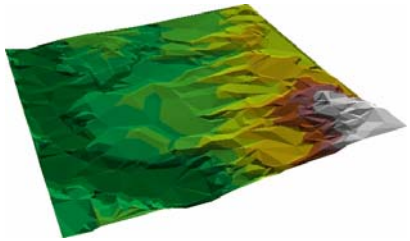

The HIBECO Model

Summary of final results

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Outline

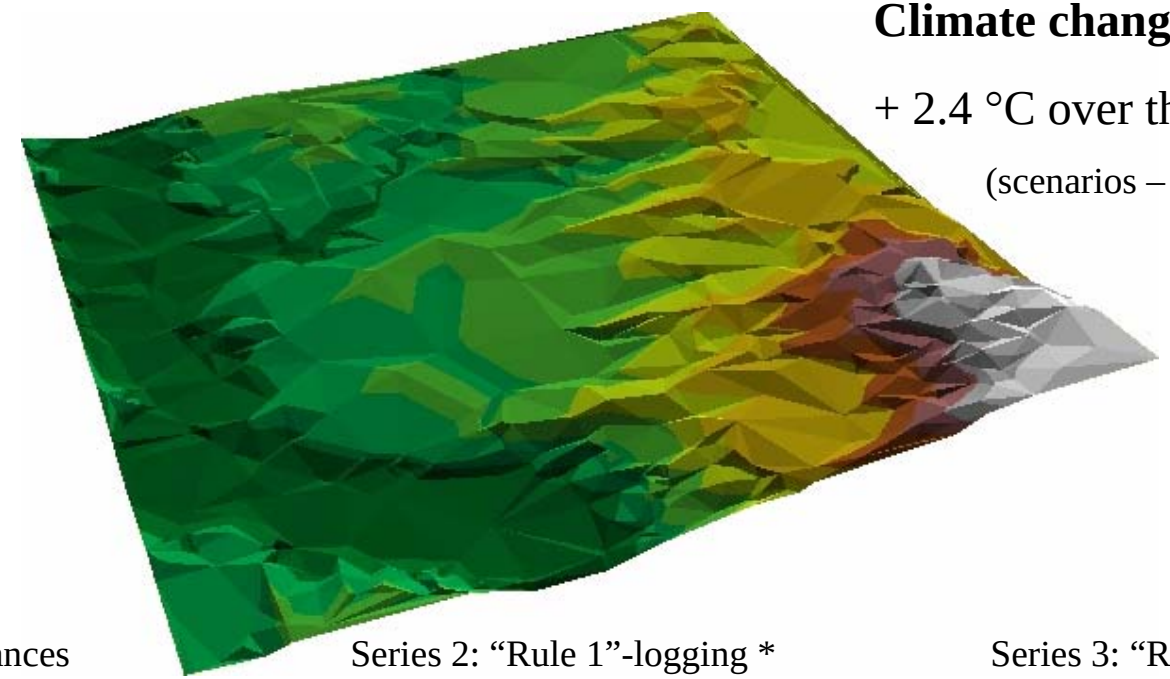
- Model description and simulation example
- Using model scenarios to explore various management policies and their consequences

Model description and simulation example

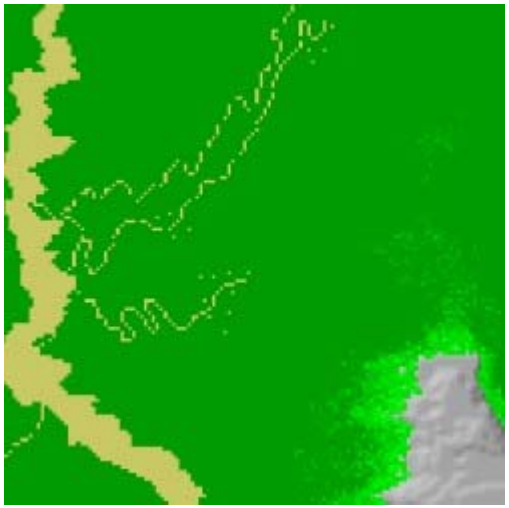
Climate change scenarios:

+ 2.4 °C over the next 120 years

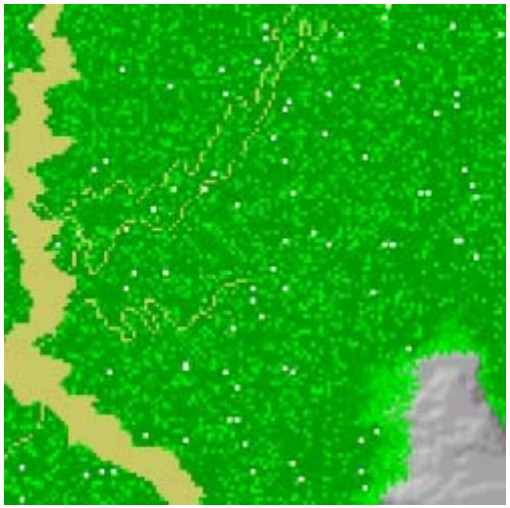
(scenarios – not prognoses!)



