Modeling N Dynamics

Effects of nitrogen deposition over time in the real (dynamic) world

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Goals of dynamic modelling of Nr effects (on biodiversity):

- Keep focusing on the efects (of Nr deposition and levels) on ecosystems (levels and deposition are important and so are the costs, but the effects need to stay in the picture)
- To deliver useful (simple?) messages even if produced by using complicated models addressing complicated issues with a number of gaps in knowledge and uncertainties
- To make efforts to stay conected with science outside CLRTAP (monitoring, experiments, models)

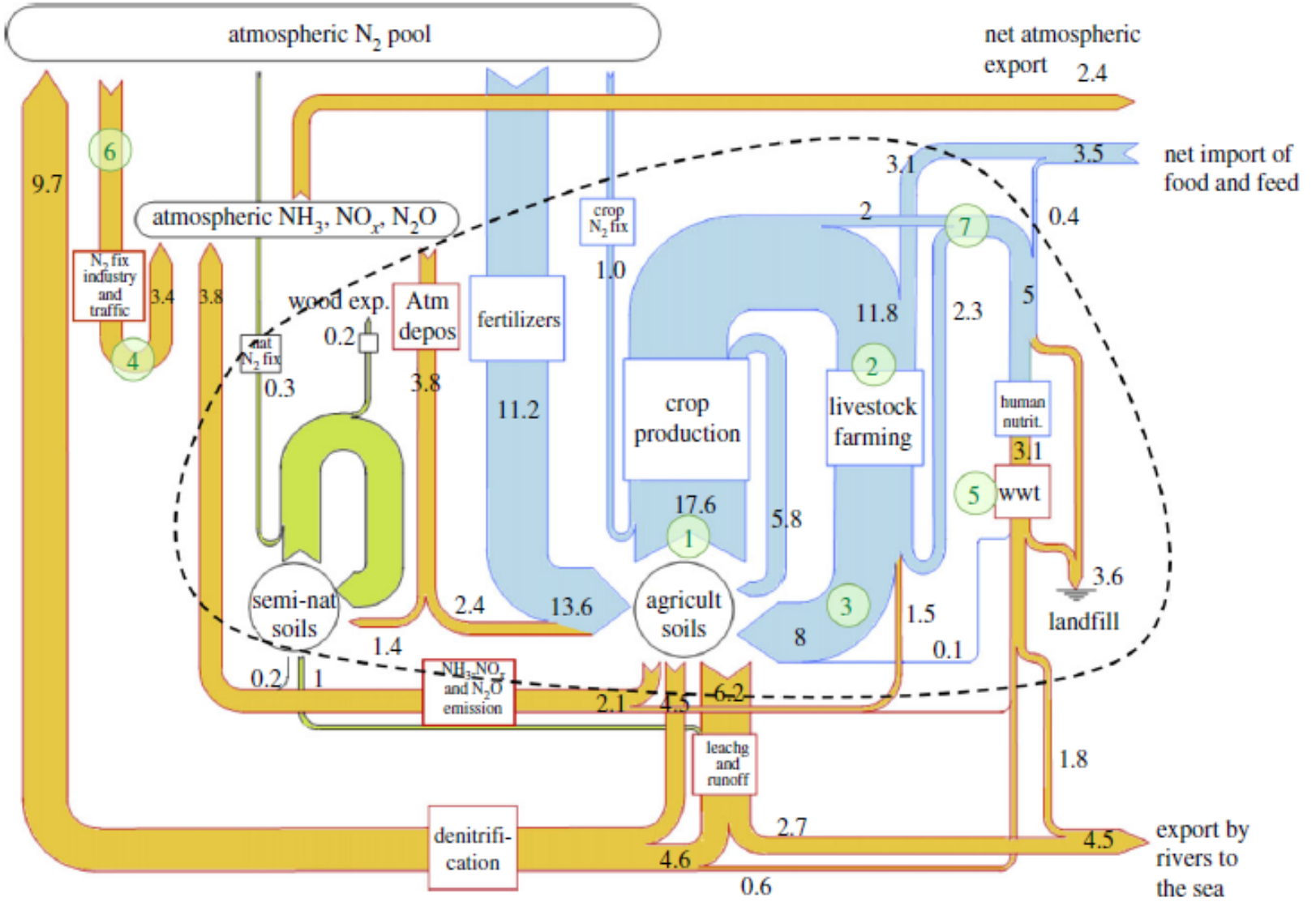

Figure 4. The nitrogen cycle within the EU-27 showing natural fluxes (Tg N) in green, (intentional) anthropogenic fluxes as blue and (unintentional) as orange adapted from the ENA [69]. The terrestrial component of the cycle is delineated by the dotted ellipse.

