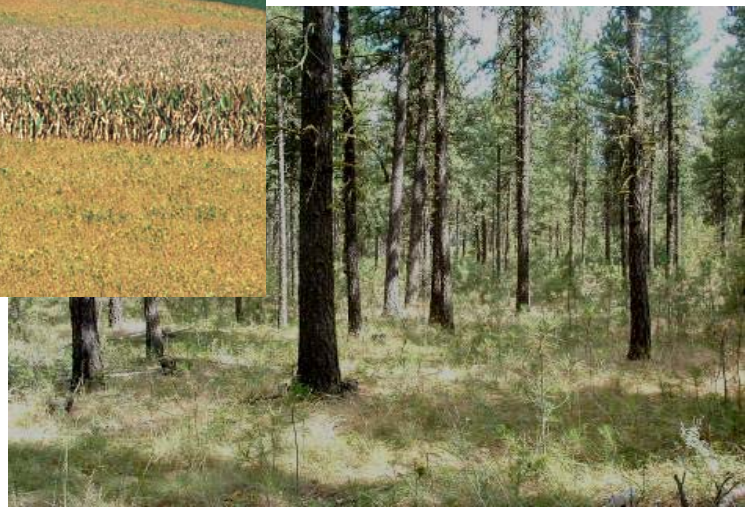
Dynamic Soil Properties and Processes Illustrated in Conceptual Models for Soil Survey



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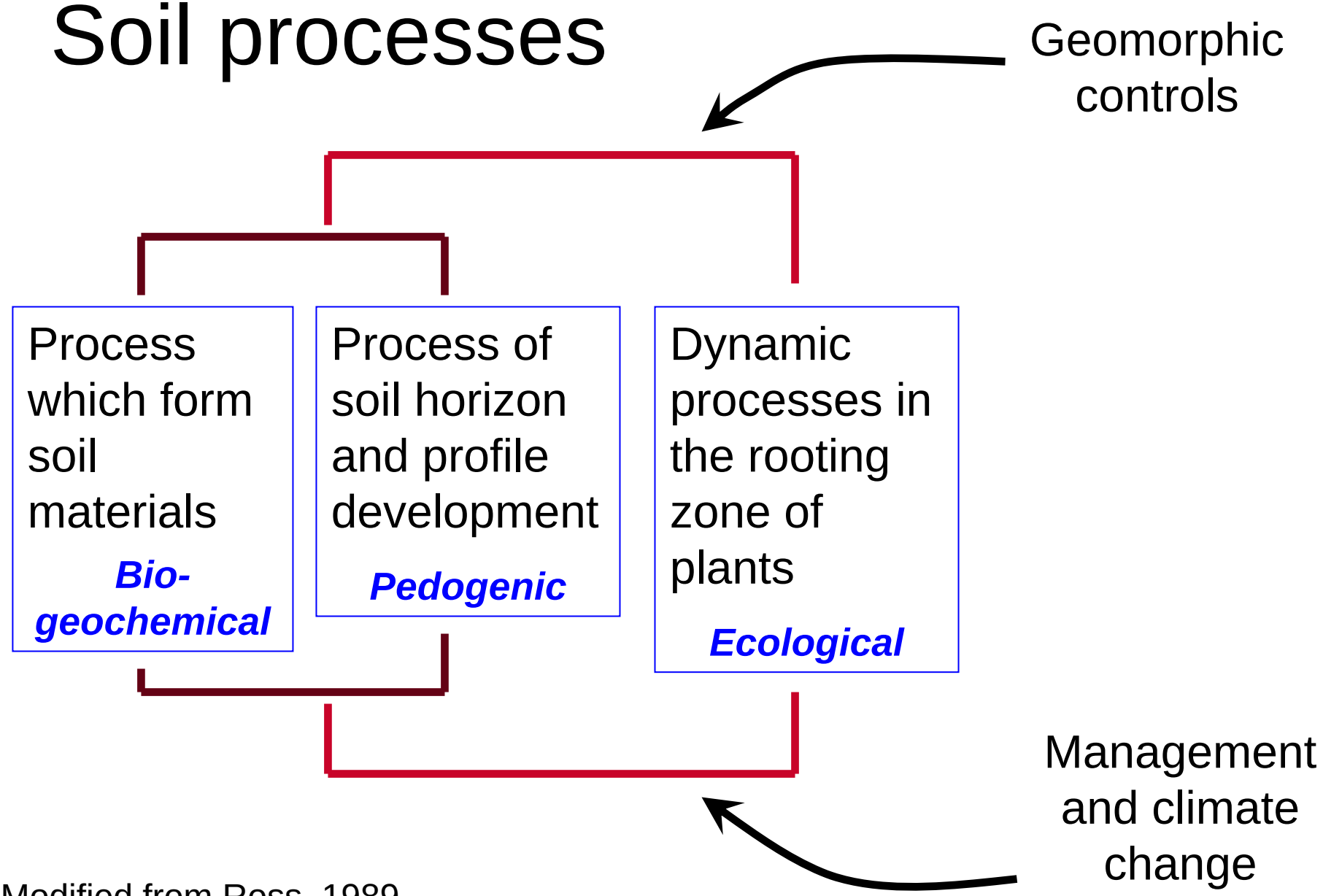
Objective