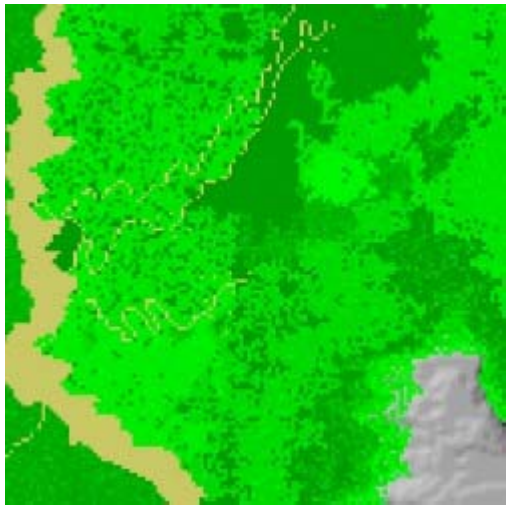
Series 1: No disturbances



Series 2: “Rule 1”-logging *

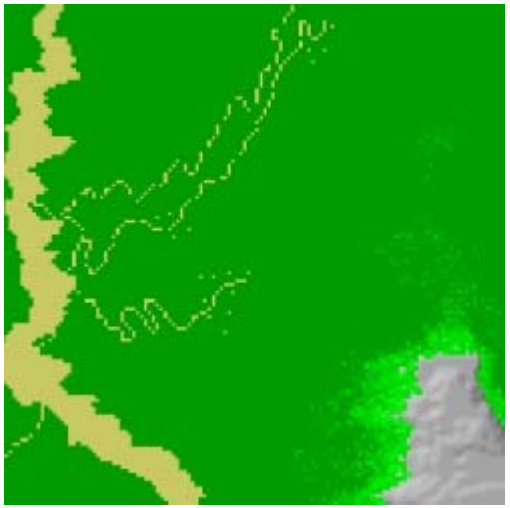


Series 3: “Rule 2”-logging *



* To be explained later in the presentation...

Using model scenarios to explore various management policies and their consequences

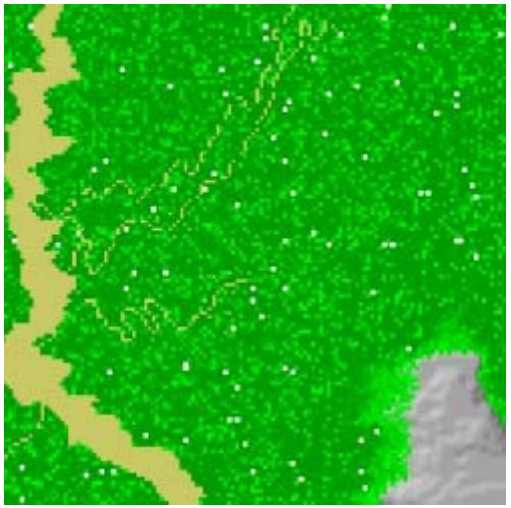


One of the main challenges from climatic change:

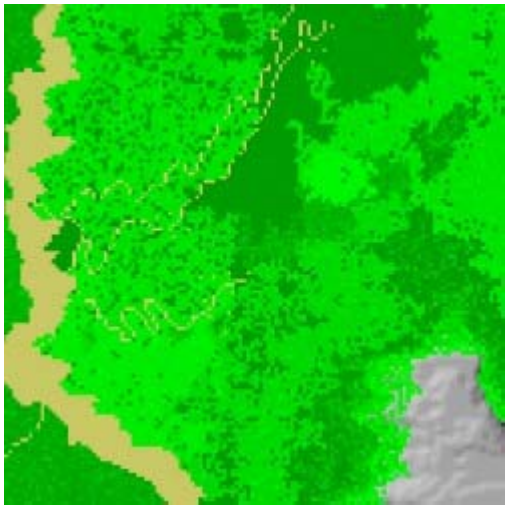
Without interference, i.e, active management by forest harvesting, the birch forest that expands into the new territory due to changing climatic conditions will be **dense** and **relatively unpenetrable** for grazing ungulates (and people).

Thus, the forest range expansion will have profound consequences for the remaining availability of open, alpine grazing fields for ungulates in the future.

