

Structure of presentations

Part - 1:

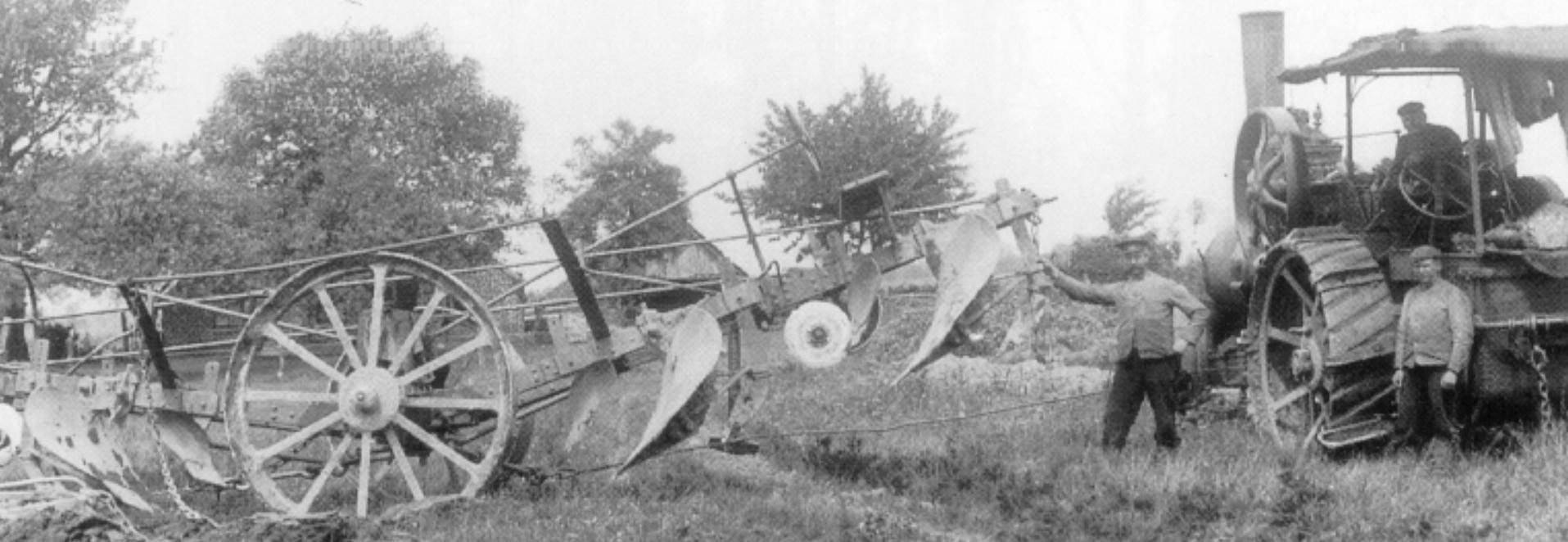
- background
- FORSPACE
 - plant processes
 - herbivore processes
 - fire

Part - 2:

- Schedule management scenario's
- Example - 1: Conversion homogeneous beech stand
- Example - 2: Landscape scale management
- Management parameters
- general aspects PCRaster





















FORSPACE: complex ecosystem model

Kramer, K., H. Baveco, R.J. Bijlsma, A.P.P.M. Clerkx, J. Dam, J. van Goethem, T.A. Groen, G.W.T.A. Groot Bruinderink, I.T.M. Jorritsma, J. Kalkhoven, A.T. Kuiters, D. Lammertsma, H.H.T. Prins, M. Sanders, R. Wegman, S.E. van Wieren, S. Wijdeven and R. van der Wijngaart

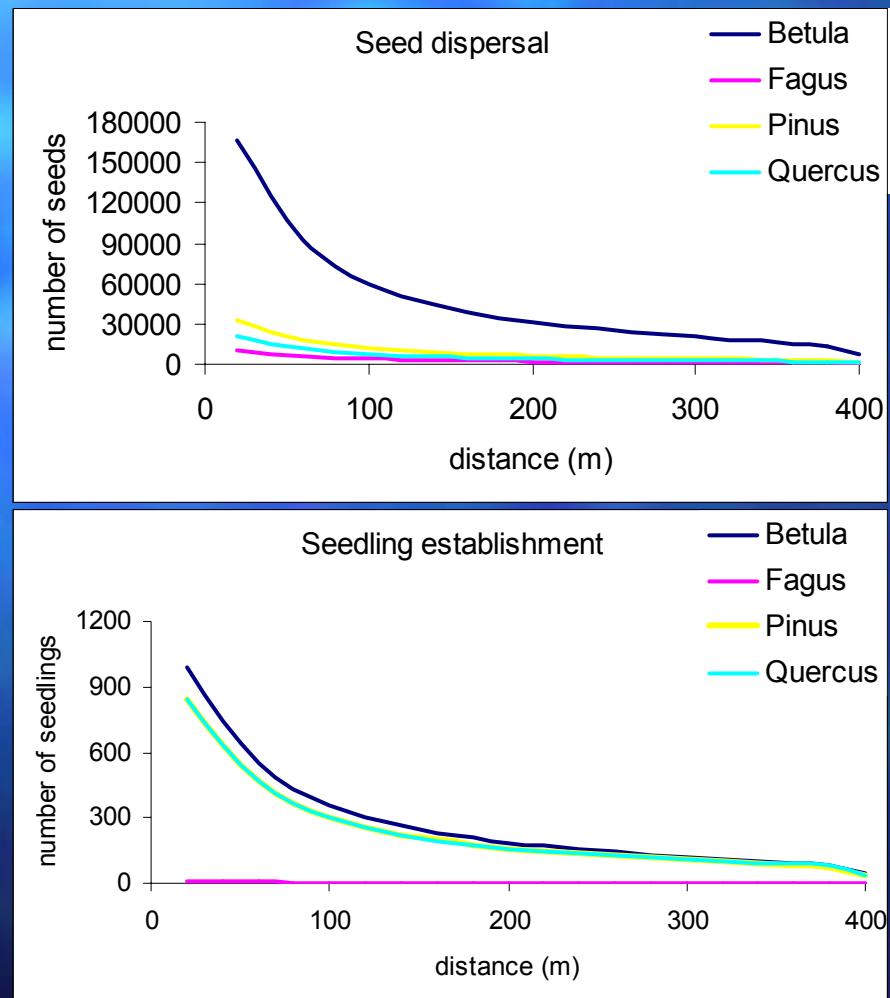
Plant processes:

- seed production
- dispersion
- germination
- light interception
- photosynthesis
- allocation of assimilates
- change of biomass
- change in plant height
and crown dimensions
- mortality
- grazing

state variables:

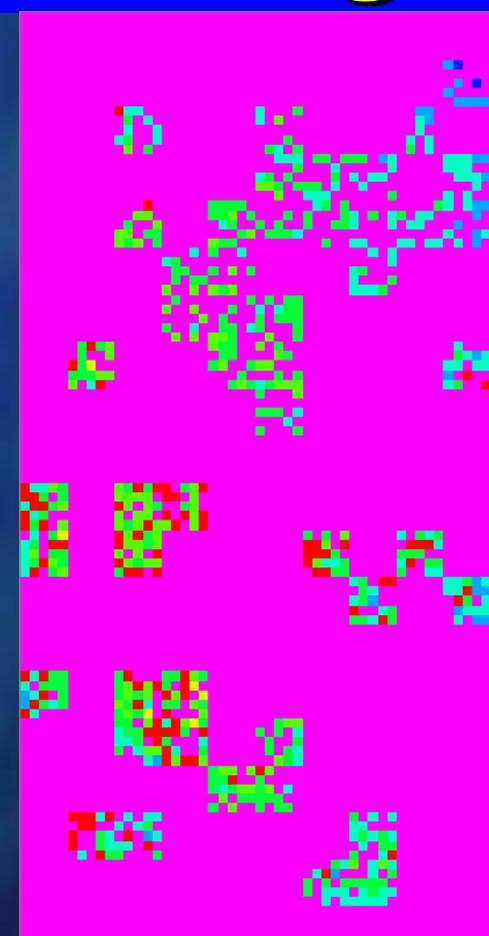
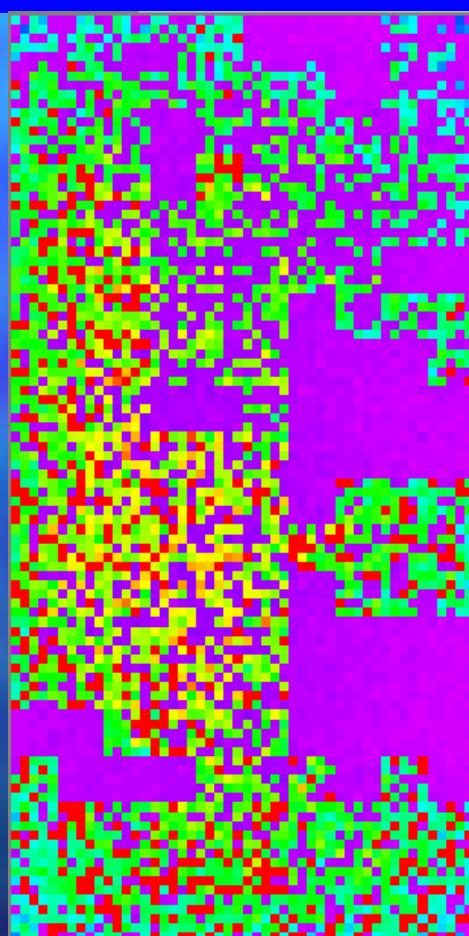
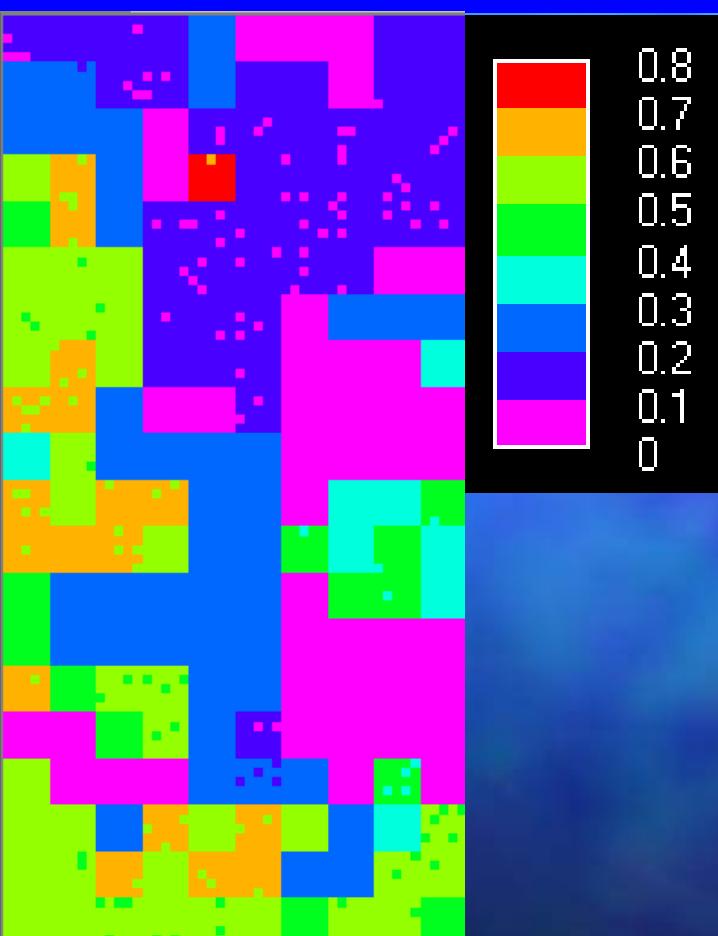
- number of trees
- weight (foliage, branches, heartwood, sapwood, coarse roots, fine roots)
- height
- crown dimensions (diameter, length,
- crown base)
- => basal area, dbh, vegetation types

Dispersal



Dispersal. E.g. Pine.

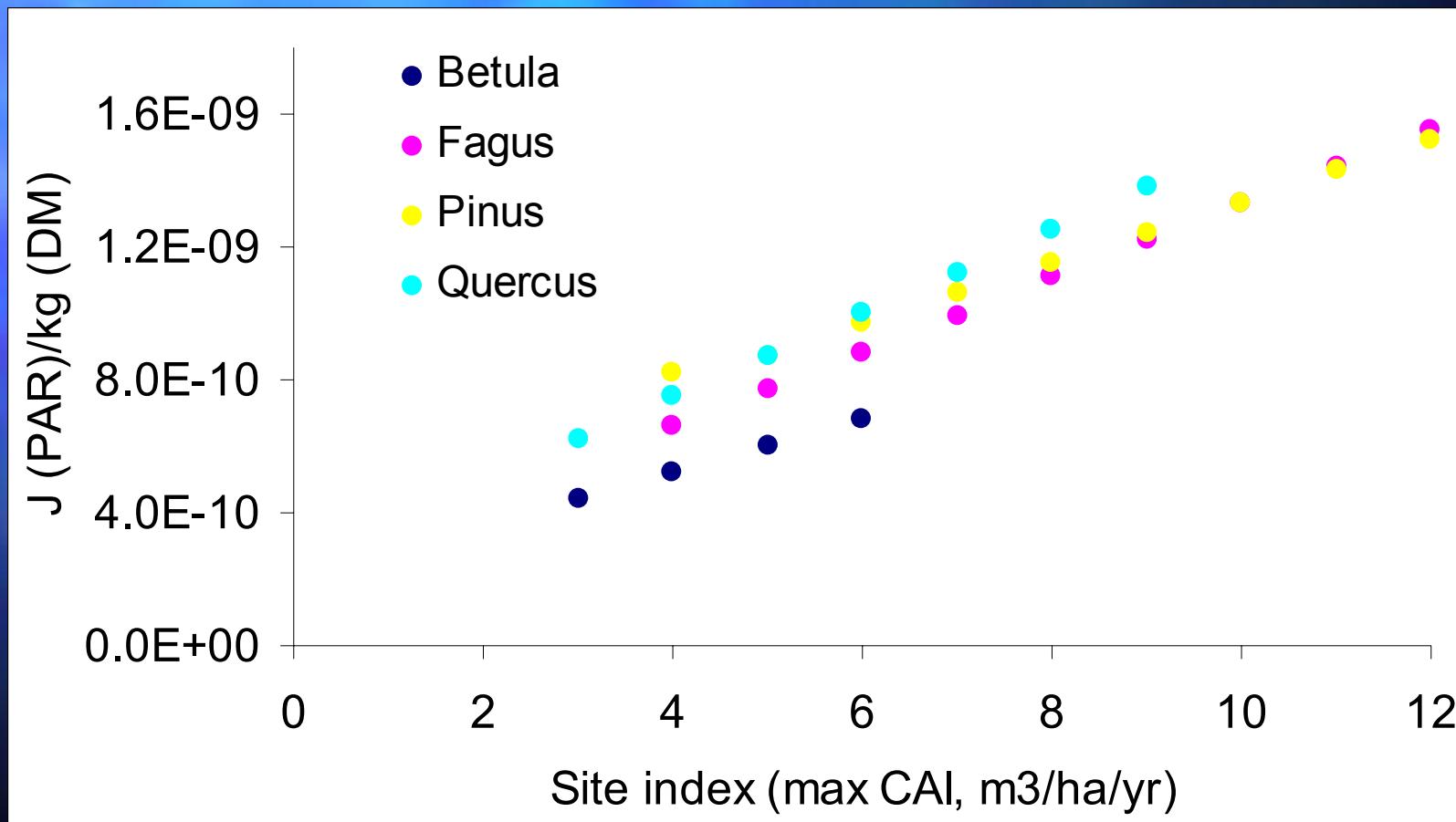
tree cover - seeds - seedlings



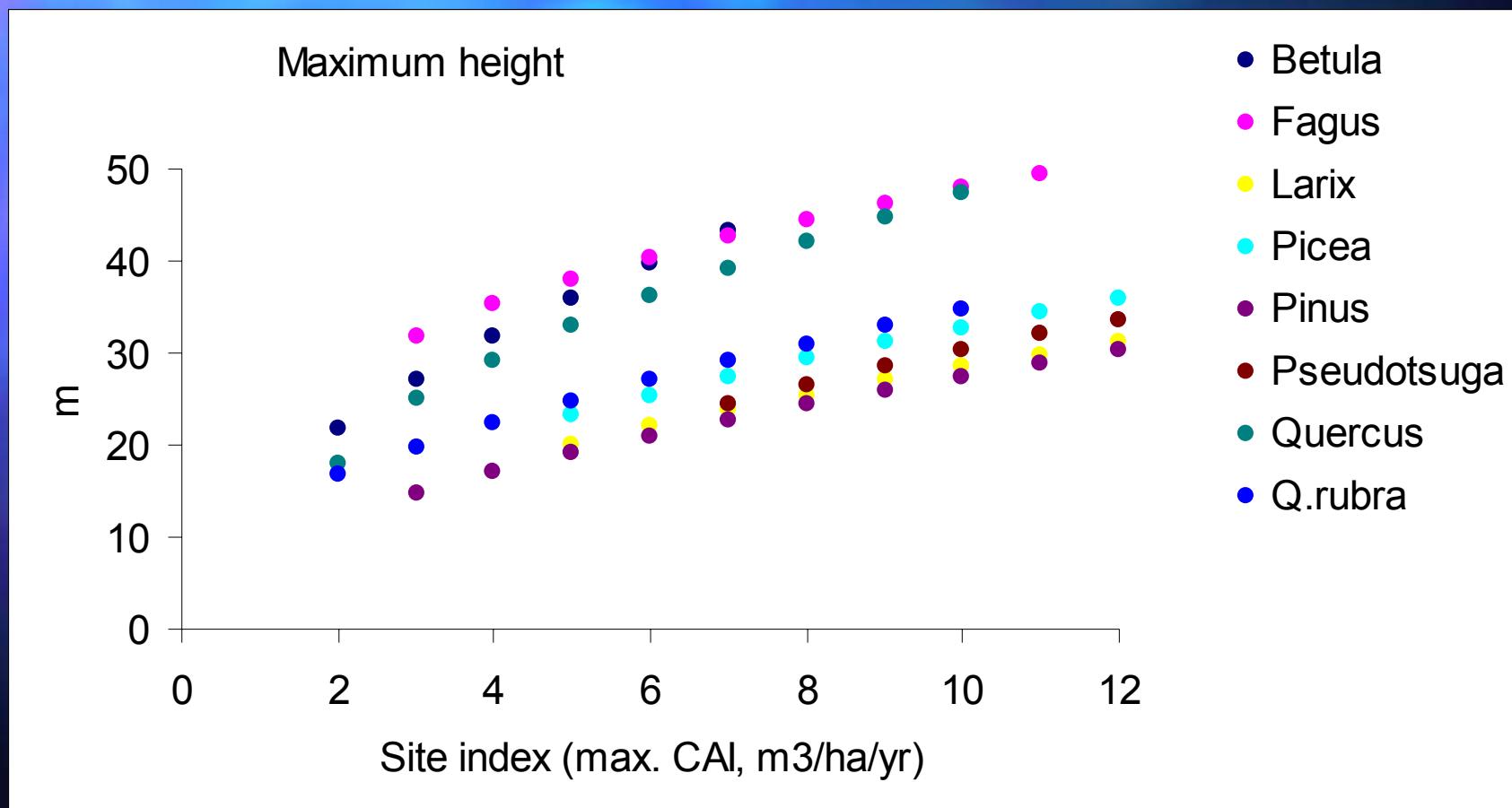
Light interception & photosynthesis

- exponential attenuation of light with LAI
- distribution over species proportionally to LAI
- conversion of intercepted light to dry mass based on radiation use efficiency
- important differences in size and growth rates of species:
 - maximum tree height
 - maximum height growth rate
 - lateral expansion

