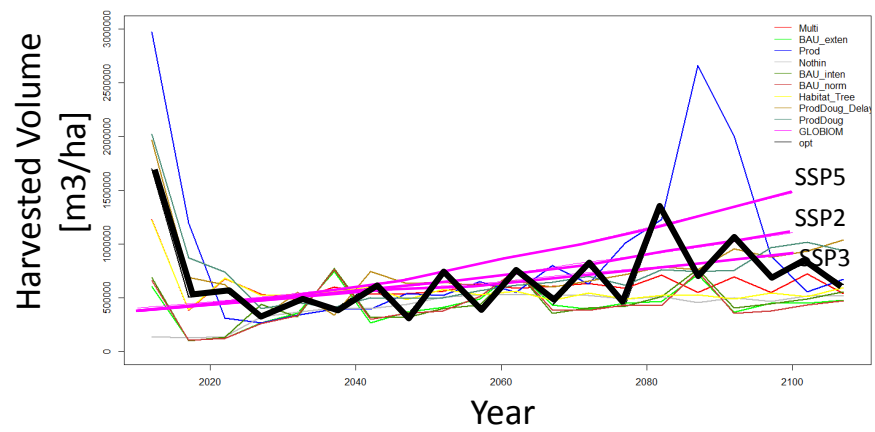
Landownership differentiation

BAU-inten	BAU-exten	BAU-norm	Prod	Multi
35	3	10	76	93
509034.8	466448.2	429091.0	1229433.0	710871.2

Habitat	Douglas	Long rotation	No-Mngmt
80	50	79	9
686256.4	788451.2	759911.6	508346.7