Active birch forest ecosystem management may *counteract* this effect to larger or lesser degree by maintaining a shifting mosaic of clearcuttings and other succession stages.



These two mosaic **examples** have the same average total cover of open patches (young stands), but these patches' **availability for grazing** by ungulates is very different...



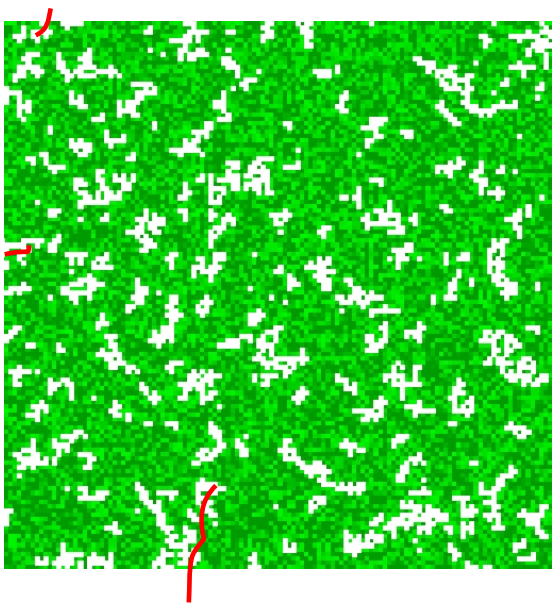
Model simulations may be used to *explore long term consequences* from various forest management regimes, or harvesting "rules".

For example, a "rule 1"-like logging policy will maintain a forest mosaic that is very different from..

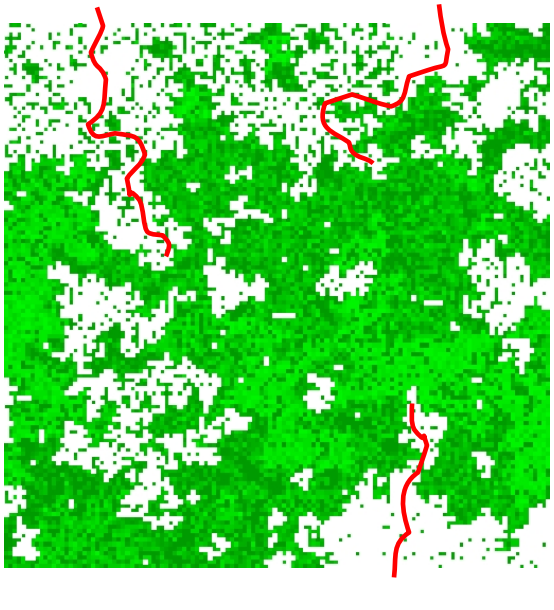
... a logging policy like "rule 2".

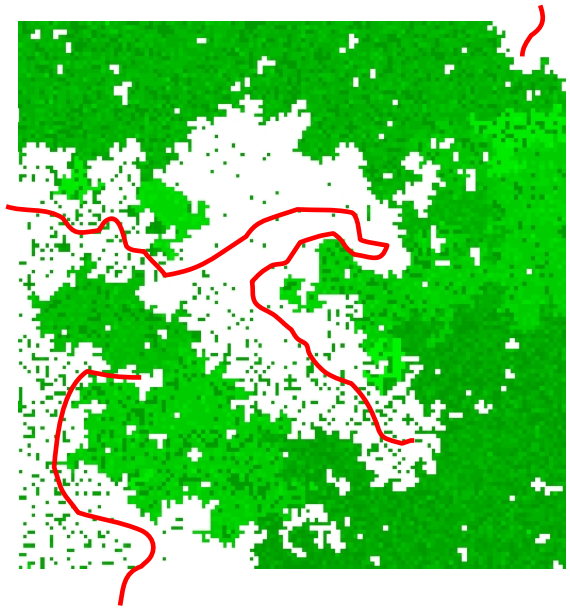
Grazing ungulates (sheep, reindeer) and forest structure

Young stands (clearcuttings) are shown as white clusters:



"Rule 1"-generated pattern





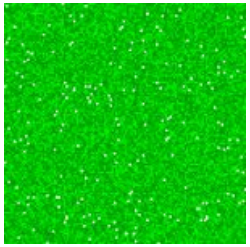
"Rule 2"-generated patterns (two parameter variations)

Sustainable pluralistic utilization of birch forest:

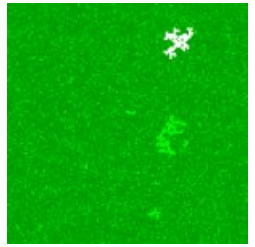
Logging rules (a part of the management "policy") can significantly influence the overall quality and availability of forest mosaic elements for other uses, like grazing habitat for sheep and reindeer, hiking/tourism, etc.