- Illustrate how conceptual process models can be used to organize information about management effects on soil/ecosystem processes and dynamic soil properties.

Why?

- To explain/predict/interpret human impacts on soil.

Soil processes



Modified from Ross, 1989
Soil Processes

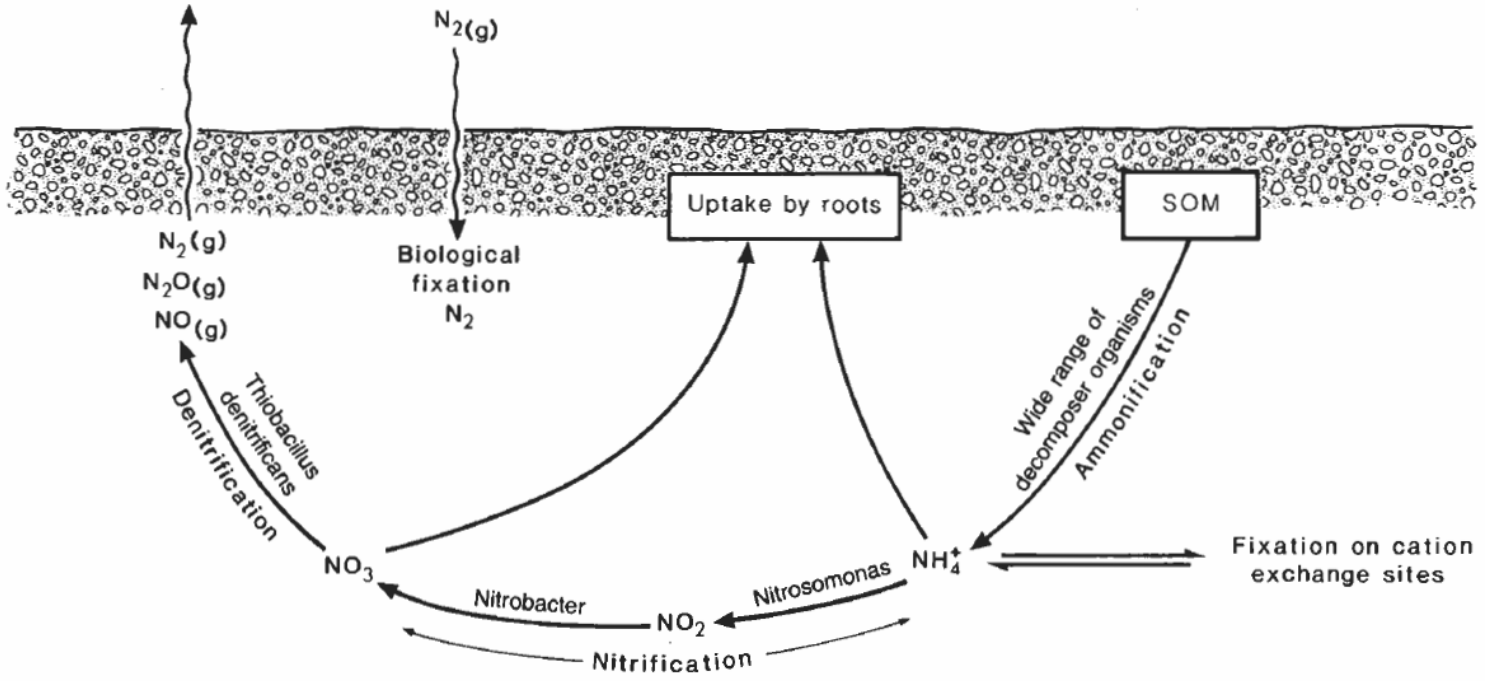
What is a conceptual model?