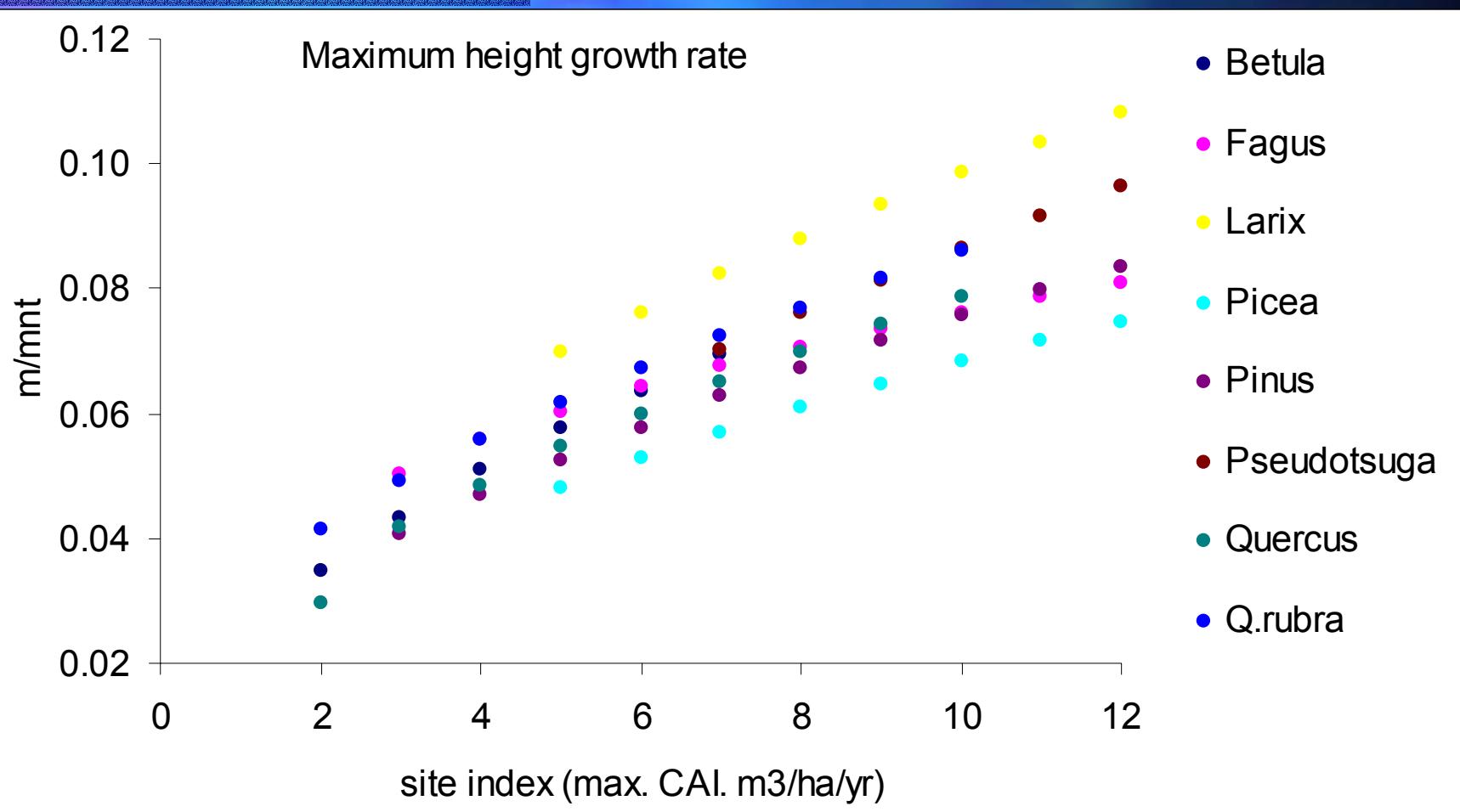
- Radiation use efficiency



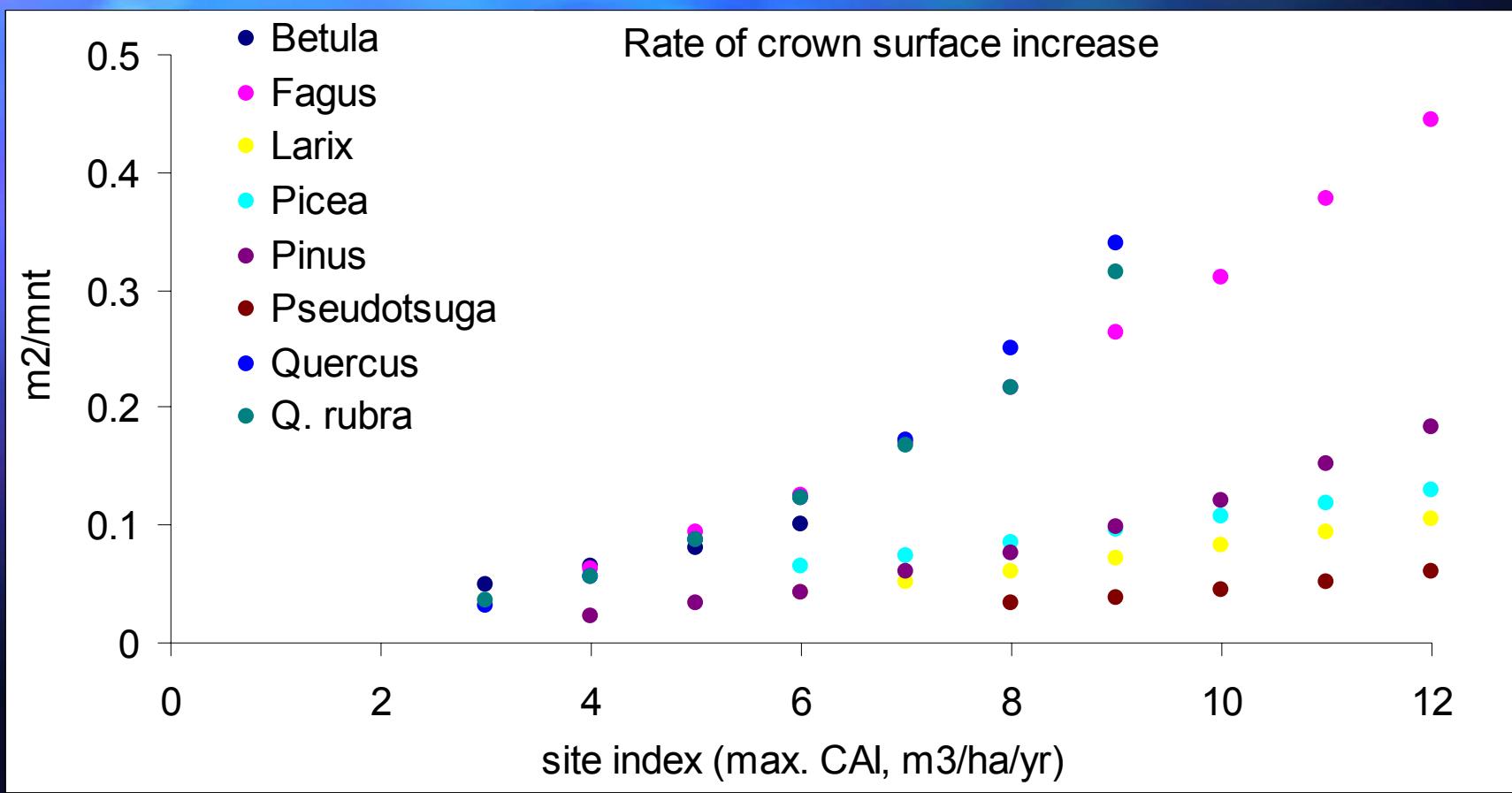
- Maximum height



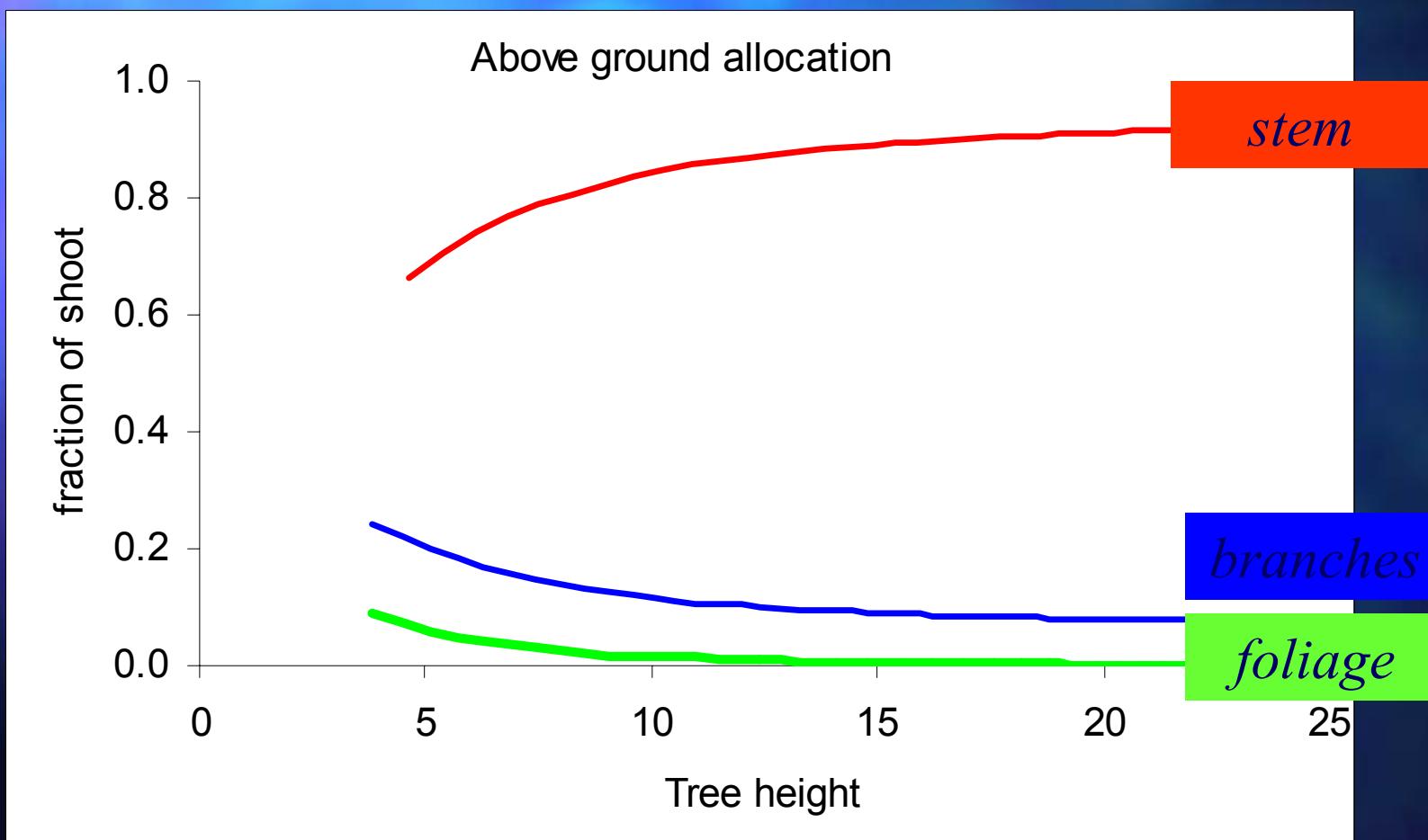
- Maximum height growth rates



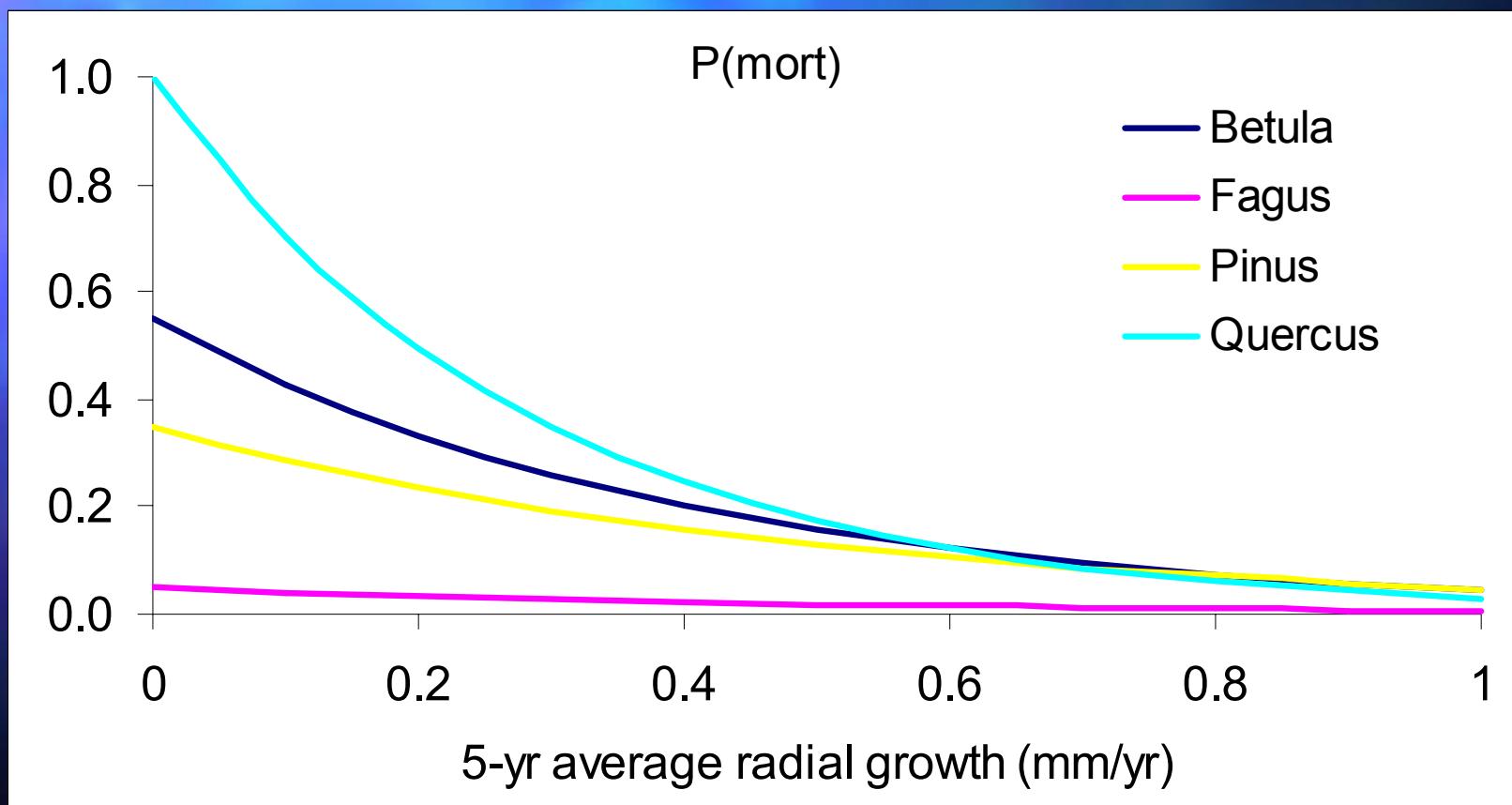
- Maximum rate of crown surface increase