Rules for local loging policy

The following two clearcutting "rules" give a **similar long term yearly gain** (mean m^3 stem biomass pr. year) for the arena as a whole, but they lead to *small* and *large* spatio-temporal variation of the mean, respectively



- Rule 1:
  - At each time increment randomly choose (for example) **5%** of the 1 Ha cells
  - Reset all chosen cells that are dominated by old-growth stands to young stands (i.e., local logging events at 1 Ha scale)



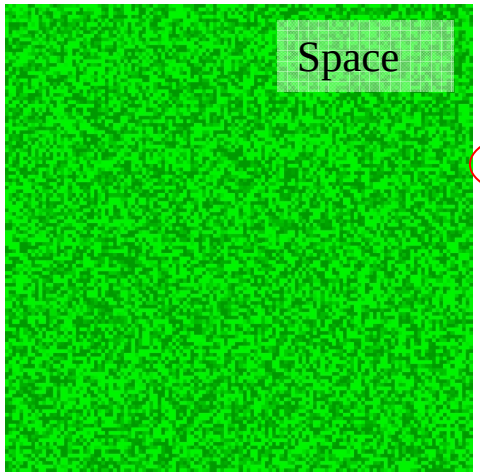
- Rule 2:
  - At each time increment randomly choose (for example) **one** of the arena cells with old-growth stands
  - Perform logging in this cell, and **all connected cells** with old-growth stands (i.e., logging with no spatial scale constraints up to arena size)

Rule 1 logging is a "*scale-specific* process, since all logging events are constrained to a specific maximum scale (for example, 1 Ha). **Rule 2** logging is *scale-"free"*, since the extent of any particular clearcutting is not spatially constrained by the rule *as such*.

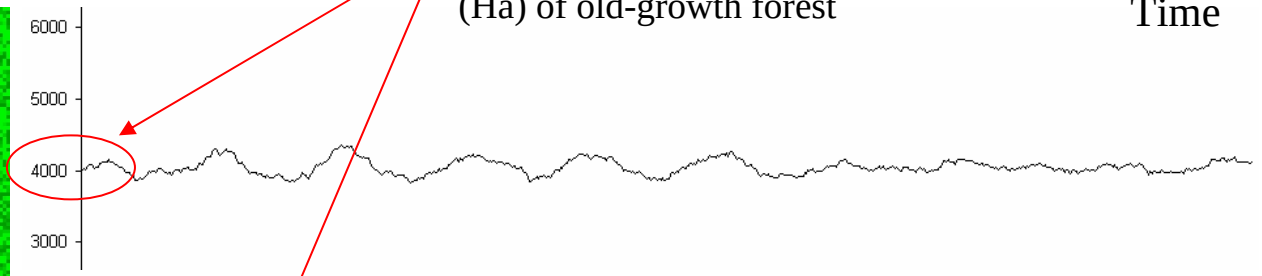
Some results

Qualitative differences between shifting mosaics from "Rule 1" and "Rule 2" logging policies

Rule 1 (example)

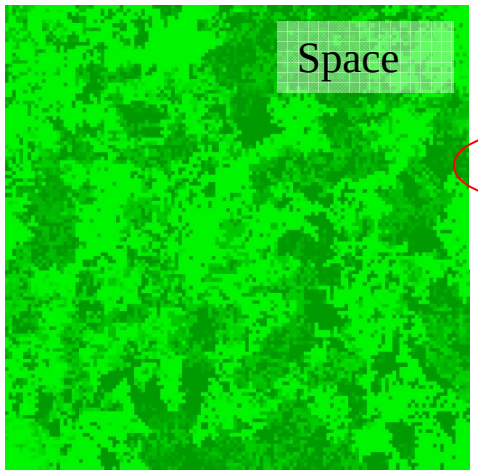


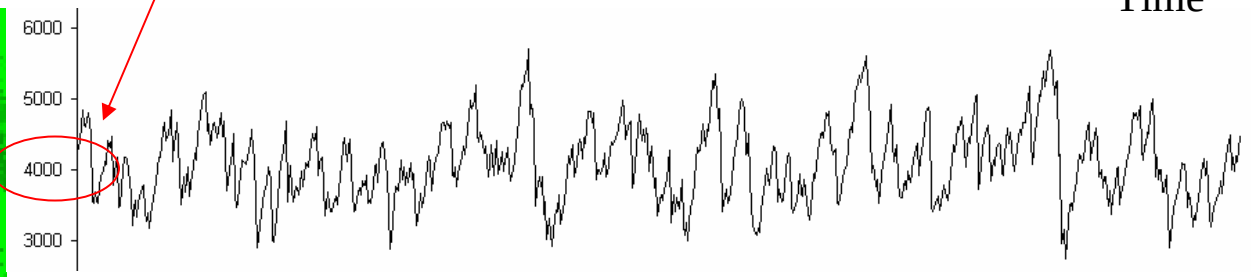
Similar magnitude: total cover (Ha) of old-growth forest