Land-type constrained-Div-Volume optimization

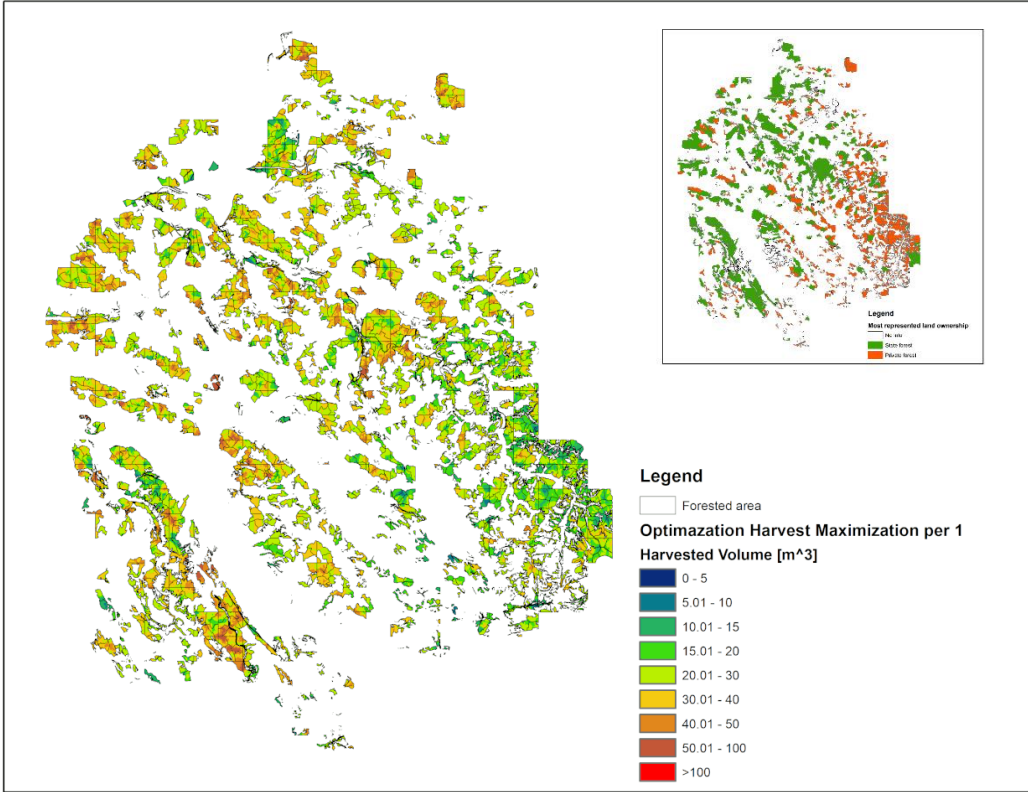


Optimization results

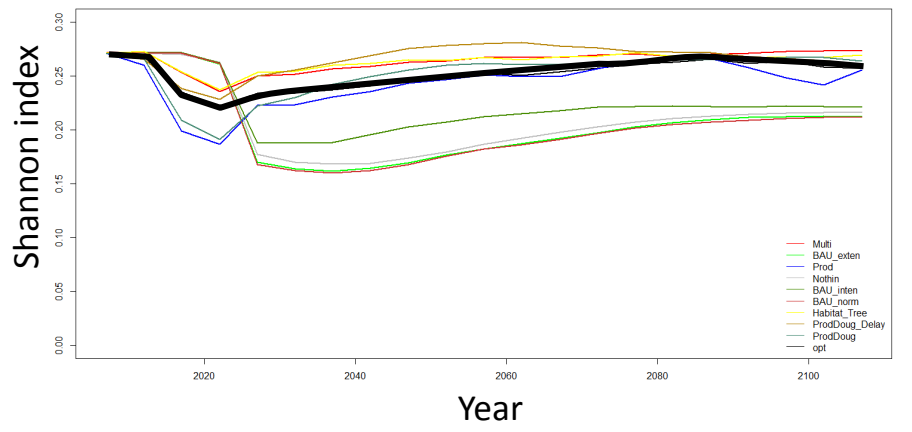
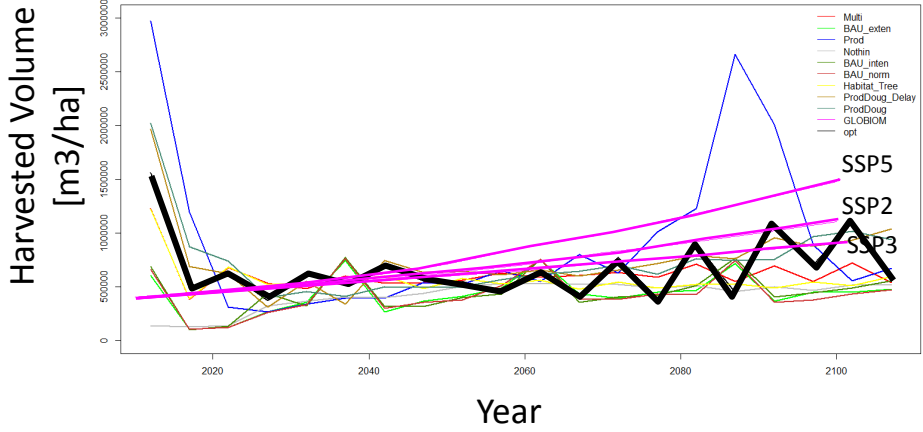
No Landownership differentiation

BAU-inten	BAU-exten	BAU-norm	Prod	Multi
17	8	13	56	97
405397.7	366708.3	356094.0	2003621.8	696077.0

Habitat	Douglas	Long rotation	No-Mngmt
67	79	82	19
733645.6	753940.1	954258.9	500506.4