A purposeful representation of reality that provides a mental picture of how something works to communicate that explanation to others.

– (Starfield et al., 1993)

A model that represents key processes, interactions, and feedbacks.

– (Gross, 2003)



(Ross, 1989)

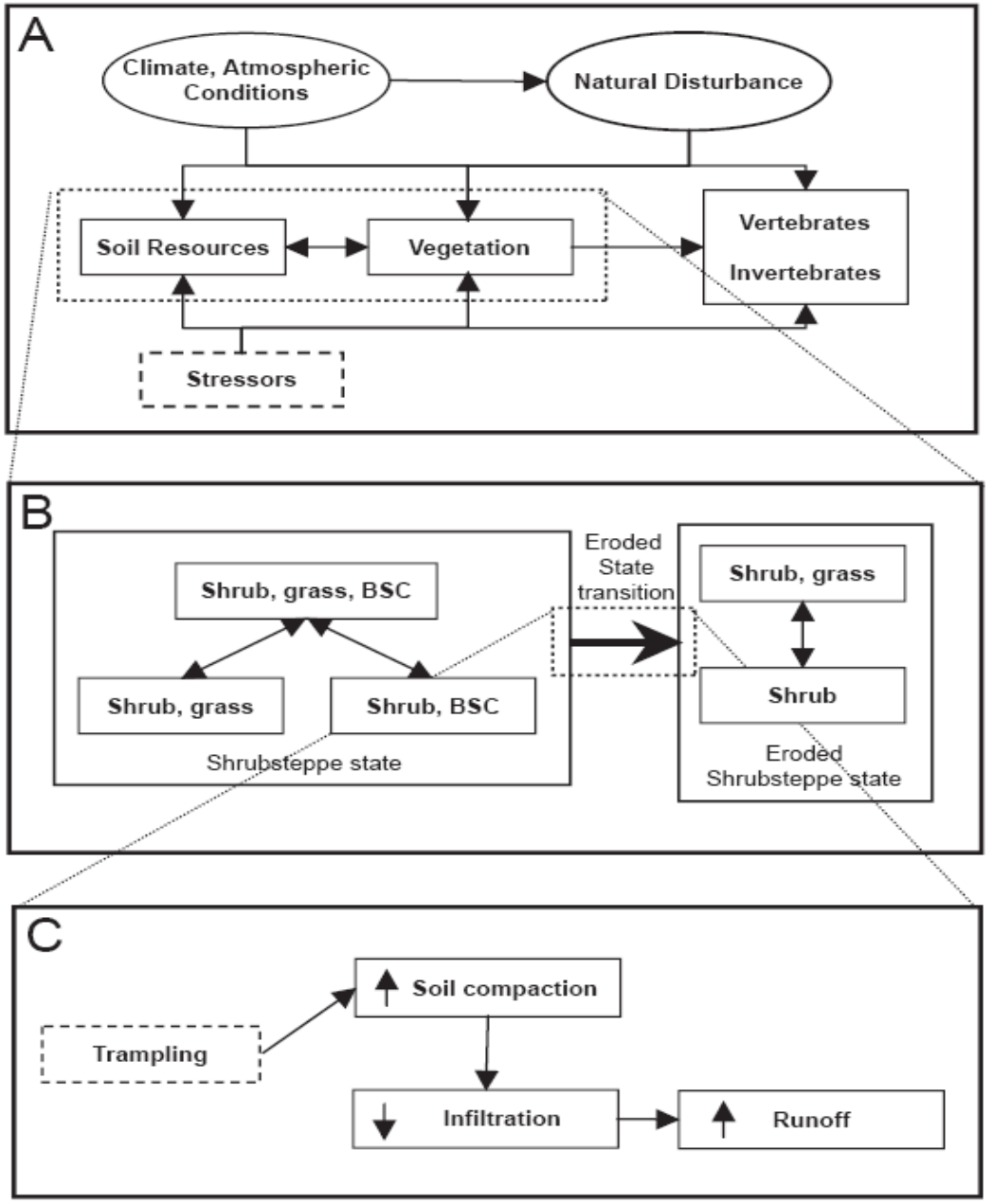
Figure 8.1 The processes of the nitrogen cycle in soil