- Short spatial correlation length ("fine-grained pattern")
- Relatively small temporal variations in total cover of any age class

Rule 2 (example)

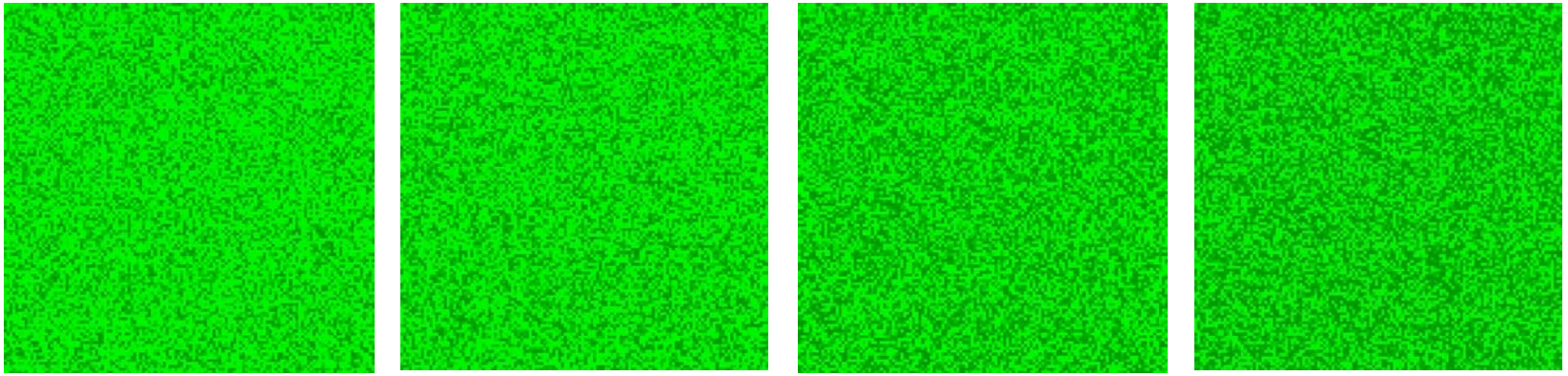




- Relatively large spatial correlation length ("clumped")
- Relatively large temporal variations in total cover of any age-class

1. Effect from logging intensity on **old-growth cover**

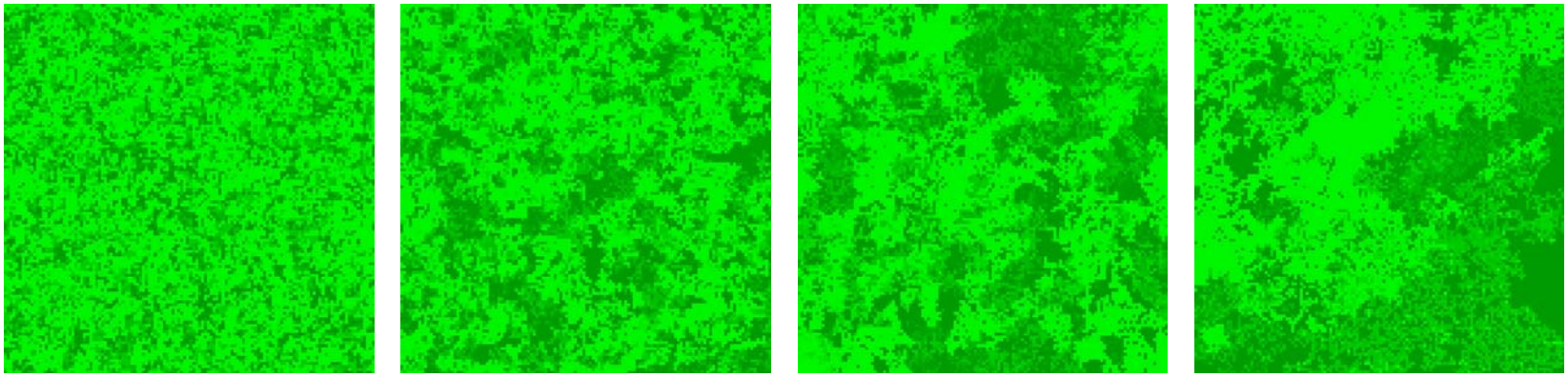
“Rule 1” scenario



15% old-growth ⟶ **35%** old-growth

Decreasing logging frequency (number of 1-Ha clearcuttings pr year) increases the mean total cover of old-growth stands