Harvested volume maximization

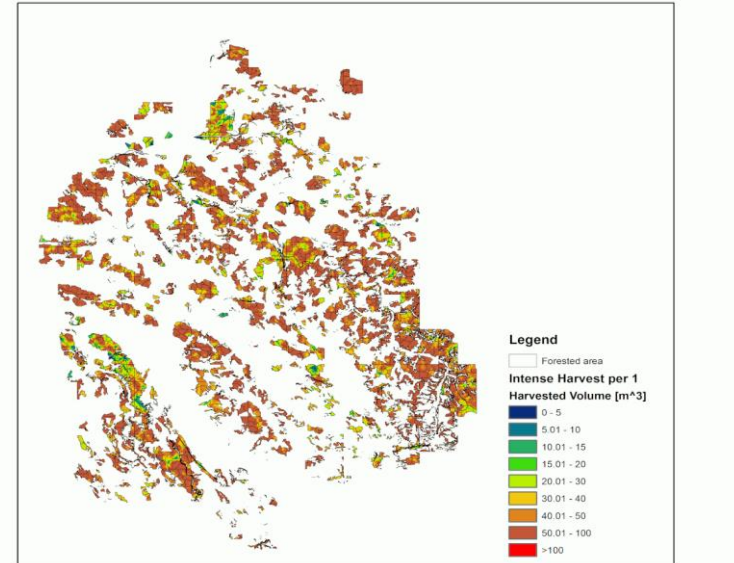
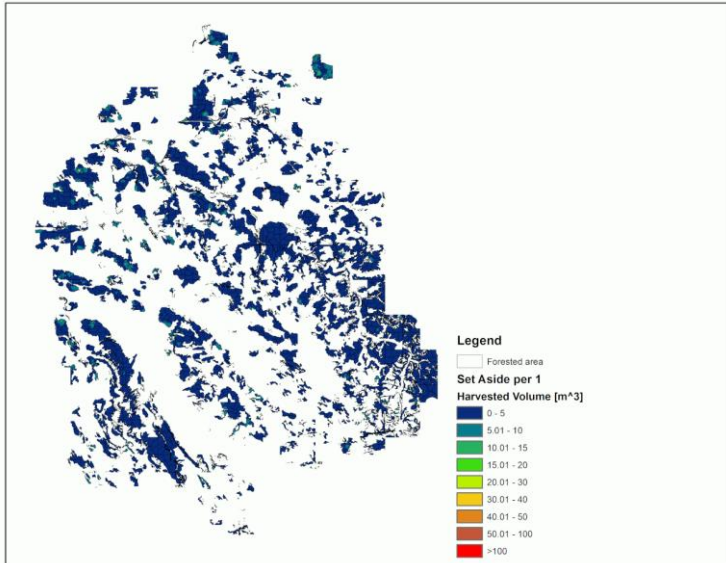
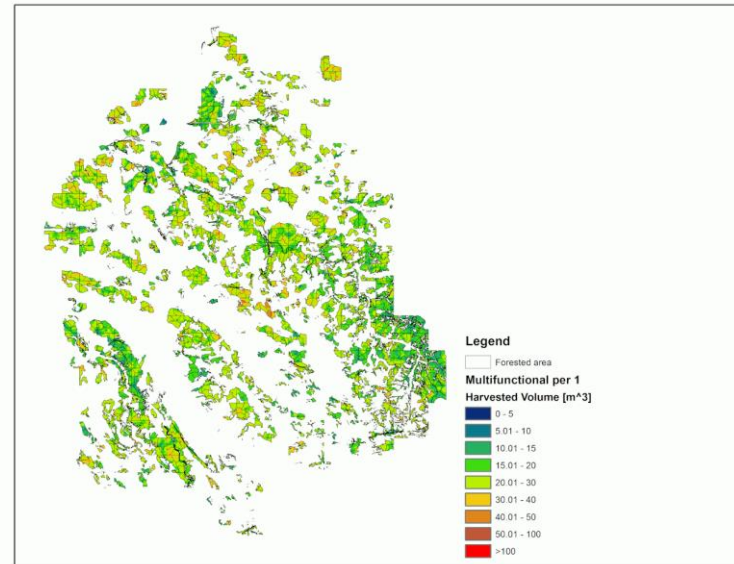
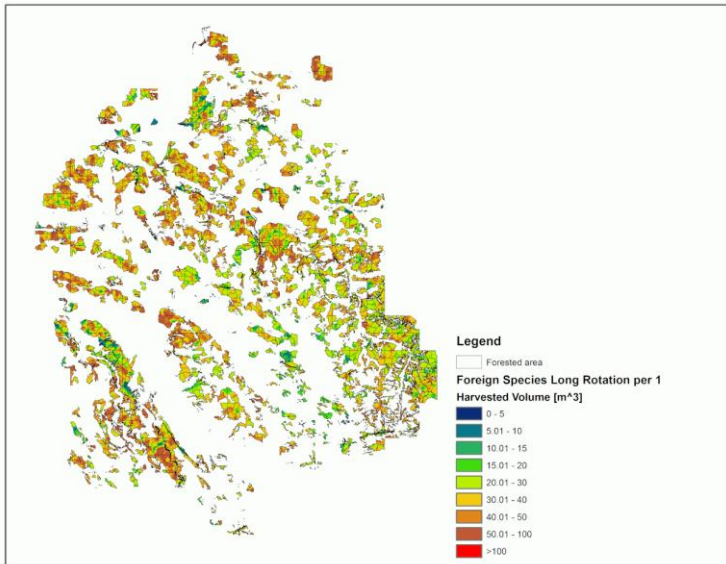