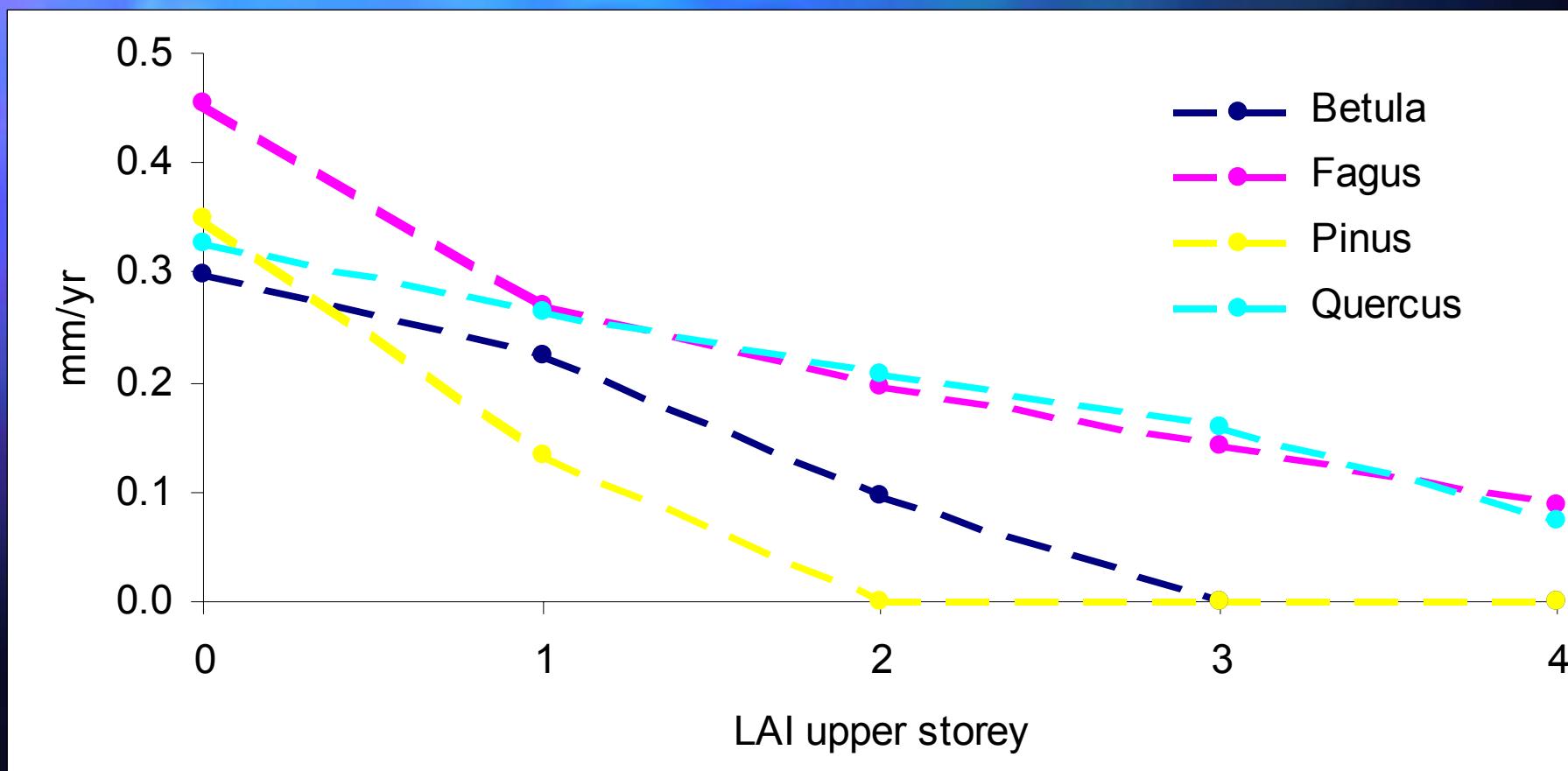
Allocation. E.g. Betula



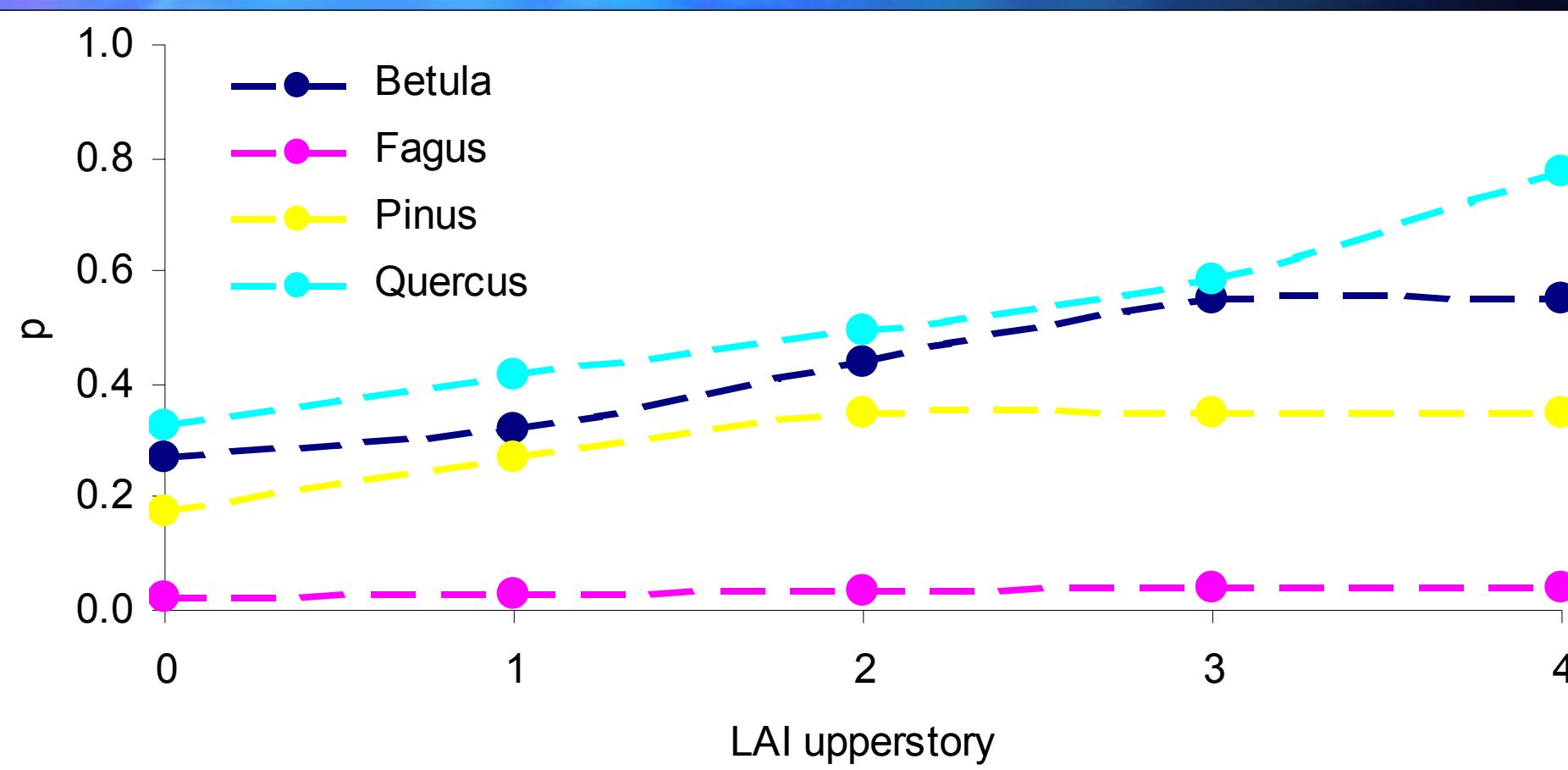
Mortality



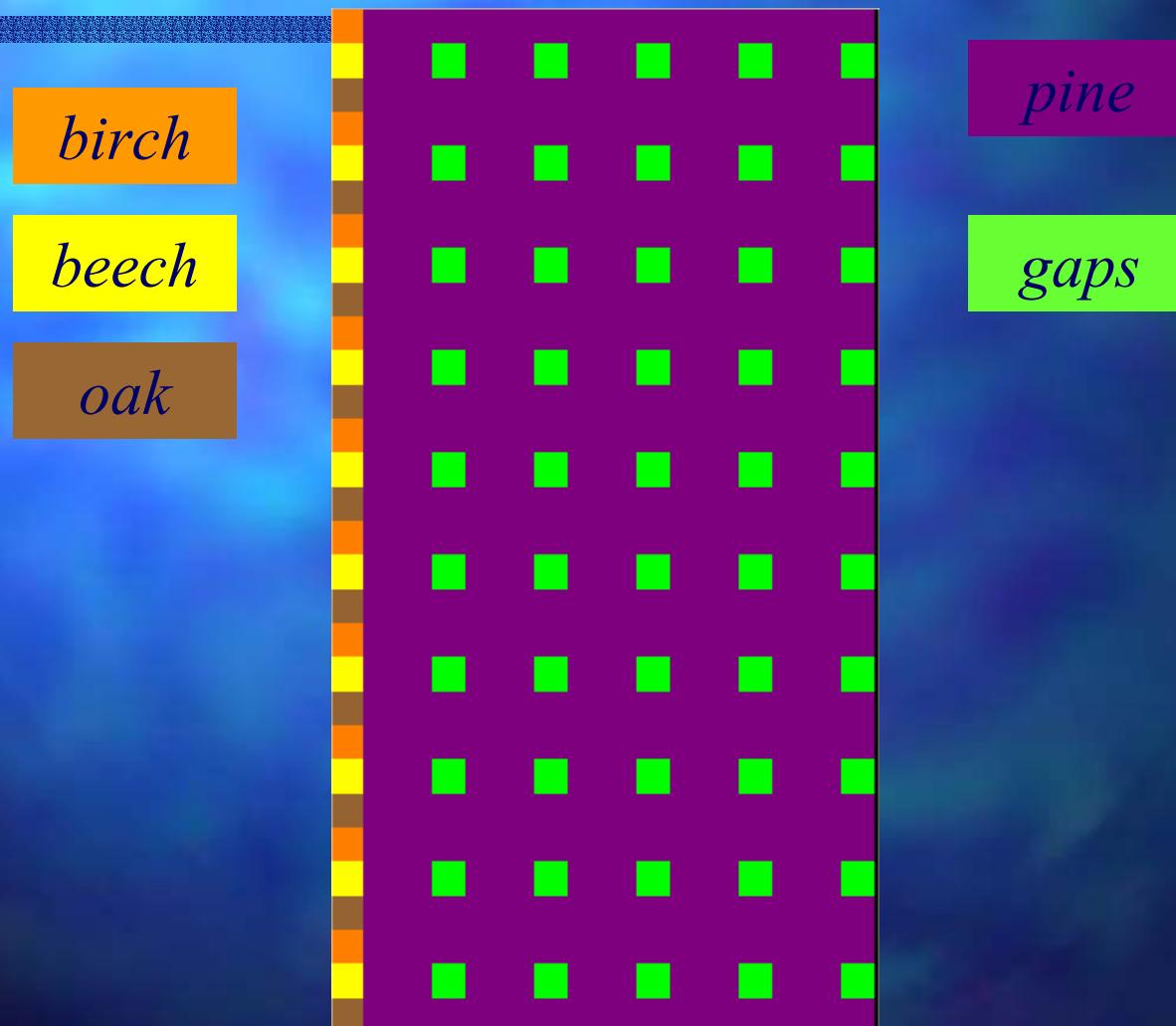
Average radial growth under canopy



Probability of mortality under canopy



Example: Colonization of birch, beech, oak in pine forest

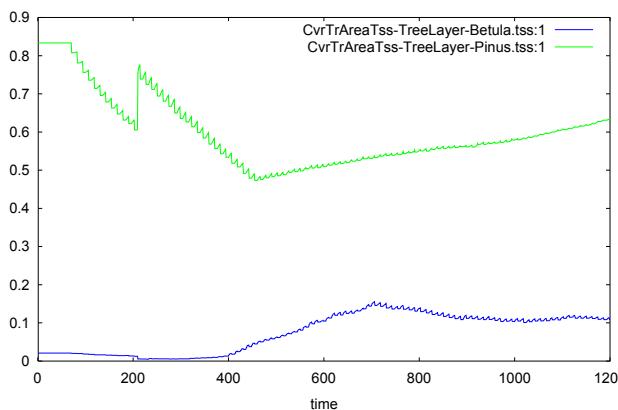
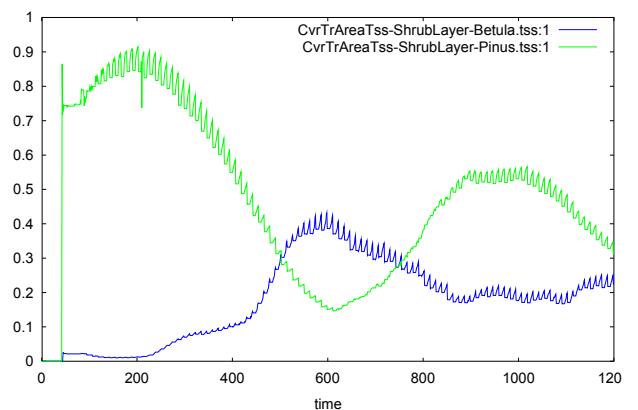


Colonisation -

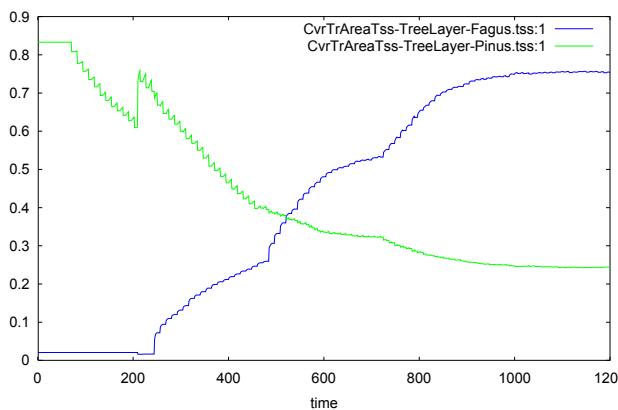
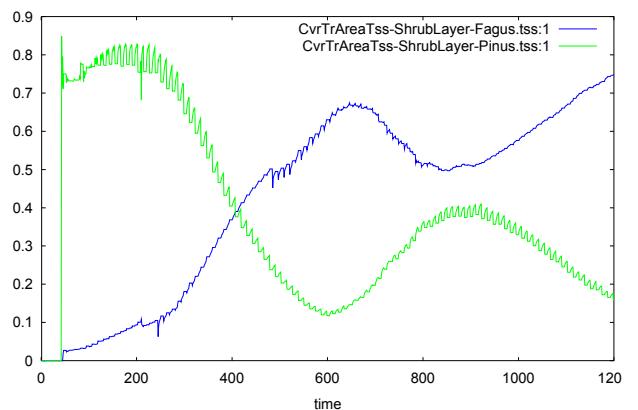
cover shrublayer:

cover treelayer:

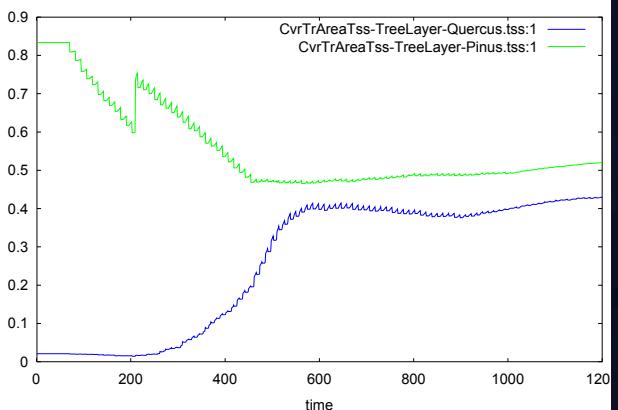
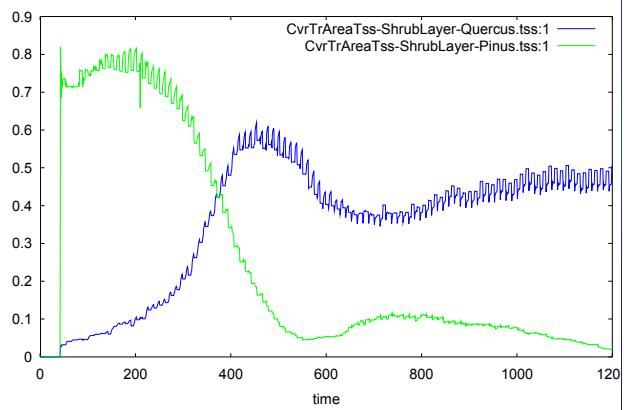
Birch \rightarrow pine