“Rule 2” scenario

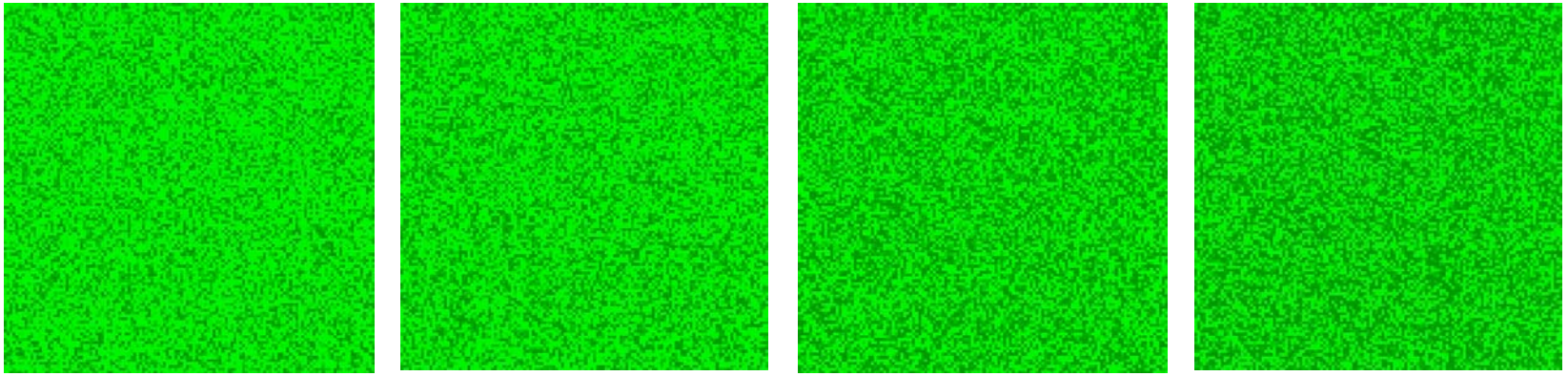


15% old-growth ⟶ **35%** old-growth

Decreasing number of (scale-free) “rule 2” clearcuttings pr year also increases old-growth

2. Effect from logging intensity on **heterogeneity**

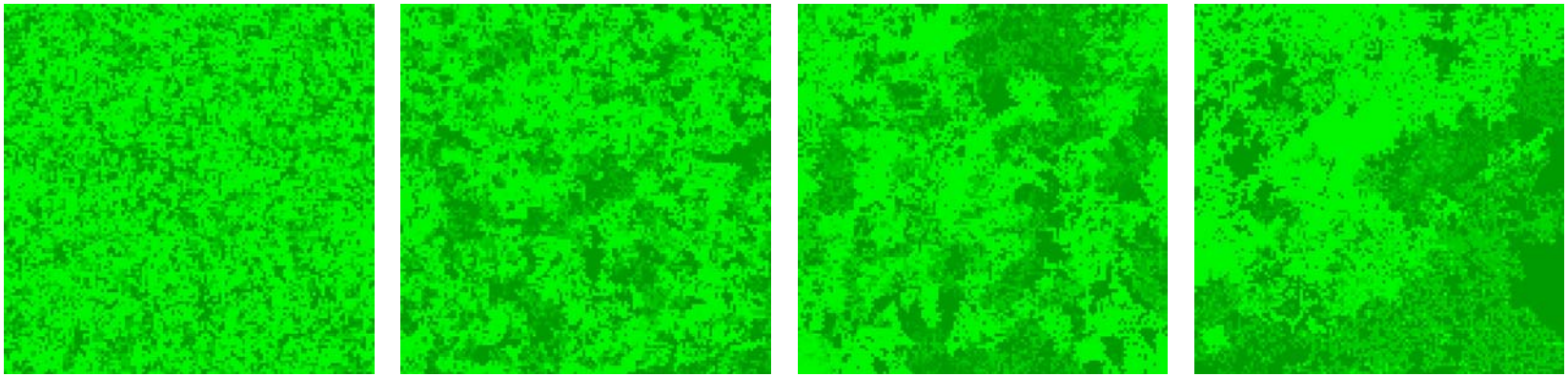
"Rule 1" scenario



15% old-growth ⟶ **35%** old-growth

Decreasing logging frequency (number of 1-Ha clearcuttings pr year) makes the forest mosaic more **homogeneous** (smaller transect- and time series variability)