- Global N fixation: 203 Tg Nr natural, 210 Tg Nr anthropogenic
- In EU 27 “Intentional” (blue) and “Unintentional” (orange) fluxes of Nr both larger than “Natural”

Fowler D et al. 2013 The global nitrogen cycle in the twenty-first century. Phil Trans R Soc B 368: 20130164.

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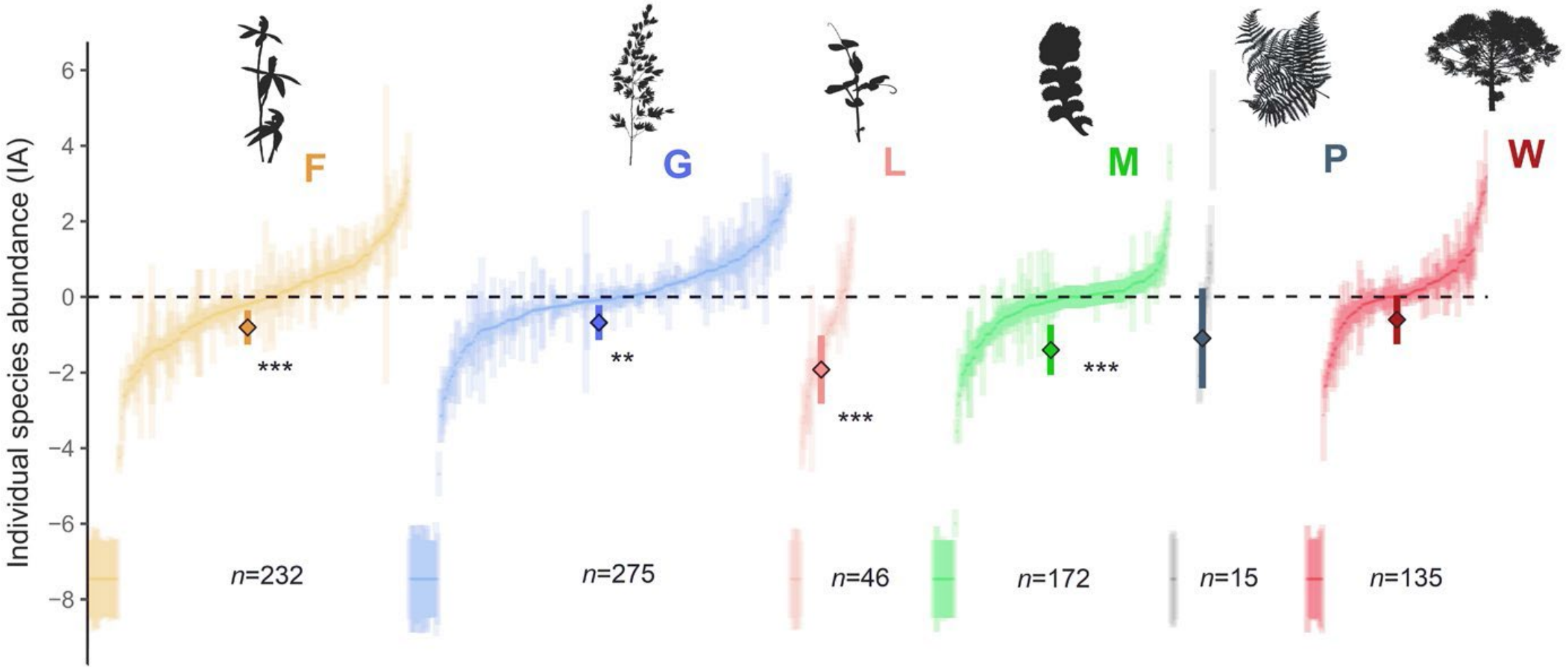
Focussing on biodiversity

- Politically popular, recognised as an important issue, easy to relate to by non-experts
- The well established links between Nr and biodiversity gives potential for political use
- Parts of the science (and models) well established
- Binds together air pollution, climate change and land use in one framework
- Provides criteria compatible with current CL methodology



”We found that all metrics of plant diversity responded negatively to increasing yearly N addition”

Midolo G et al., 2019, Global Ecol Biogeogr. (Forbes, Graminoids, leGuminosae, non-vascular, ferns, Woody species, 115 N addition studies)