Beech \rightarrow pine



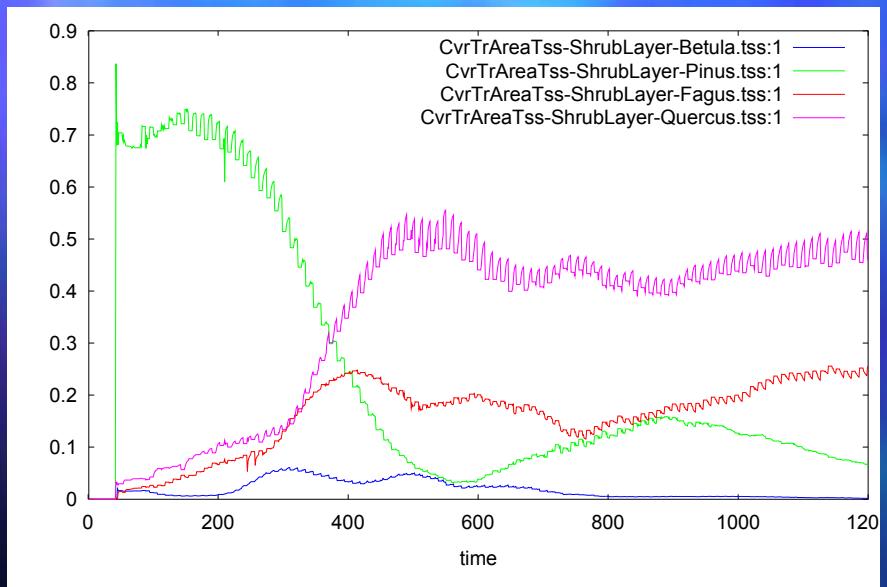
Oak \rightarrow pine



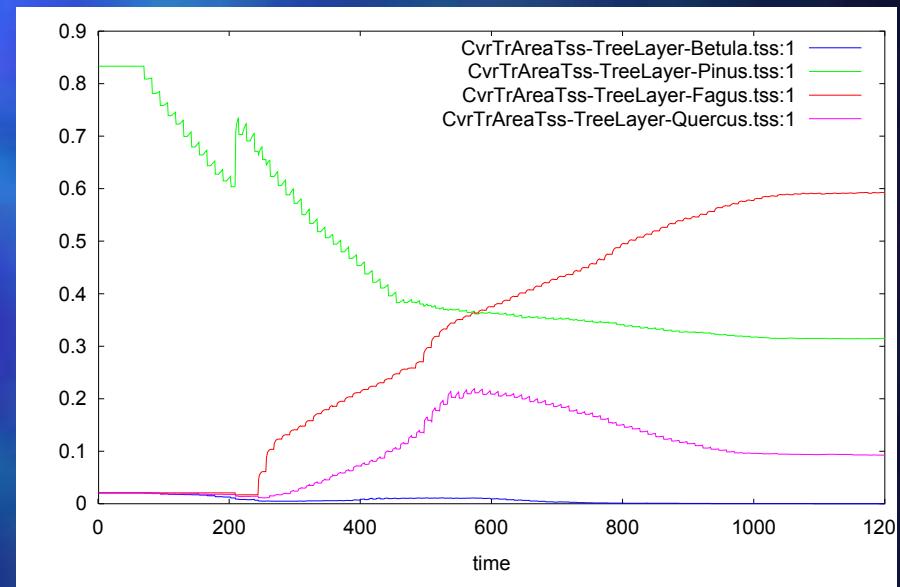
Colonisation -

Birch + Beech + Oak -> Pine forest

cover shrublayer:

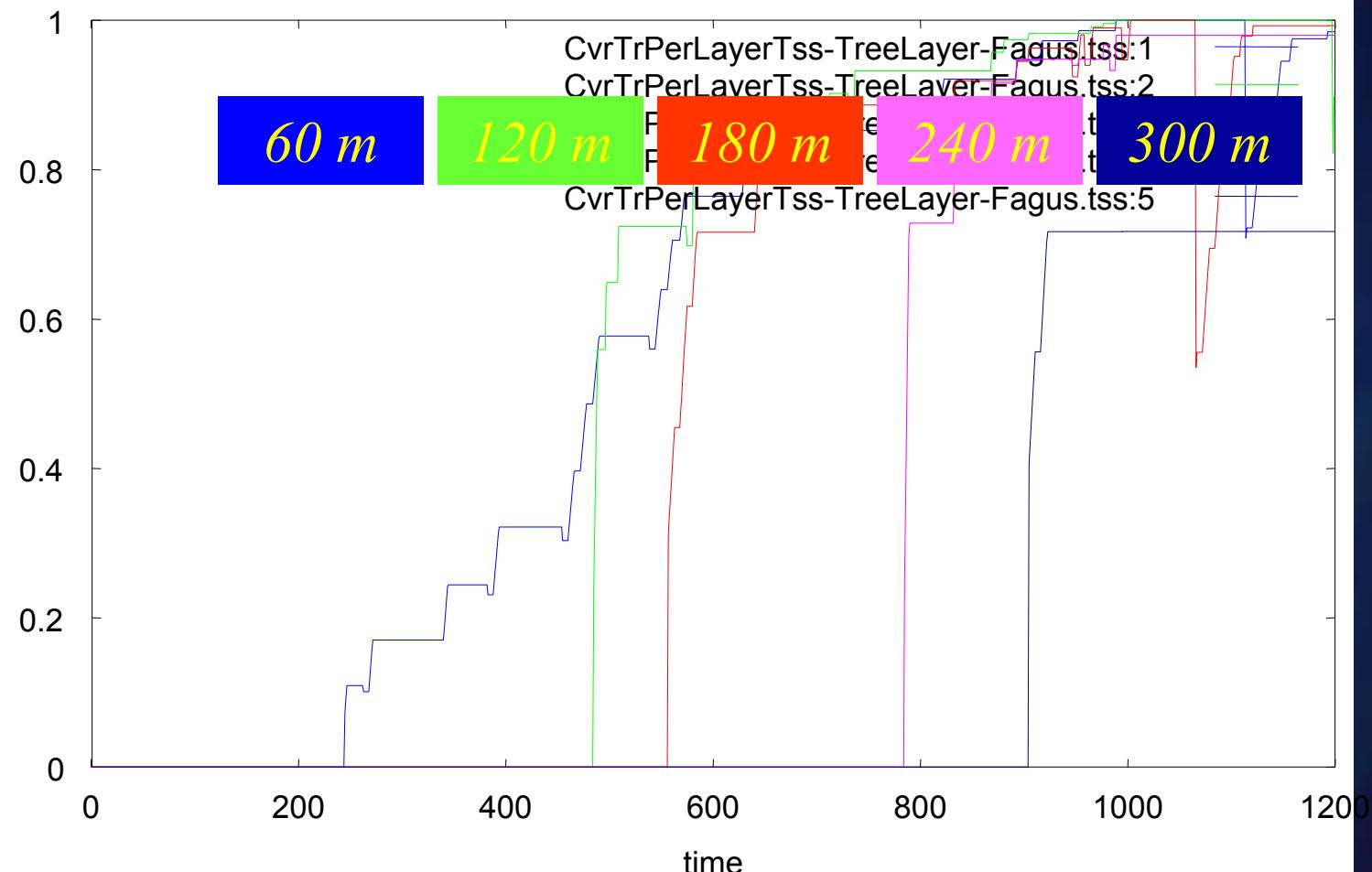


cover treelayer:

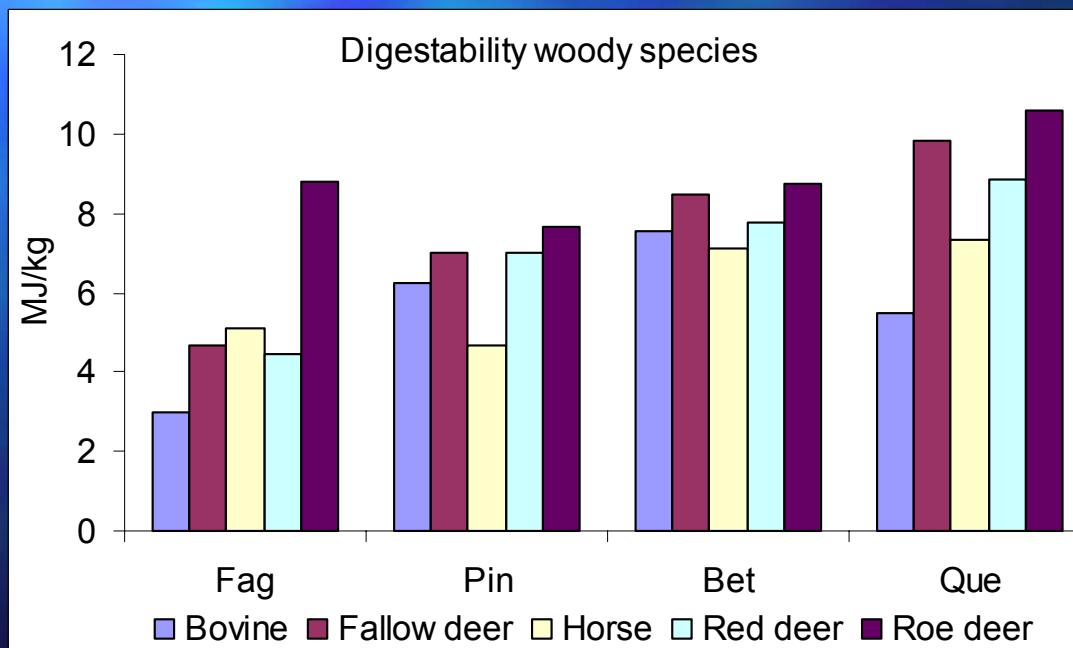
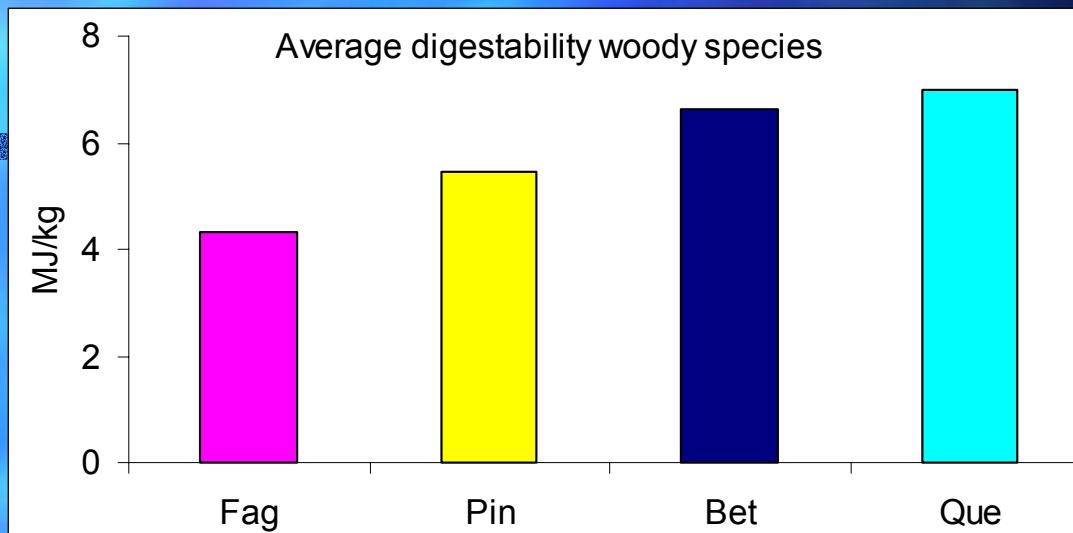


Colonisation -

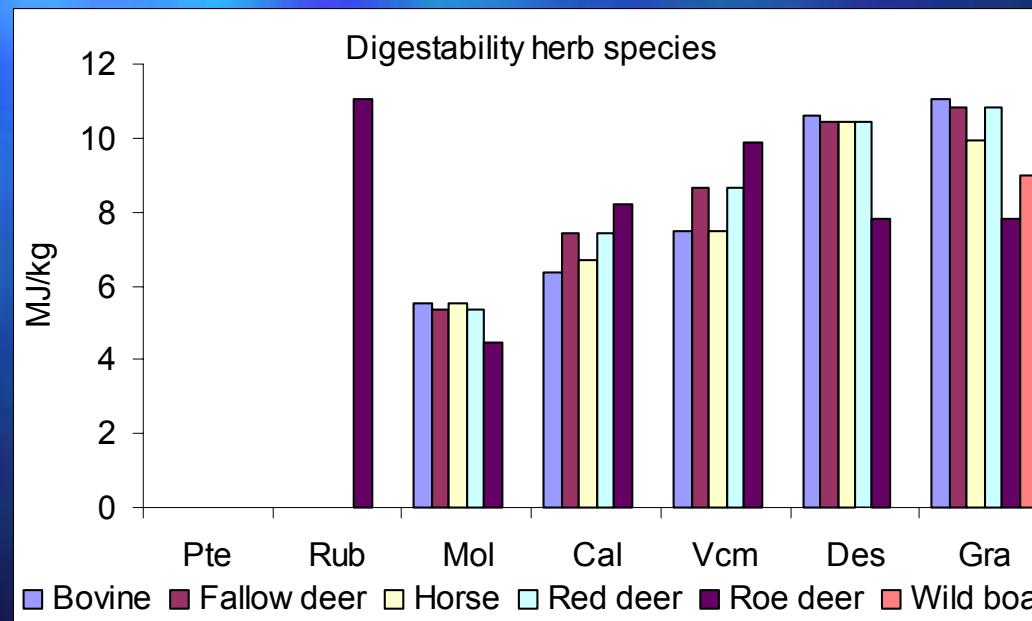
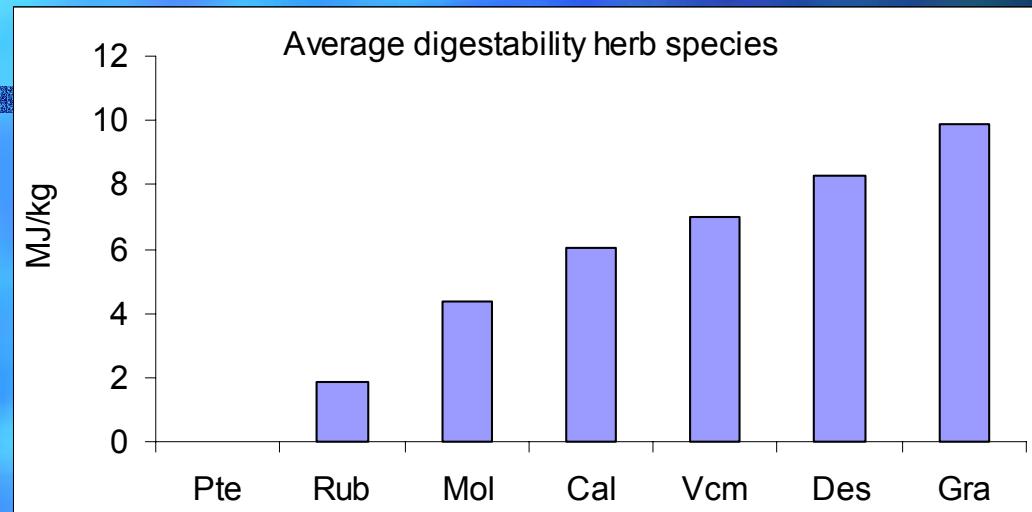
Beech -> Gaps in pine forest



Grazing - woody species



Grazing - herb species



Principal equations plant dynamics

number :

$$N_{s,l}(t+1) = N_{s,l}(t) - NMrt_{s,l}(t) + NGrm_s(t)$$

$$Nsds(t+1) = Nsds(t) + RNsddsp_s(t) - TNsds(t) - NGrm_s(t) - \frac{GrzSd_s(t)}{CWsds}$$

l = treelayer, shrublayer, herblayer

s = species of herbs, shrubs, trees

weight :

$$W_{x,s,l}(t+1) = W_{x,s,l}(t) + RW_{x,s,l}(t) - TW_{x,s,l}(t) - GrzW_{x,s,l}(t)$$

x = foliage, branches, stem(heartwood, sapwood), fine roots, coarse roots

structure :

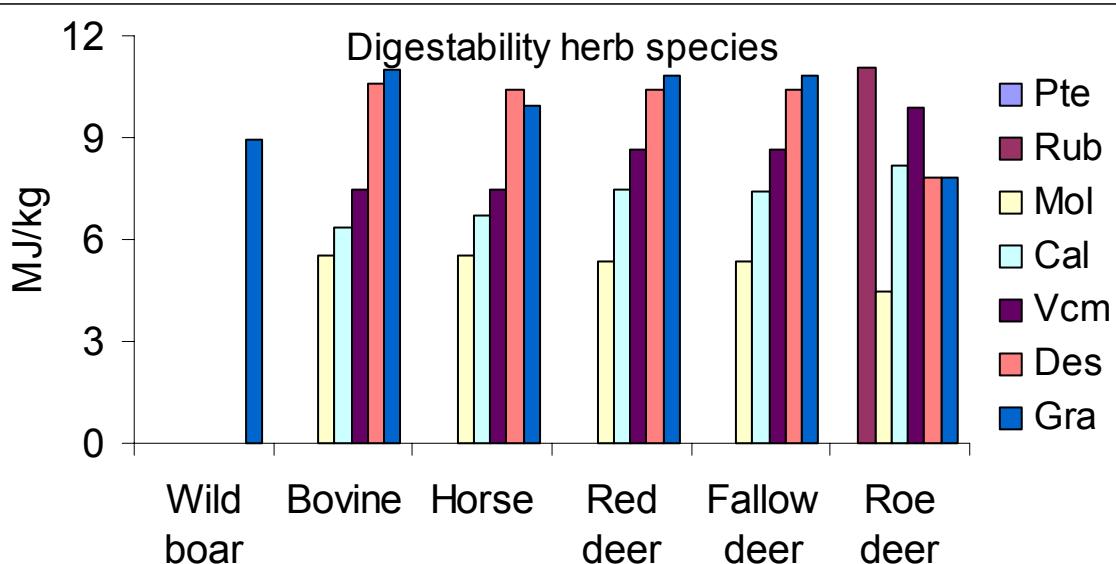
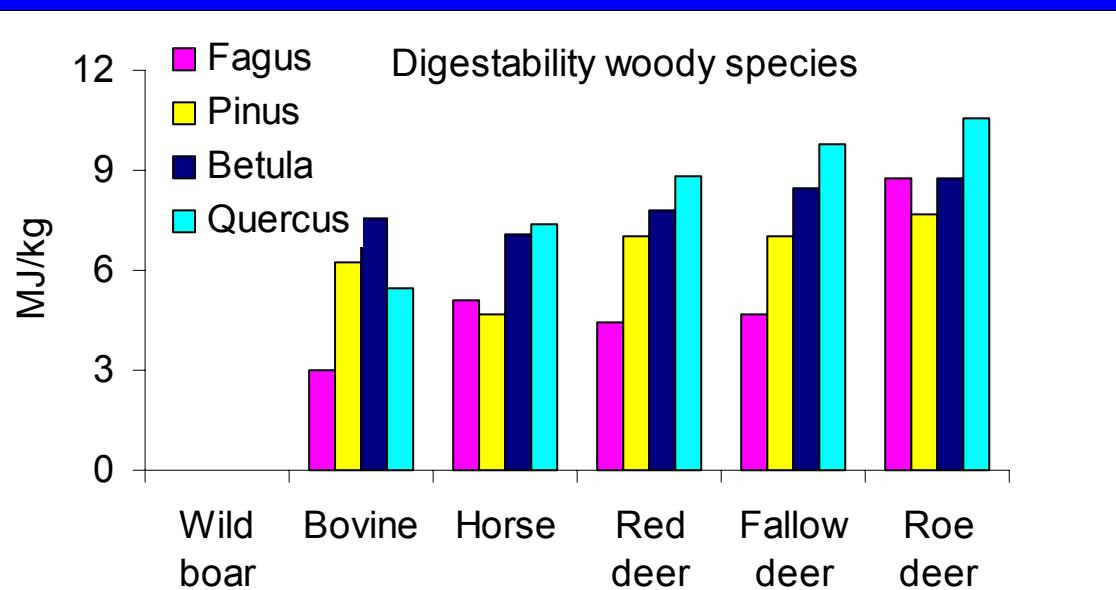
$$S_{s,l}(t+1) = S_{s,l}(t) + RS_{s,l}(t) - RdcSGrz_{s,l}(t)$$