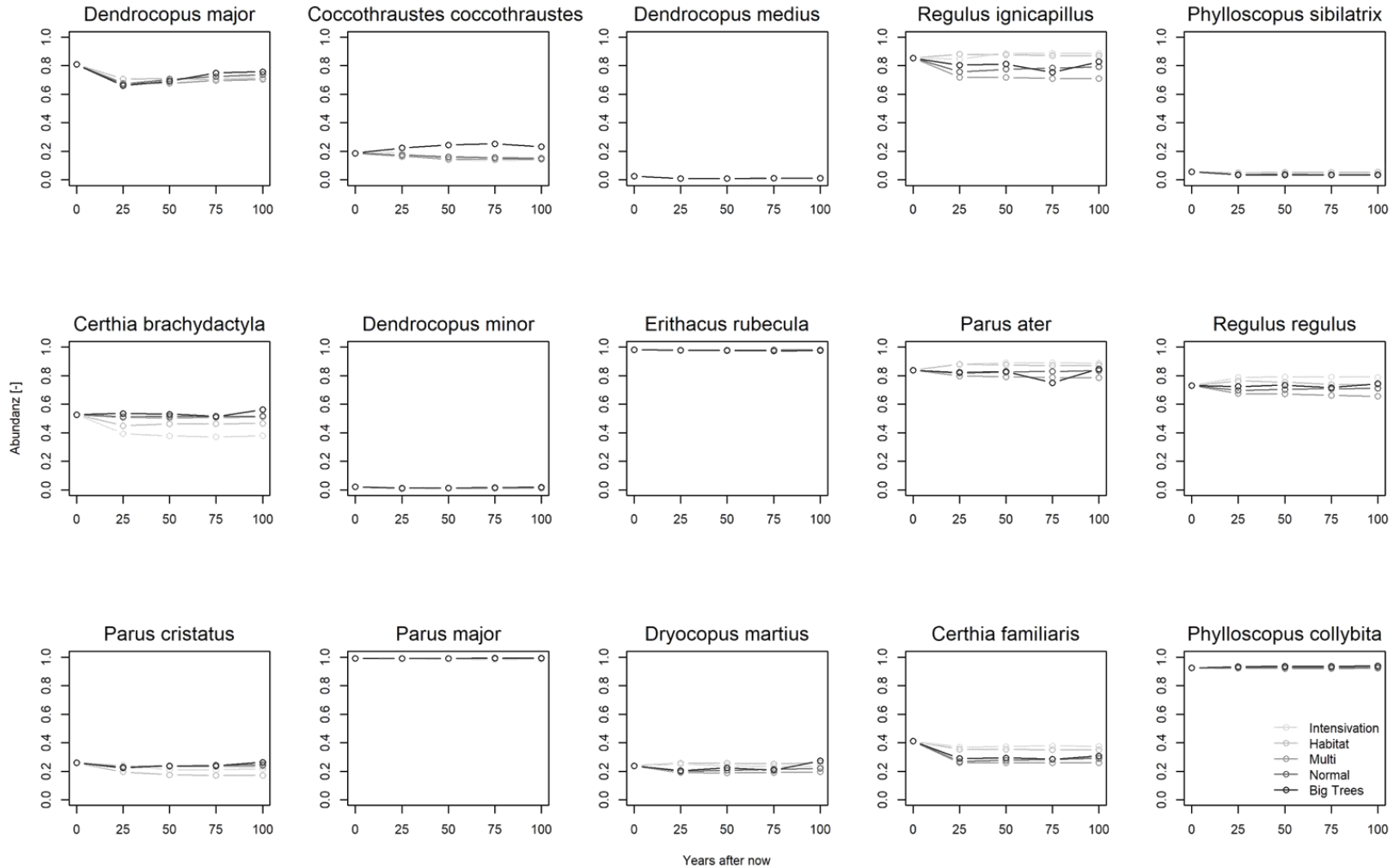
- Simulator SILVA is structure sensitive and can reproduce indicators for biodiversity
- Management scenarios have a high impact on the structure and thus on biodiversity
- Thanks to the simulator present challenges and trade-offs can be evaluated and weighted
- Structures can potentially be connected to biodiversity indicators
- Extension of modelling to the full landscape is possible



Thank you for your attention







- I. Development of silvicultural scenarios based on socio-economical conditions together with the future global demand of wood under different climate scenarios.
- II. Generation of forest structures using the Single Tree Simulator SIVA