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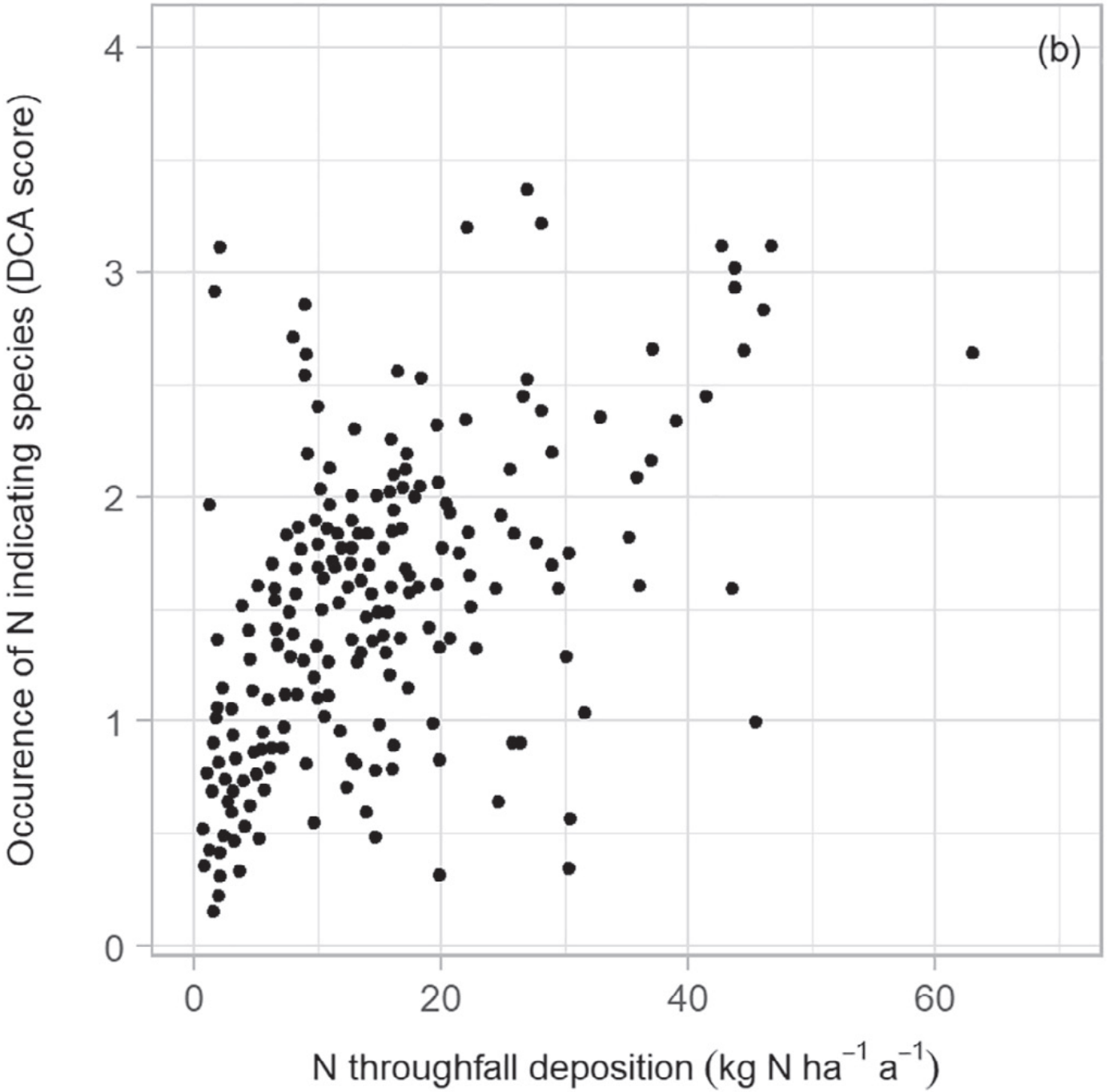


Experiments and observations

- Experiments often large N doses (Midodlo et al – mean ca 100 kg N/ha/yr added)
- Atmospheric deposition: smaller range, smaller changes
- Large span in DCA score (or other metrics) within small deposition interval

Schmitz A., et al., 2019, Env. Poll.
After Seidling W., et al., 2008., 488 ICP Forests plots