S = height, crownbase, radius

Herbivore processes: state variables:

- food and terrain selection
 - consumption of available food
 - energy requirement for:
 - maintenance
 - gestation
 - lactation
 - change in bodyweight
 - birth
 - mortality
- number of juveniles
 - number of adults per age class
 - weight per cohort per species

Terrain and food selection



bovine

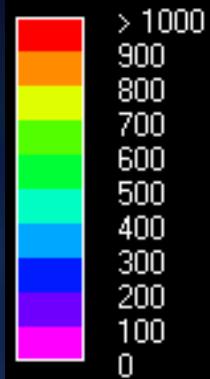
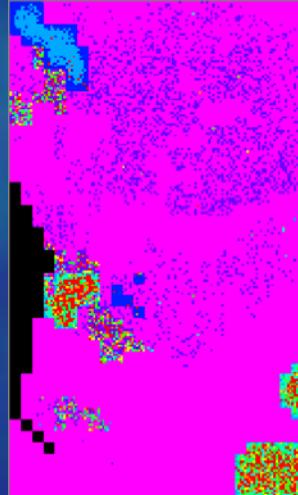
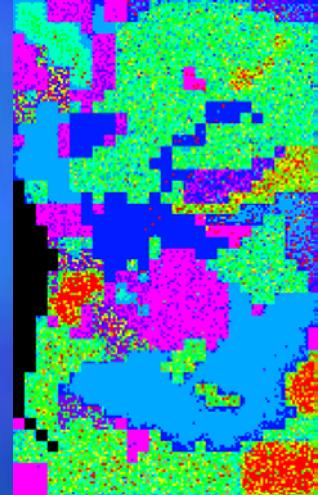
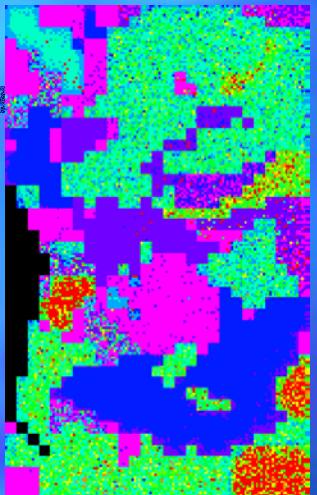
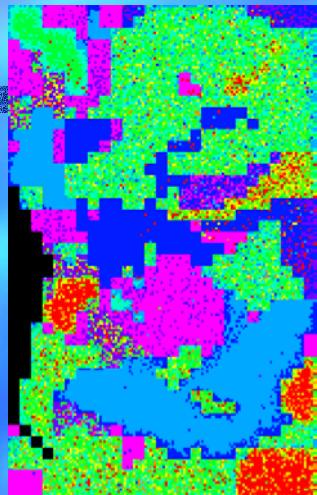
red deer

horse

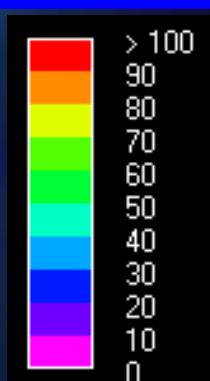
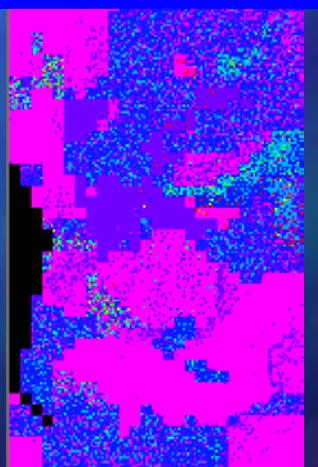
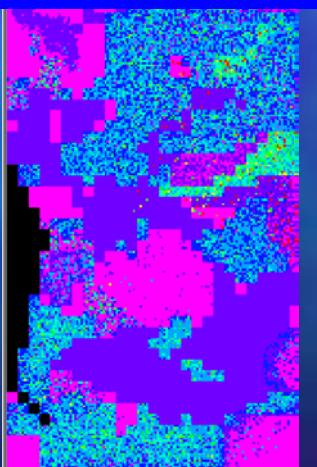
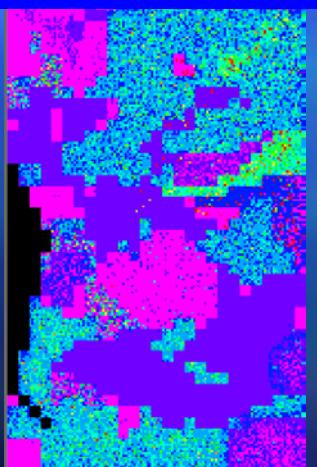
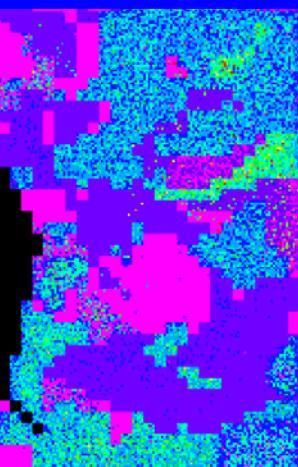
roe deer

wild boar

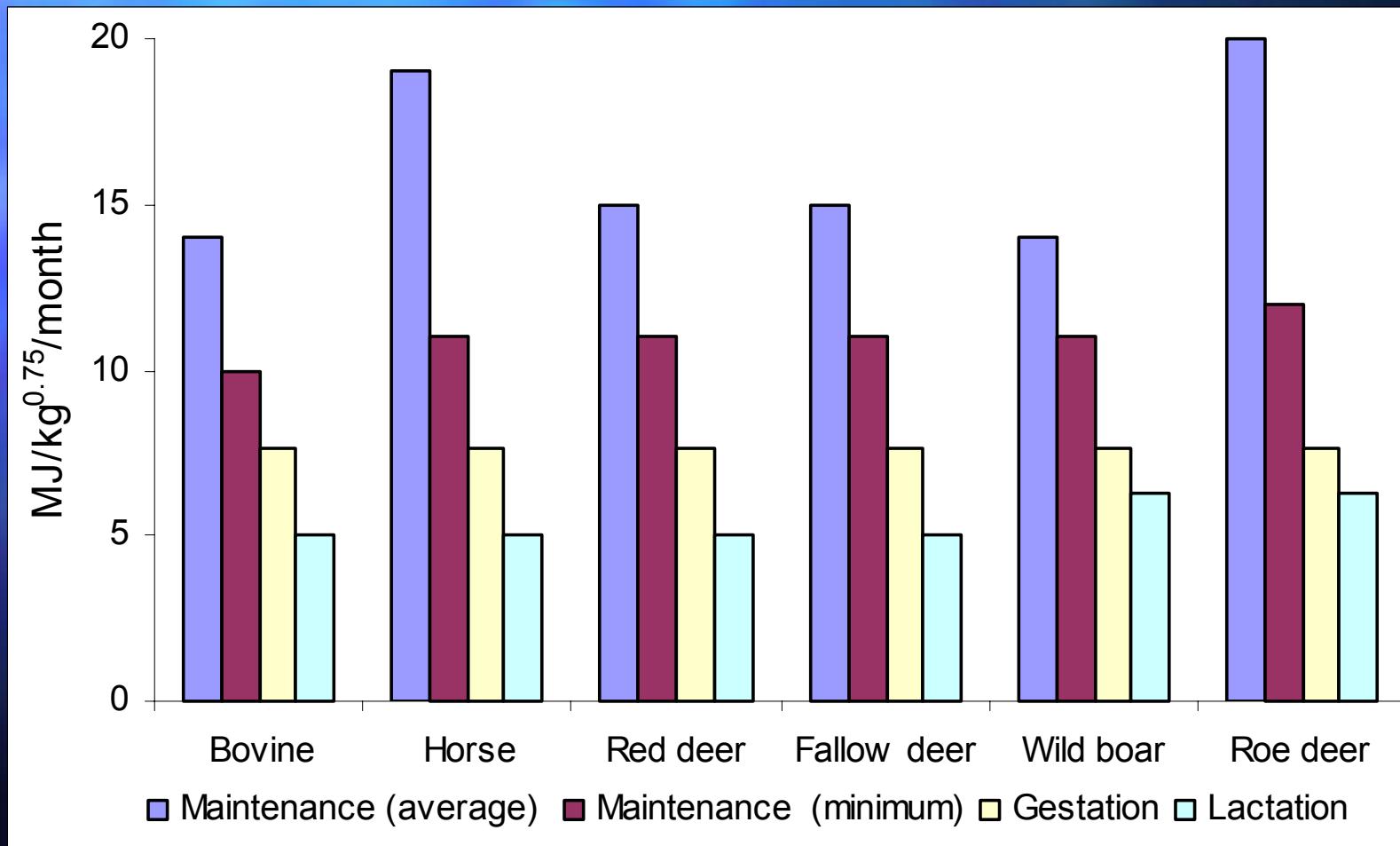
available energy (MJ/yr)



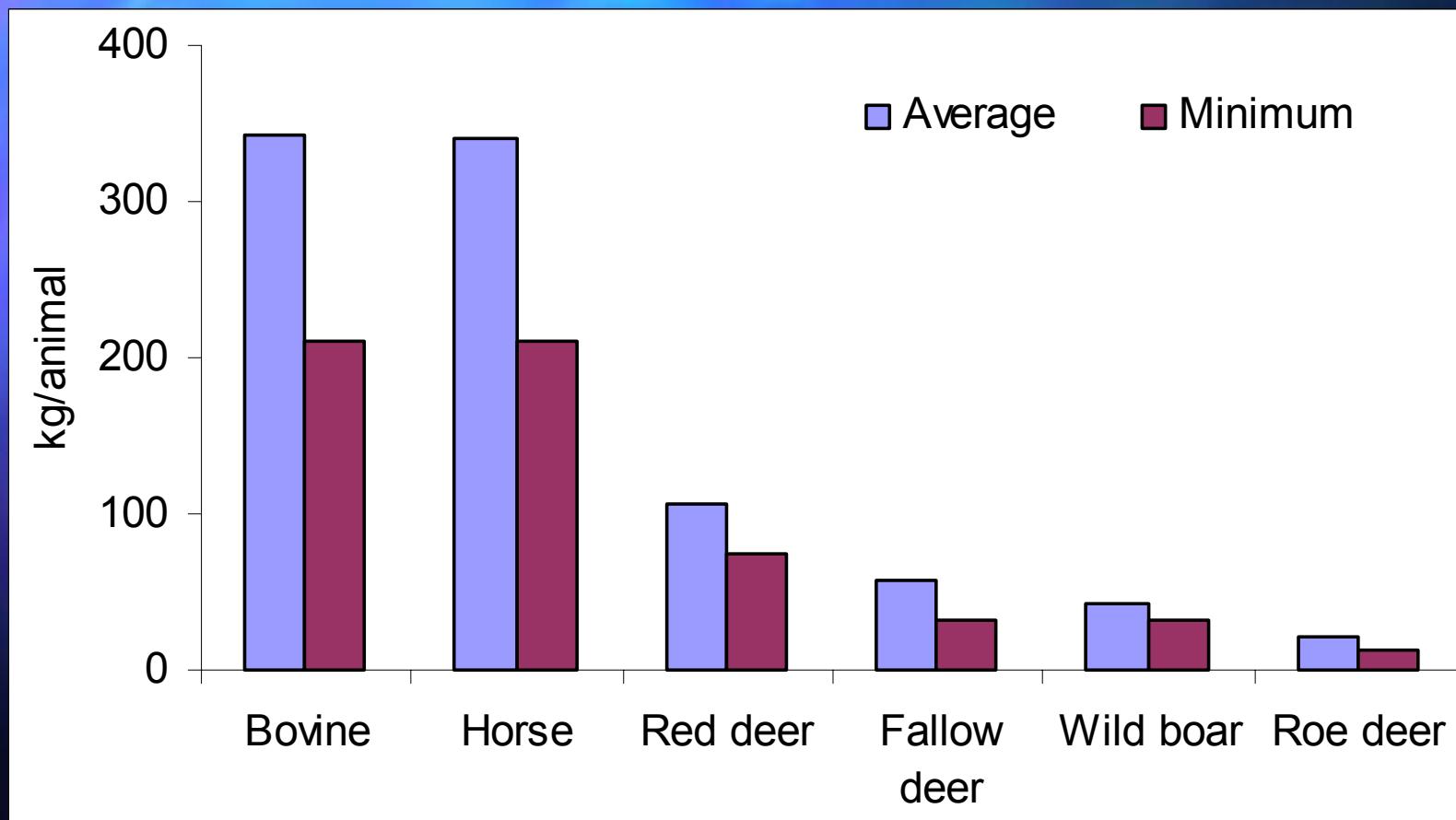
consumed energy (MJ/yr)