"Rule 2" scenario



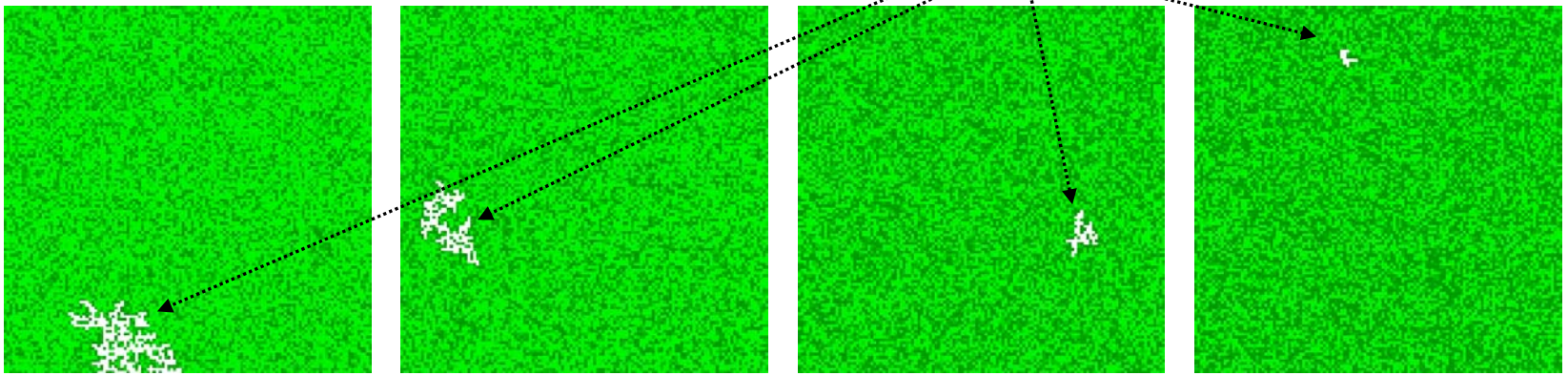
15% old-growth ⟶ **35%** old-growth

Decreasing number of (scale-free) "rule 2" clearcuttings **increases heterogeneity**

3. Effect from logging intensity on **accessibility**

“Rule 1” scenario

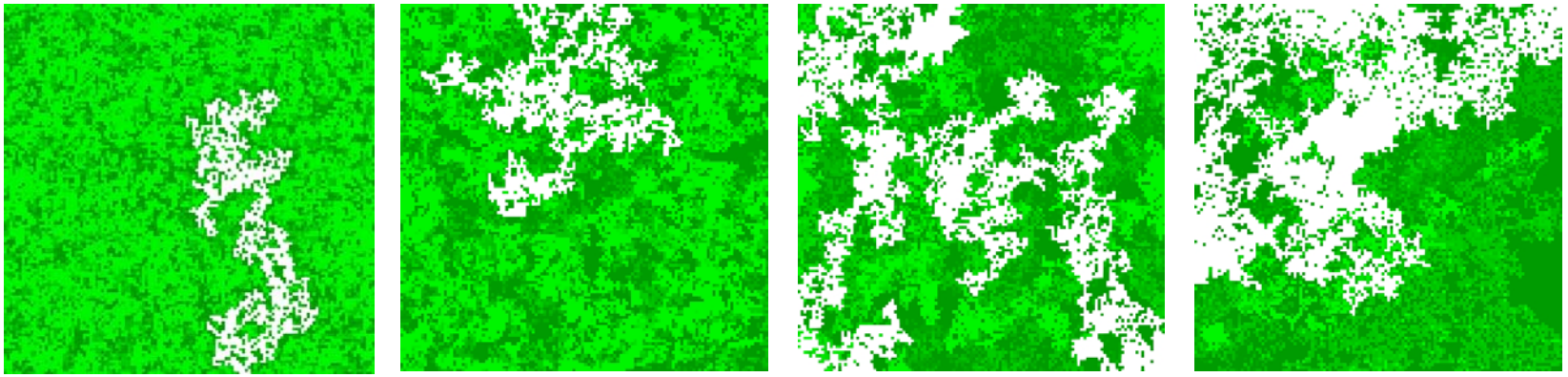
Largest cluster of clear-cutting



15% old-growth → 35% old-growth

Grazing accessibility of open areas **decreases** with increased old growth cover