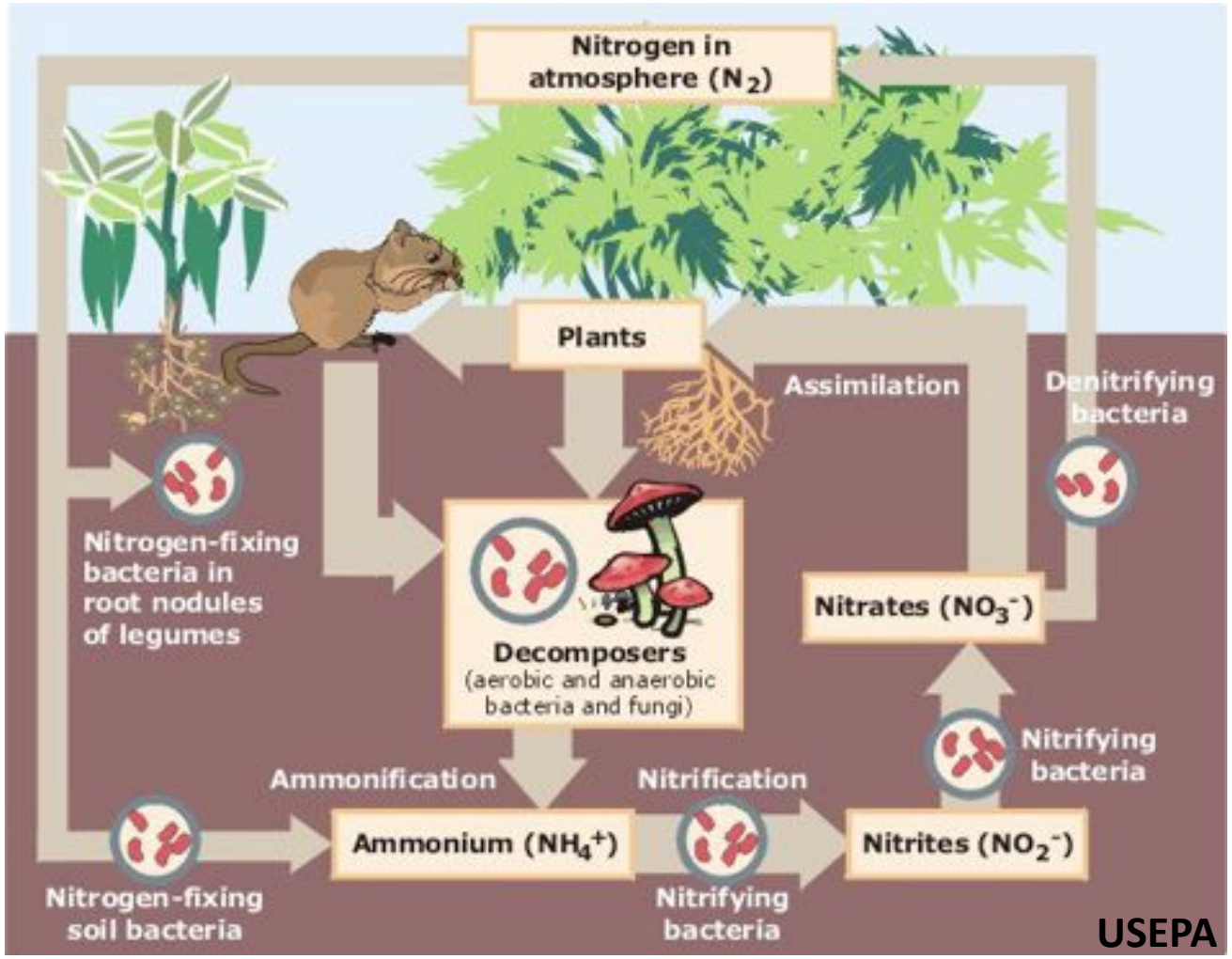
N_2 → N_R

N-fixation

Biological & Anthopogenic

Particles and gasses: NH3, NH4, HNO3, NO3, NO2, HO2NO2, HONO,PAN, MPAN

N_R → N_2



Where do we stand?

- Complicated issue, non-linear processes, different trajectories with increasing and decreasing Nr load, other factors more important for biodiversity.
- Huge effort in data collecting and model development! (PROPS, ForSAFE-VEG, VSD+ Veg, Pnet, MAGIC7, SMART and more) Progress has been made and work continues.
- Despite the efforts the geochemical part of the DM still needs further work before confidently matching observations and that is only the first step, link to plant species comes after that.
- There is a overwhelming evidence of Nr impact on biodiversity from experiments and from monitoring.

Ways forward

- To keep up the effort on model development, data collection and experiments
- Team work. Co-operation with the Convention and with other groups is essential: models are good framework bringing the parts of the problem together
- Communication about packaging the results and the messages – within the Convention and nationally.

Conclusions

- The use of DM of biodiversity requires co-operation of experts from different fields (e.g. geochemists, microbiologists, plant physiologist and botanist) and use of data from monitoring and from experiments. CLRTAP is an excellent platform for further development, but need to be connected with external groups.
- Because of the multiple factors influencing biodiversity, non-linear nature of most considered processes and cumulative nature of the impact of Nr, the dynamic models are necessary tools to synthesise our knowledge for the policy purposes.
- The complexity of the problem and of the tools to analyse it does not mean the policy message needs to be complex.

Thank you for your attention

Effects on ecosystems: why dynamic modeling?

- Exceedance maps acidification: well established link to observable effects, shorter time lags, link geochemistry-biology relatively straight forward, less confounding factors
- Exceedance map N as a nutrient: ***a risk map*** to a larger extent than acidification exceedance, effects often cumulative, confounding factors very important (site history, climate change, land use etc), more difficult to verify with present day observations
- No doubt that N is changing ecosystems and affecting biodiversity!