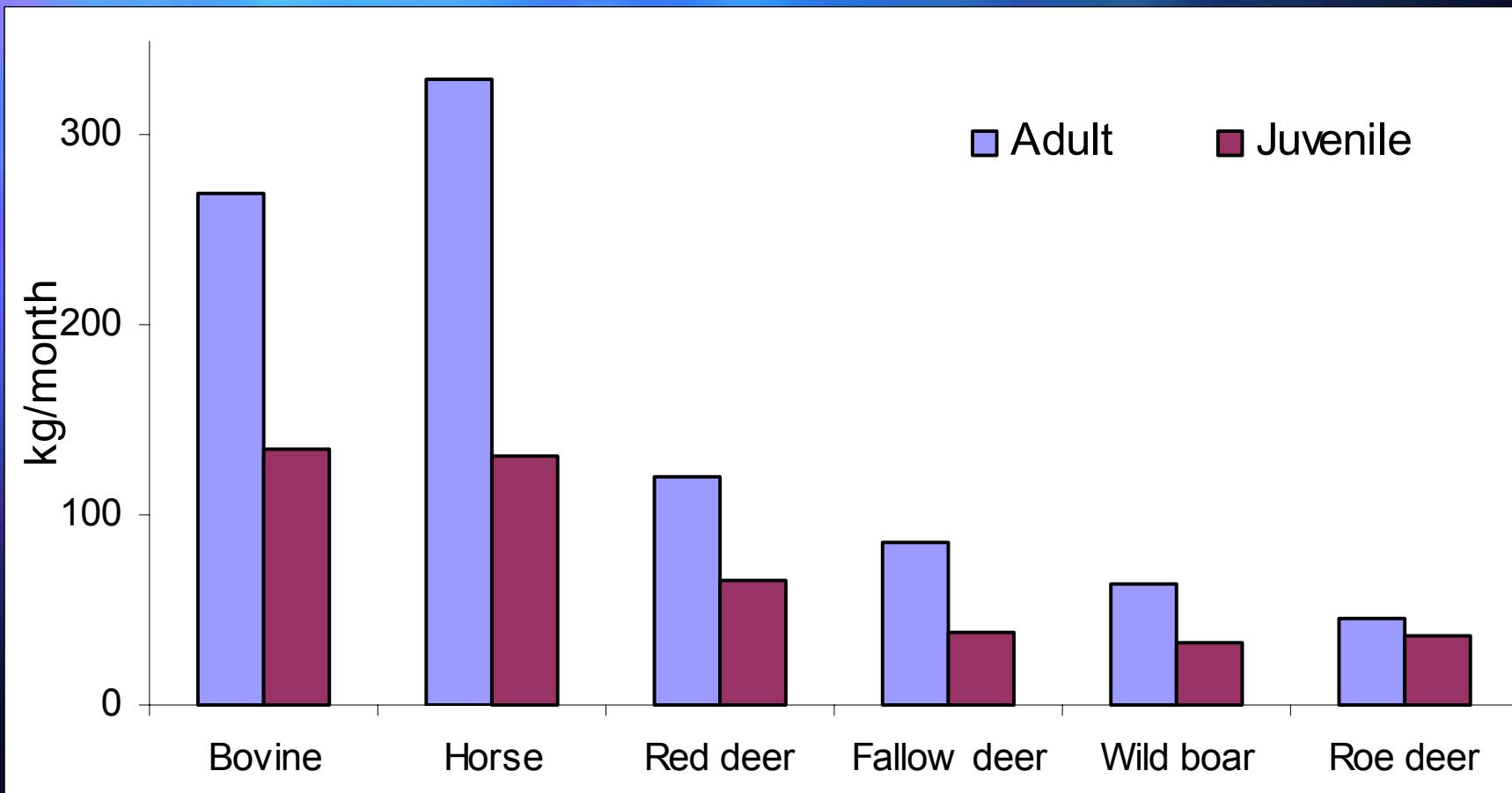
Energy requirements



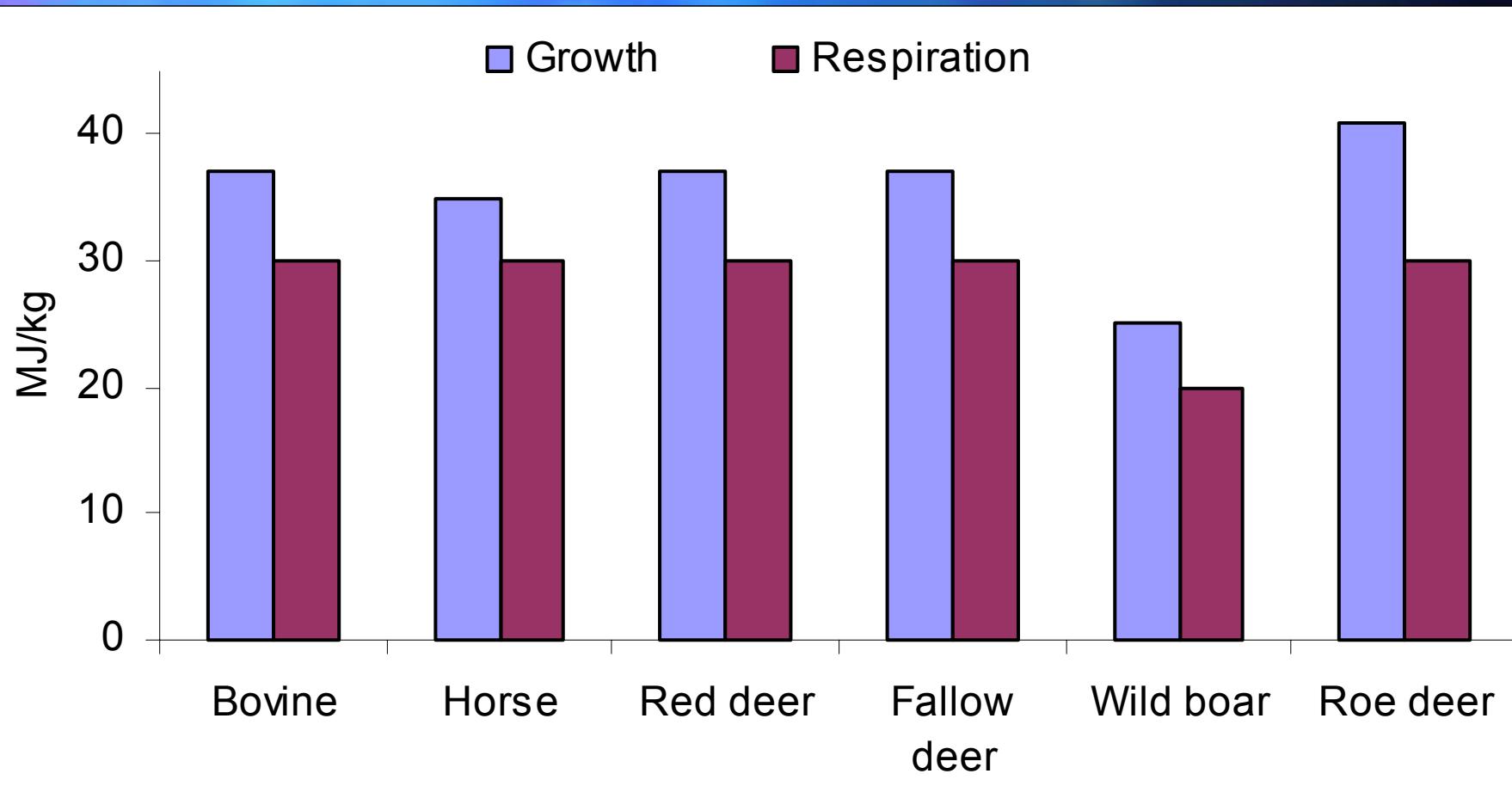
Body weight



Maximum food intake



Conversion of energy in dry matter



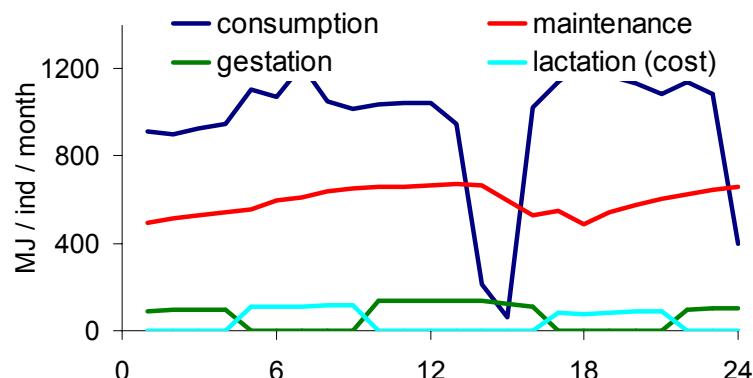
Change in body weight

$$\frac{dWgh_{Ad}}{dt} = \frac{Cns_{Ad}}{CGrw} - \frac{Prg + Lct + Mnt_{Ad}}{CRsp}$$

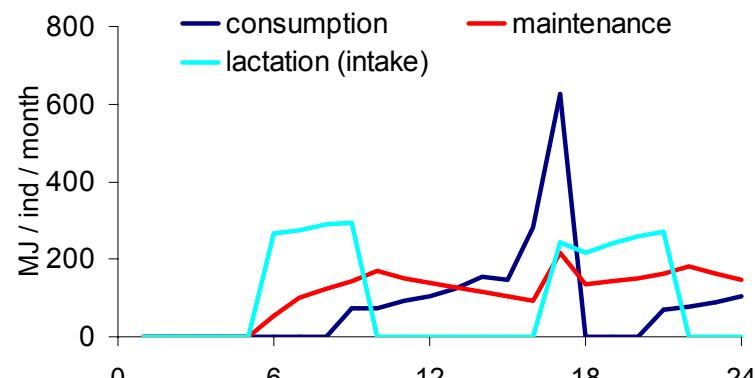
$$\frac{dWgh_{Jv}}{dt} = \frac{Lct + Cns_{Jv}}{CGrw} - \frac{Mnt_{Jv}}{CRsp}$$

Red deer

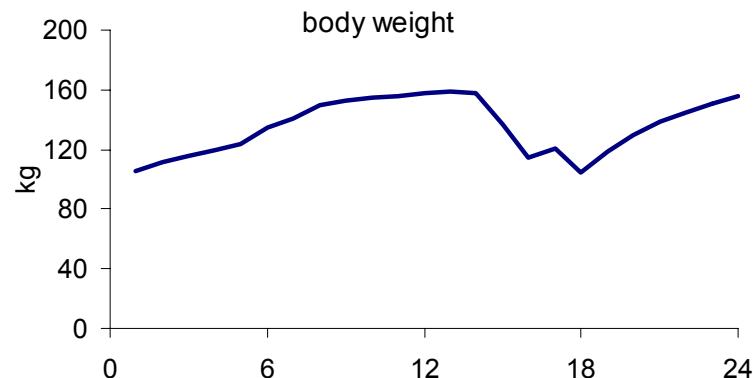
adults



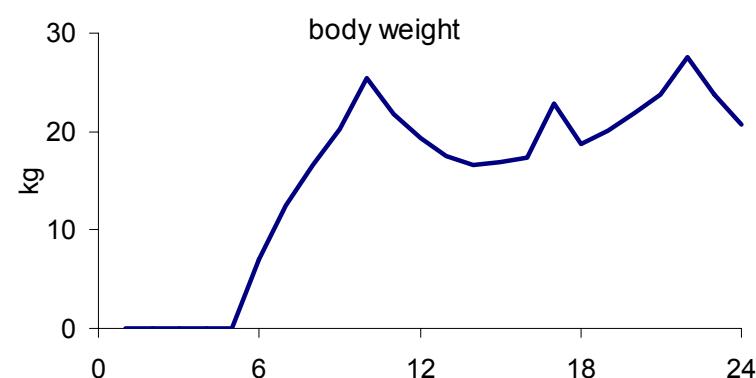
juveniles



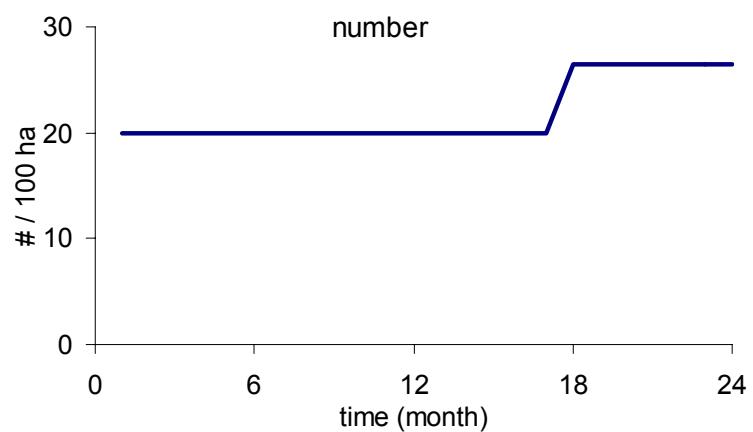
body weight



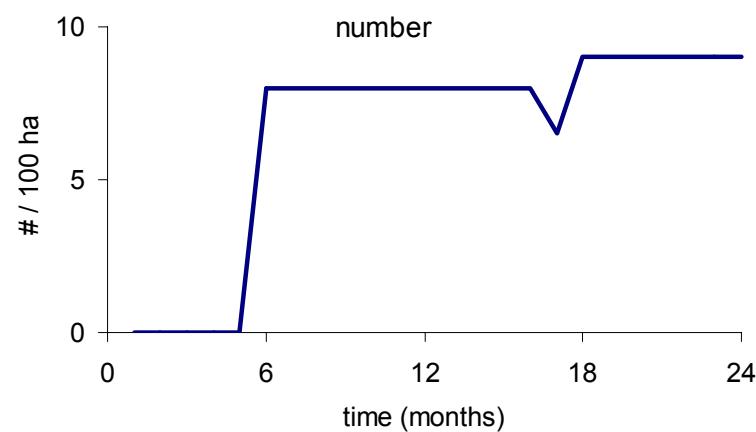
body weight



number



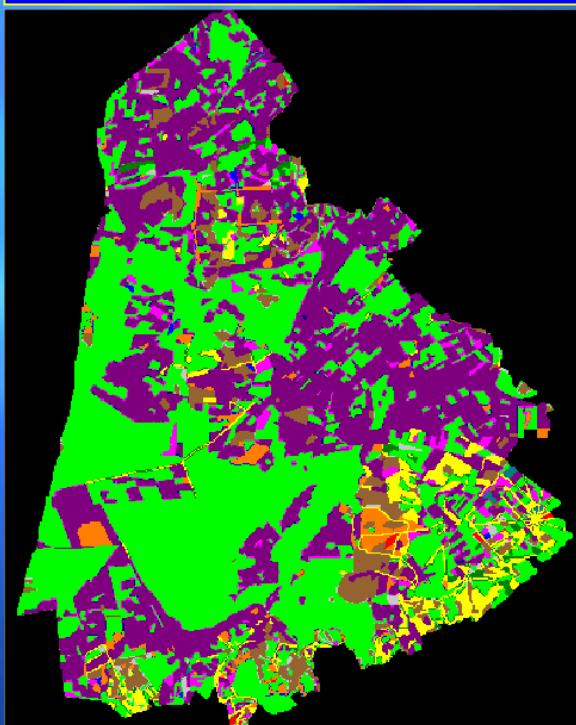
number



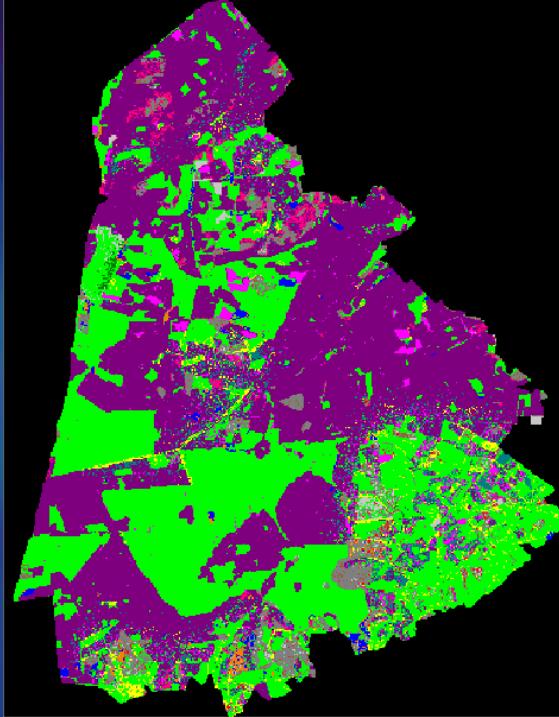
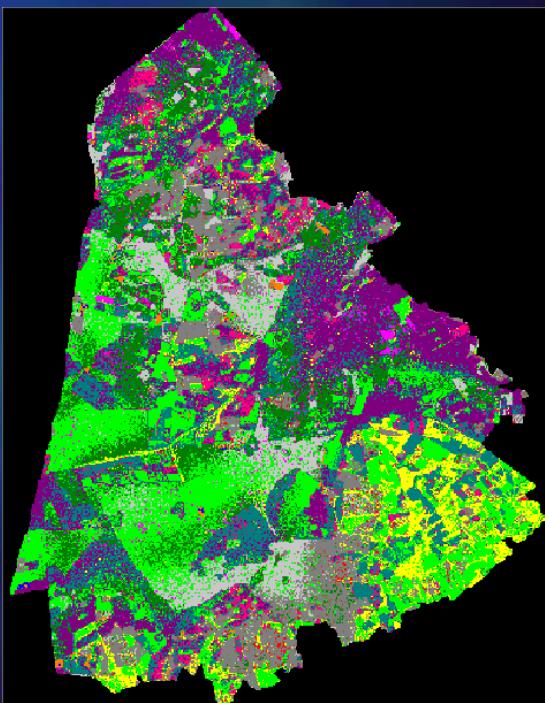
$T=50$ yr. grazing



$T=0$



$T=50$ yr. no grazing





Fire

- build-up of fuel load: FORSPACE
- fire intensity: fuel load and wind speed
- flame height: herb-, shrub-, tree layer, fire intensity
- fire frequency: stochastic
- burned area: fuel load in which an ignition occurs is burned
- mortality of trees is species dependent
- herb and litter layers are removed

Principal equations fire

intensity :

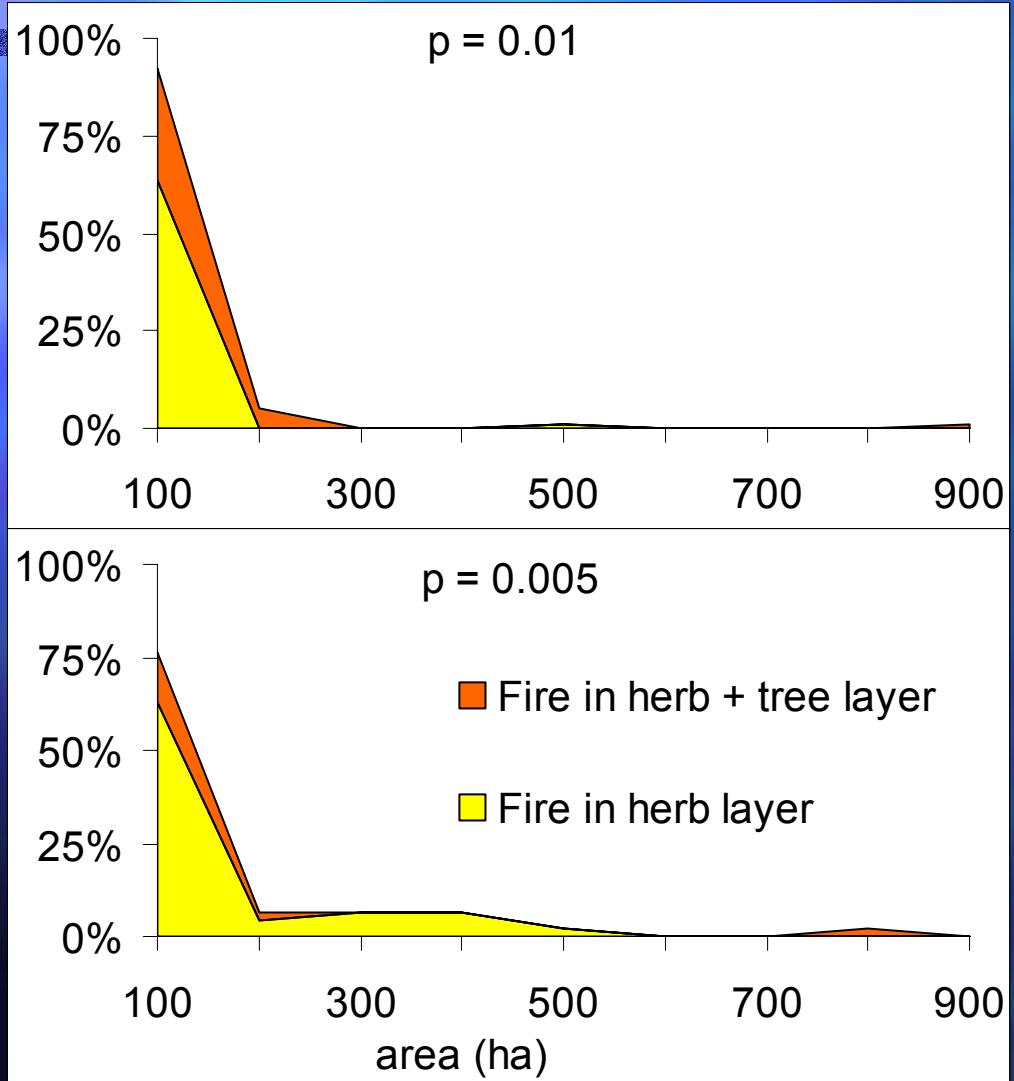
$$I_l = \frac{RSpr}{IC \cdot H_{comb} \cdot Fld_l}$$

height of the flames :

$$HghFlm_{Hl} = I_{Hl} / CFlm^{0.46}$$



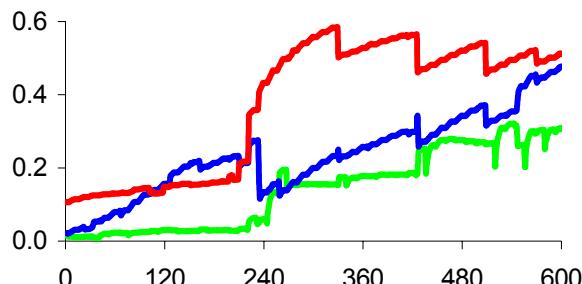
Size of burned area



Frequency distribution of the size of the burned area and fire frequency

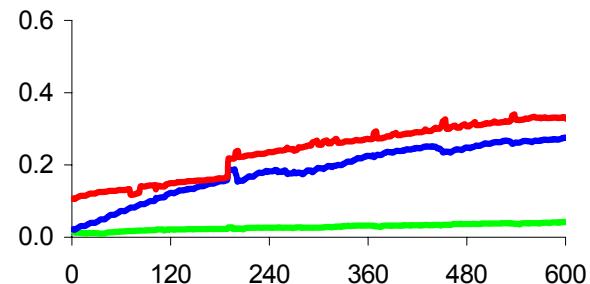
Quercus robur, fire

no ungulates:

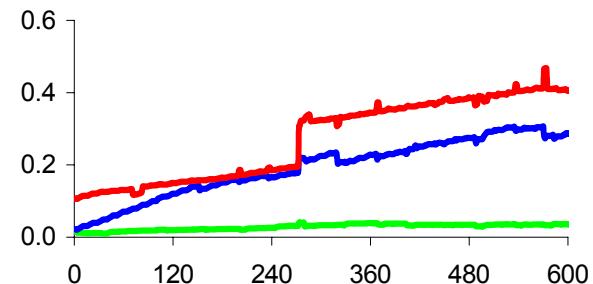


population control:

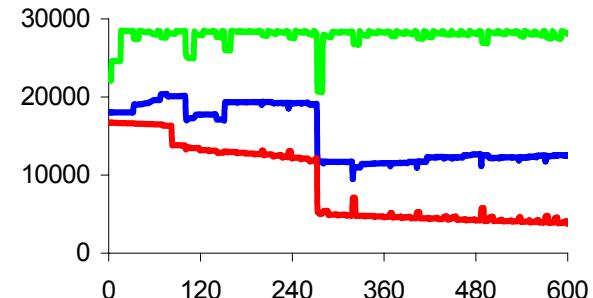
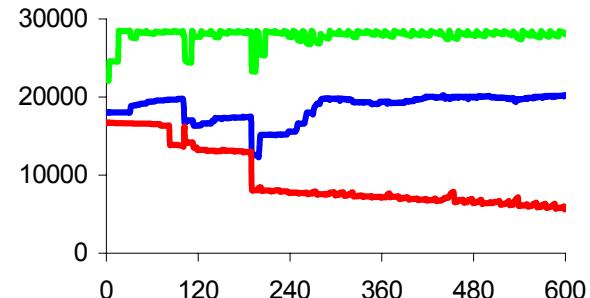
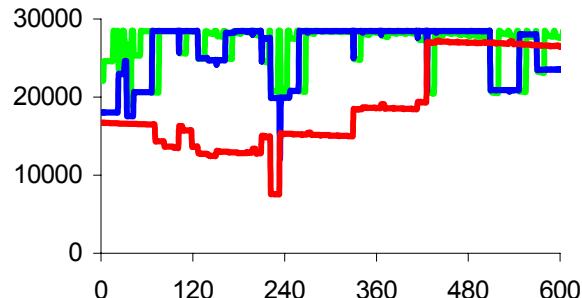
Average cover



no population control:



Number of occupied cells



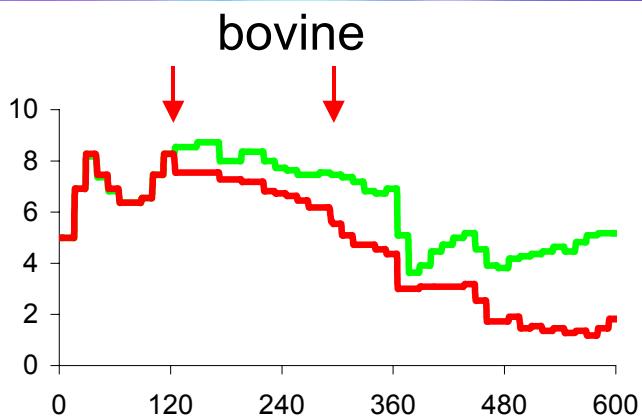
time (months)

tree-layer

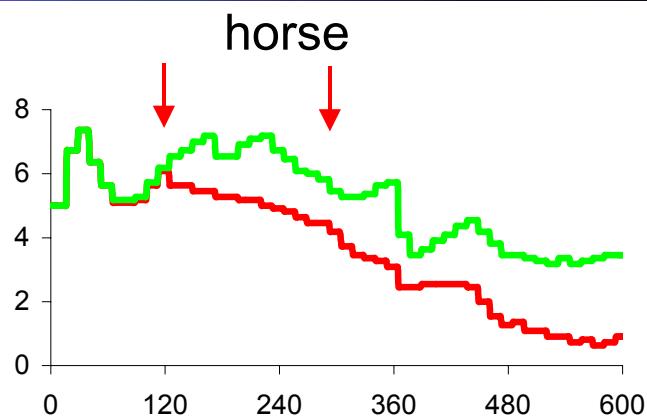
shrub-layer

herb-layer

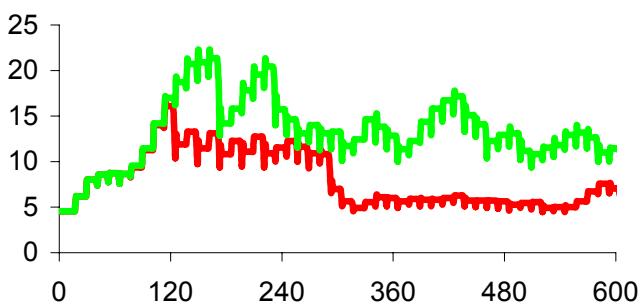
bovine



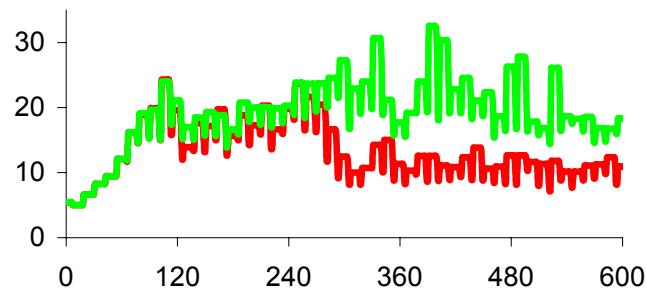
horse



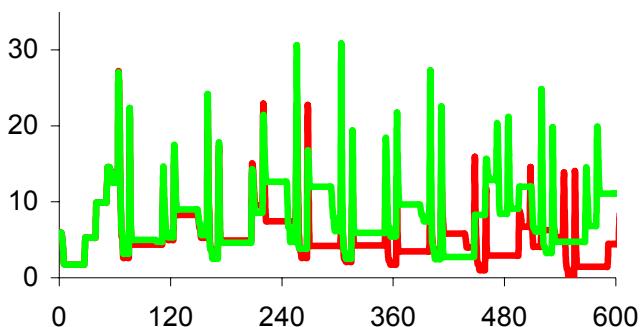
reddeer



roedeer



wild boar



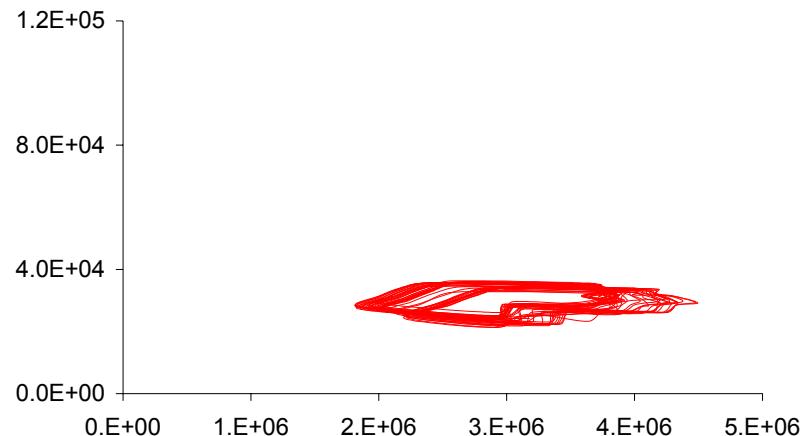
- no fire
- fire

time (months)

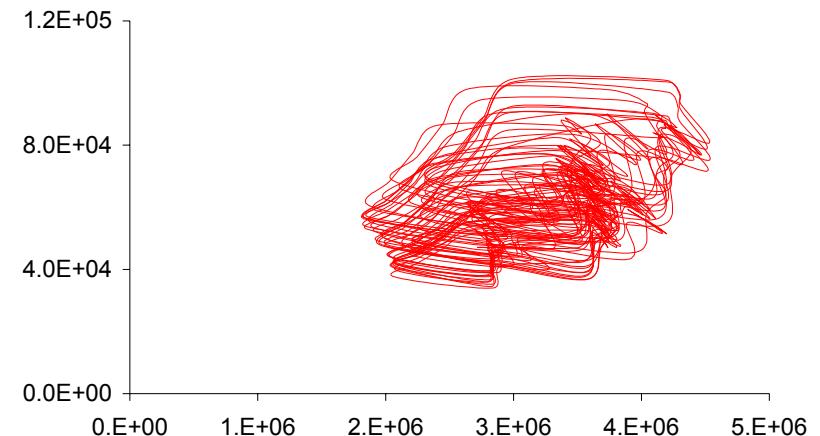
Total ecosystem foliar biomass X total ecosystem ungulate biomass

population control:

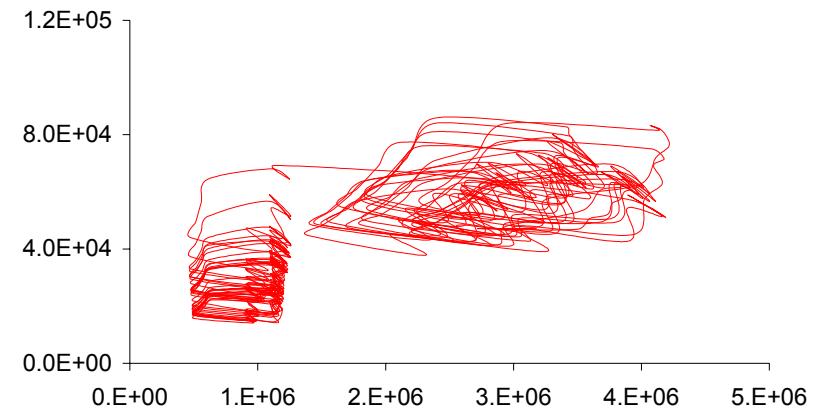
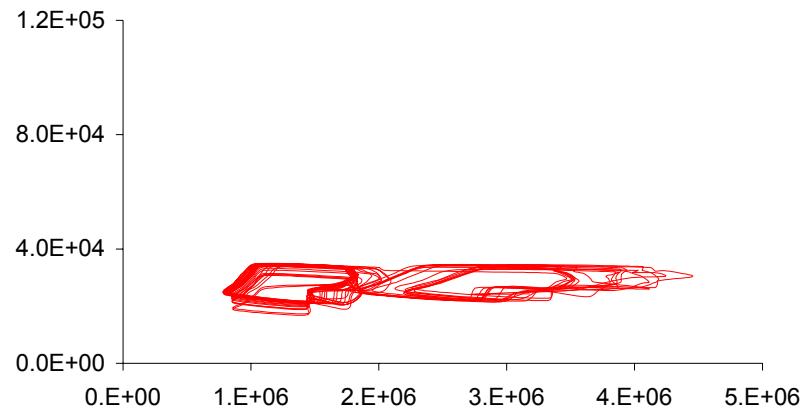
no fire:



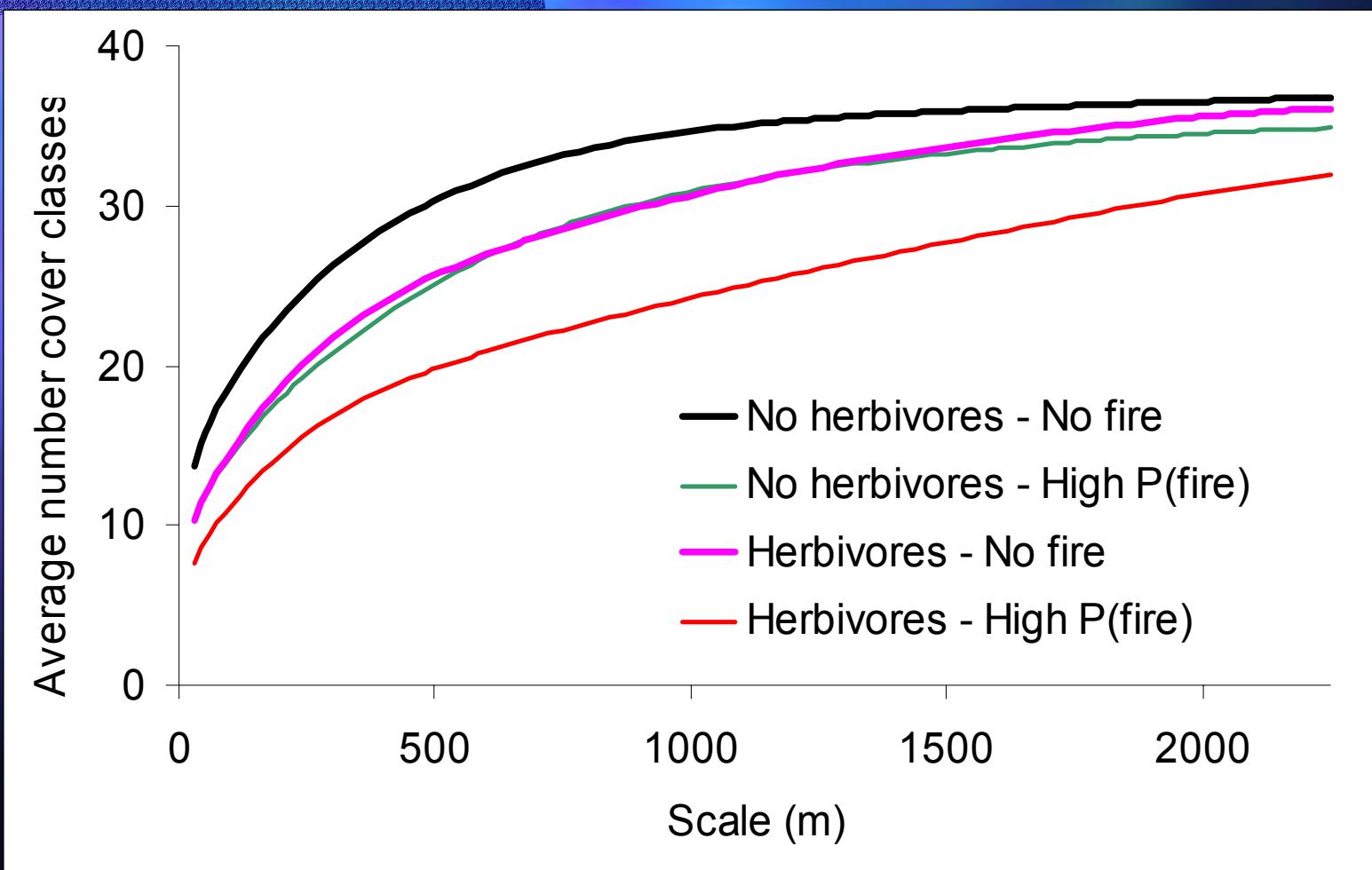
no population control:



fire:



Spatial diversity



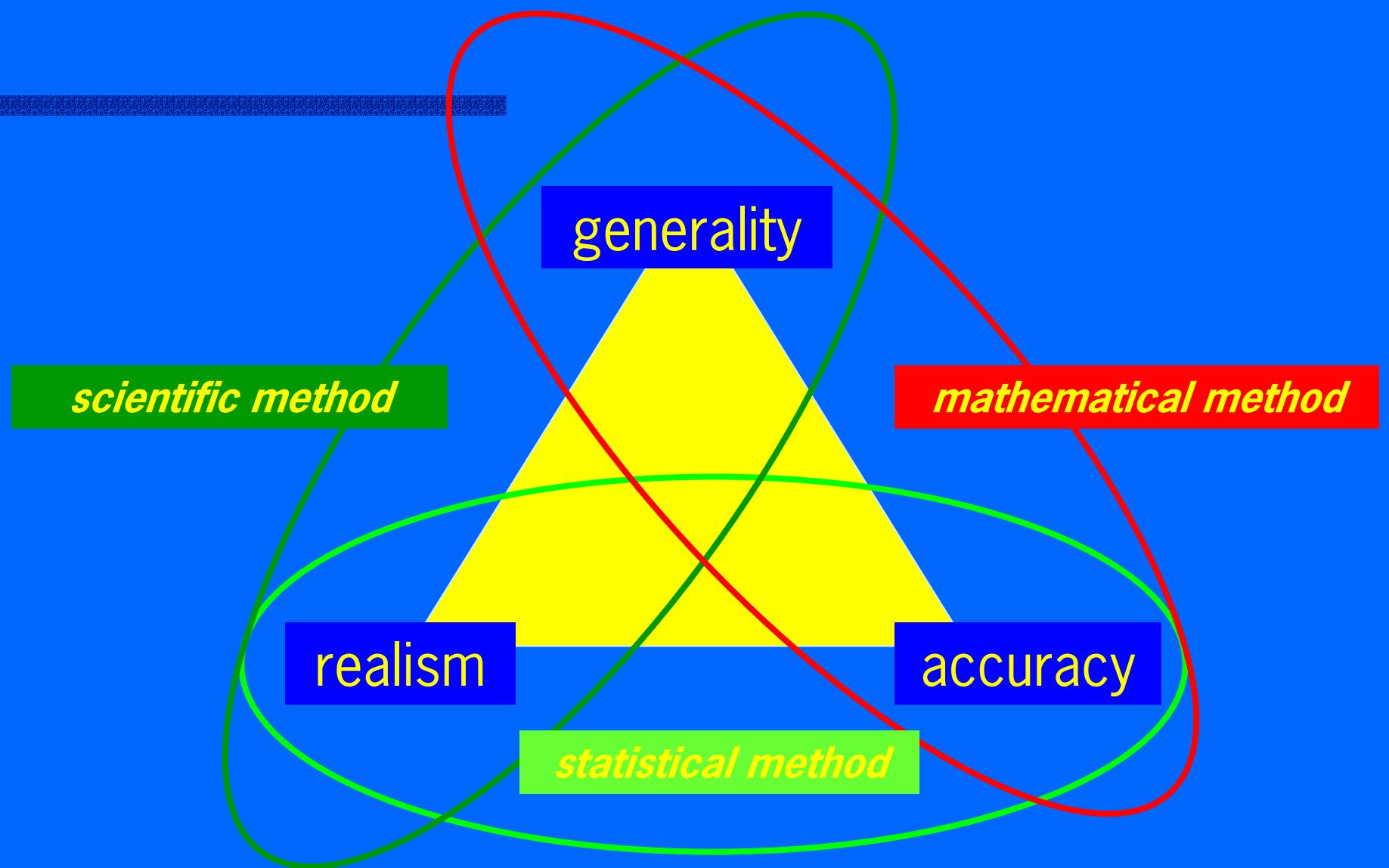
Summary

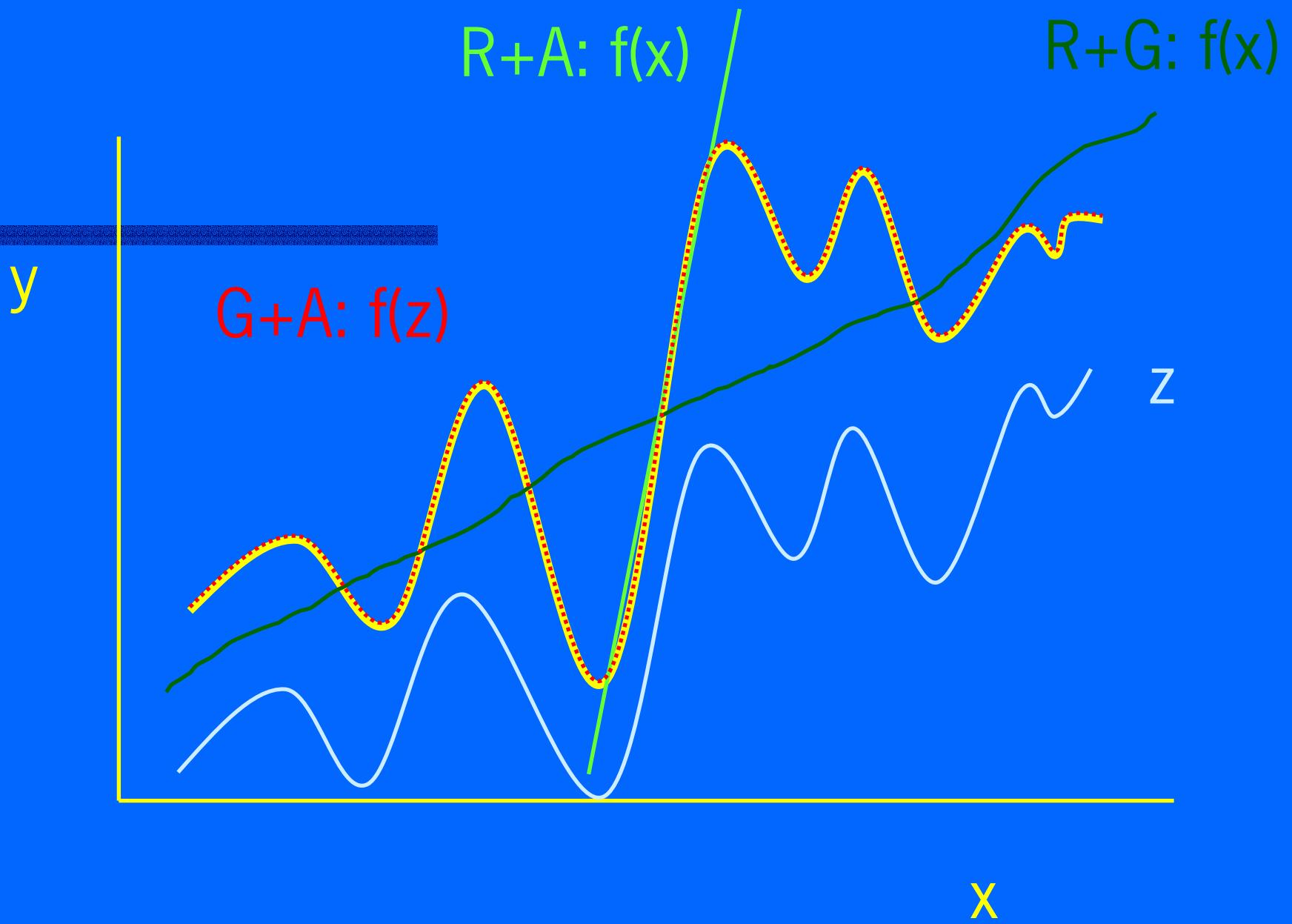
↳ Forspace:

- general model on vegetation development at landscape scale
- mechanistic, process based
- scientific aims: understanding ecosystem dynamics and importance of spatial aspects
- applied aims: support management decisions

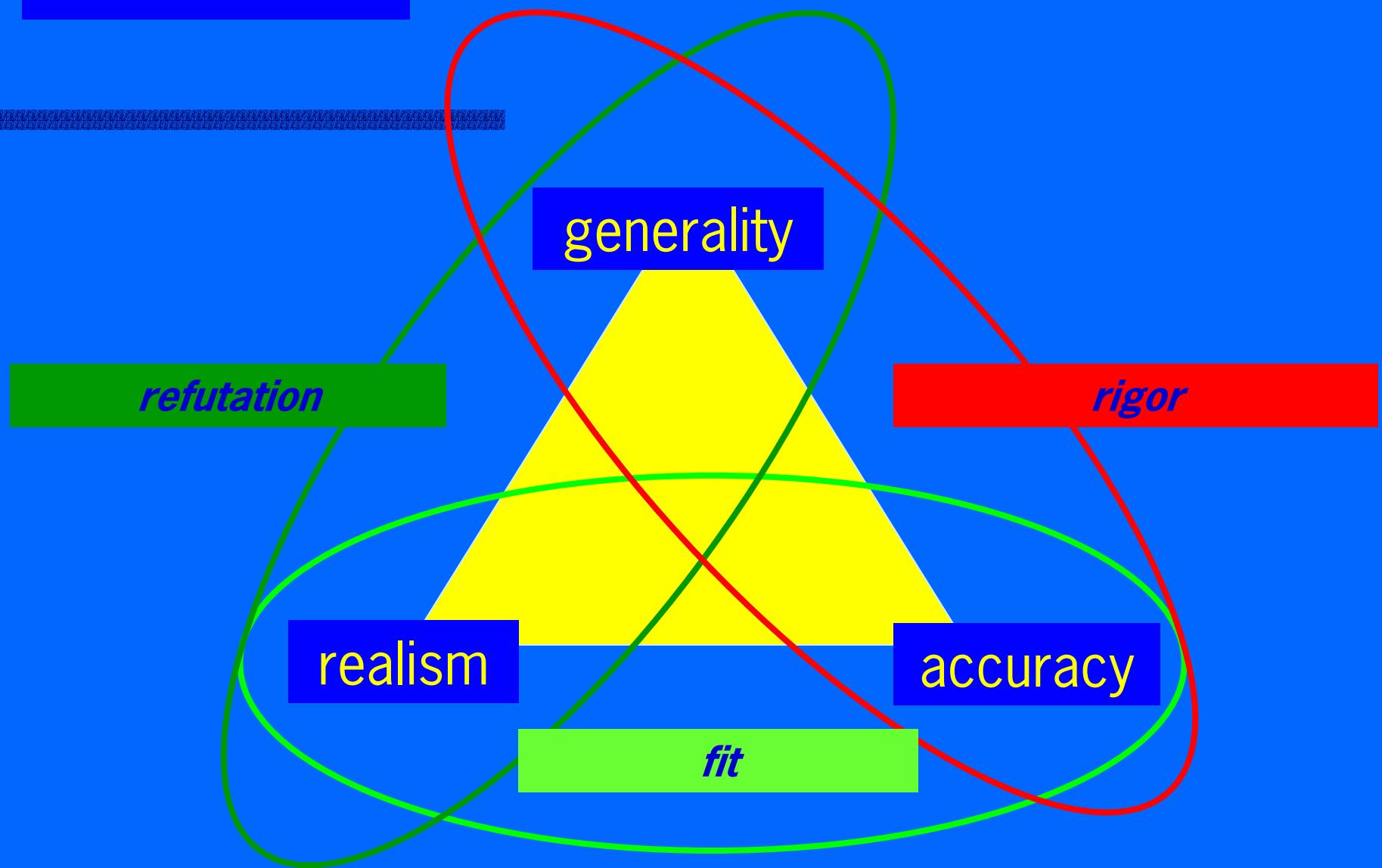


Modelling approaches

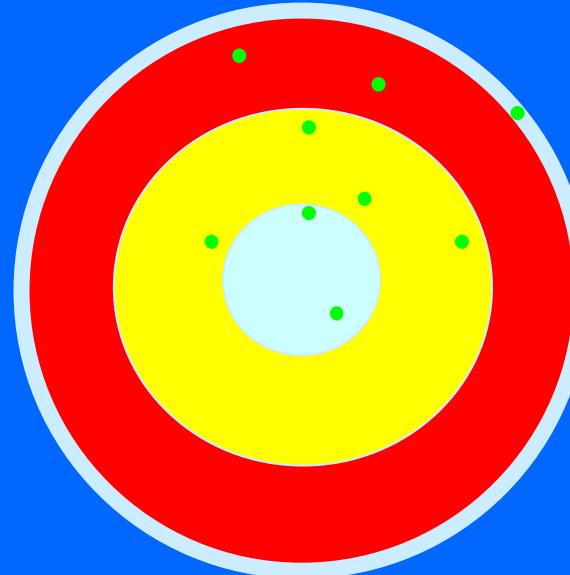
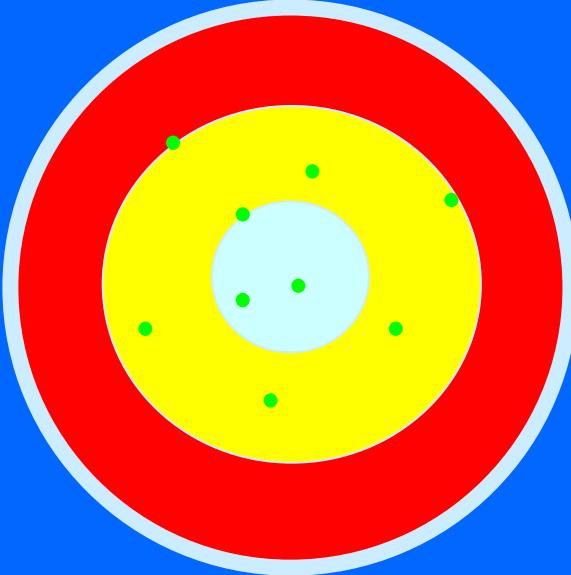
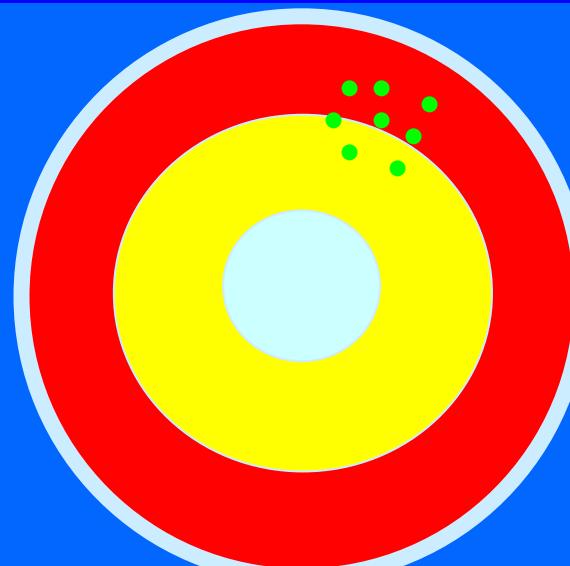
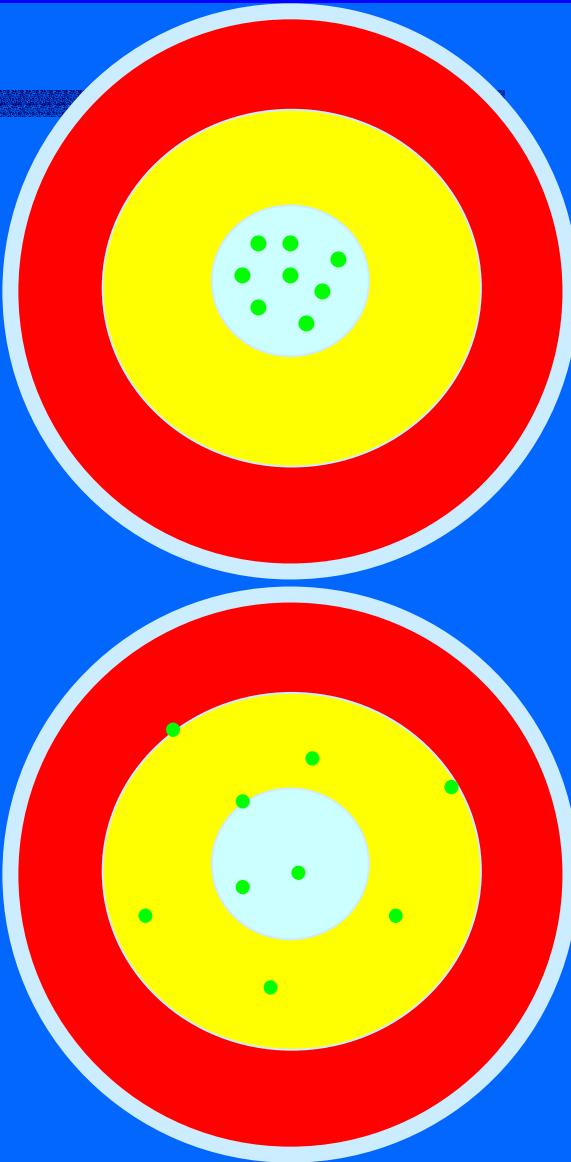




Validation

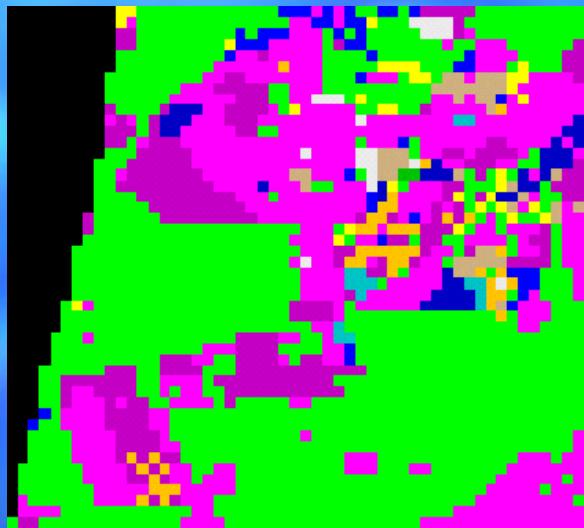


accurate - precise
systematic - unsystematic error



Vegetation development

Vegetation Type
Not classified
Bare sand
Heath land
Meadow
Open birch forest
Open pine forest
Open oak forest
Open beech forest
Birch forest
Hollow pine forest
Pine forest
Pine/oak forest
Pine/beech forest
Hollow oak forest
Oak forest
Oak/beech forest
Hollow beech forest
Beech forest



t=0 year



t=100 year



t=300 year