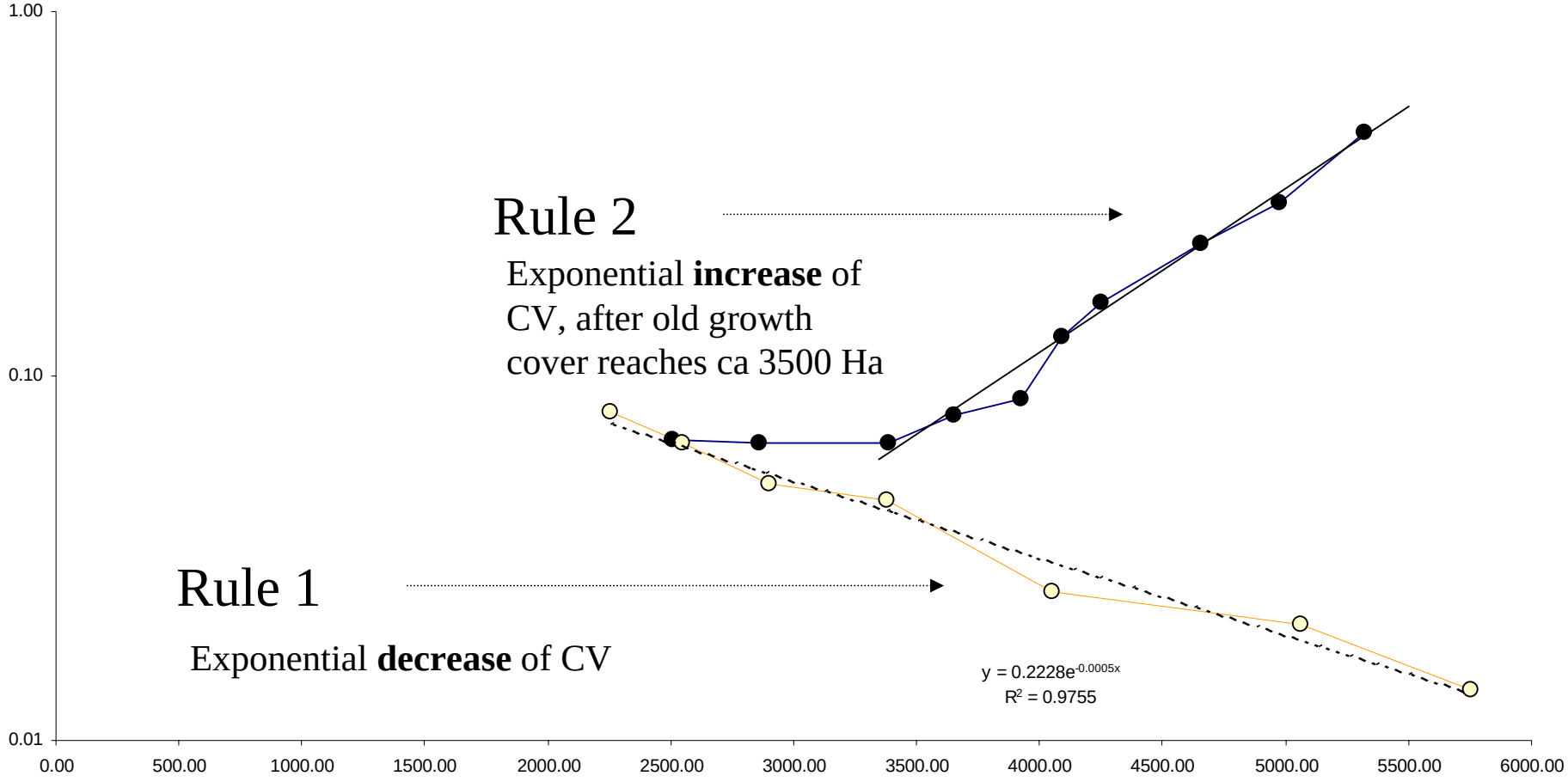
“Rule 2” scenario



15% old-growth → 35% old-growth

Grazing accessibility of open areas **increases** (!) with increased old growth cover

CV (s.d./mean) of old growth cover on arena over time (log-scale)



Old growth cover (# Ha of arena, averaged over the time series)

Conclusions

Objective for the management scenarios

- **Explore** by model simulations the long term qualitative effects on the shifting forest mosaic from applying alternative logging rules
- **Look for general "lessons"** with practical consequences for long term management of mountain birch forests
- **Explore alternative rules**, with emhpasis on practical modifications of the initial policies (a "rule 3" example is explored in Chap. 22)

Many of the basic management challenges that are illustrated in this presentation would be **too complex for decisions on policies** without the use of explicit model explorations

Sometimes model simulations produce counterintuitive (but verified) results, relative to initial “educated guesses”

“All truth passes through three stages before it is recognized.
In the first it is ridiculed,
in the second it is opposed,
in the third it is regarded as self-evident.”

- Arthur Schopenhauer
philosopher