Rangeland

MULTI-SCALE ECOSYSTEM PROCESS MODEL

NORTHERN COLORADO PLATEAU NETWORK

- Nested/hierarchical approach to showing complexity of ecosystem processes in conceptual models. The global model (A) shows the larger scale controls (drivers) that affect the system while using submodels to convey more detailed processes with (B) state and transition models and associated transition-causes (stressors) in (C) mechanistic models (from O'Dell et al. 2005)



Mechanisms of soil degradation after disturbance

- Decreased porosity
- Erosion
- Nutrient depletion
- Organic matter loss
- Reduced biological activity
- Structural degradation
- Crusting, sealing
- Change in soil-water relations
- Change in soil temperature
- Salinization
- Fire-induced water repellency

Dynamic Soil Properties

Organic matter

Aggregate stability

Salinity

Infiltration

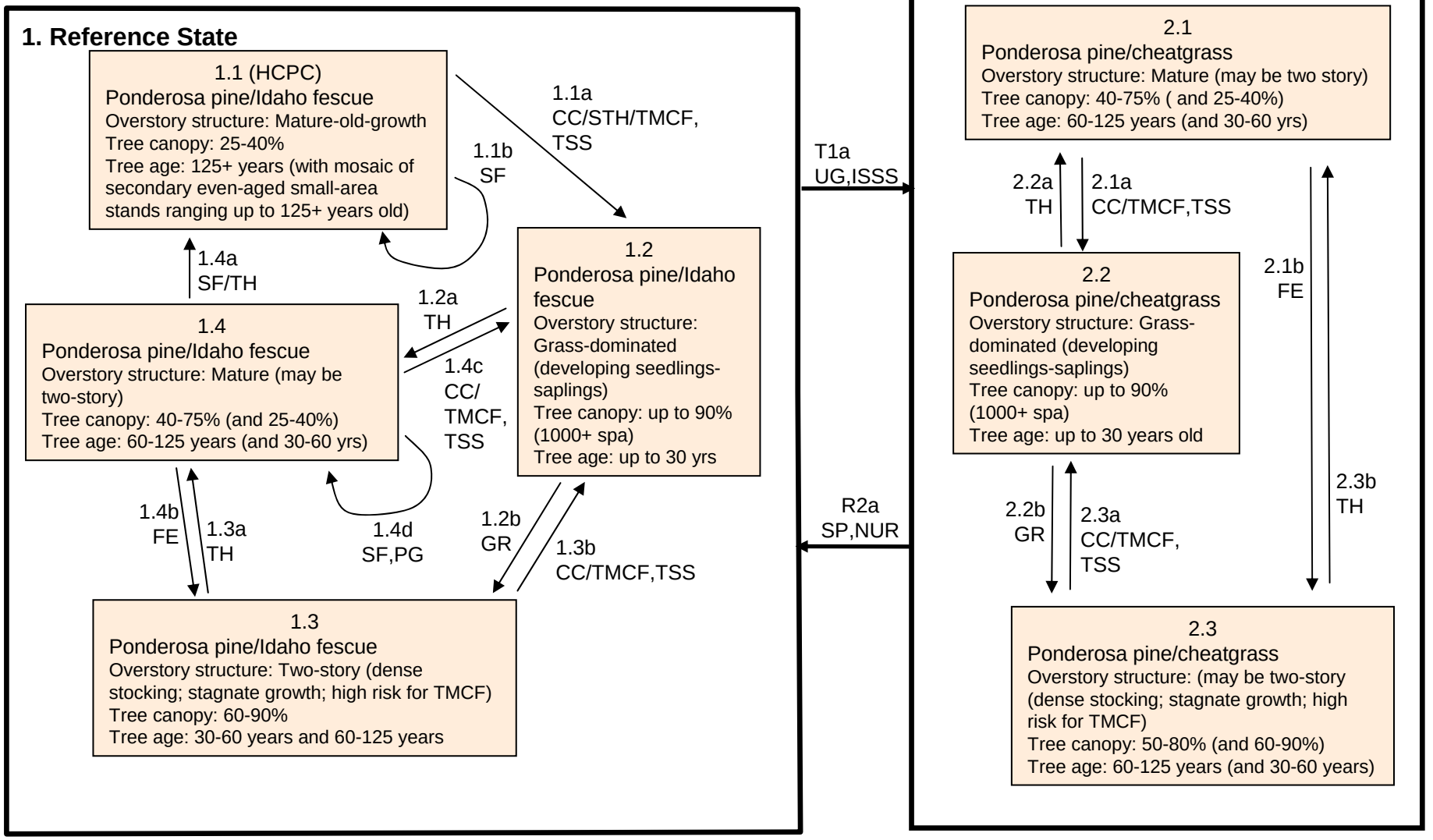
Ksat

Topsoil depth

Biological crusts

etc.

Forest State and Transition model

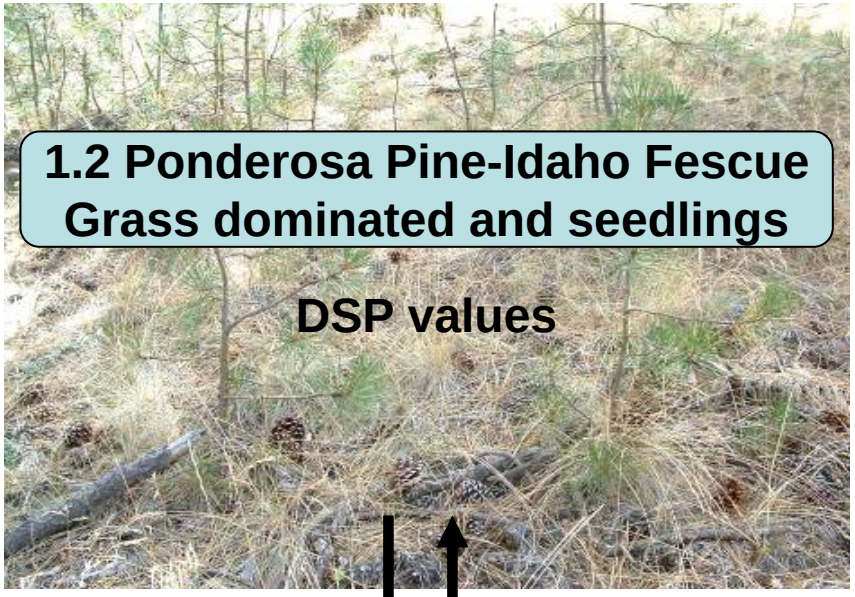


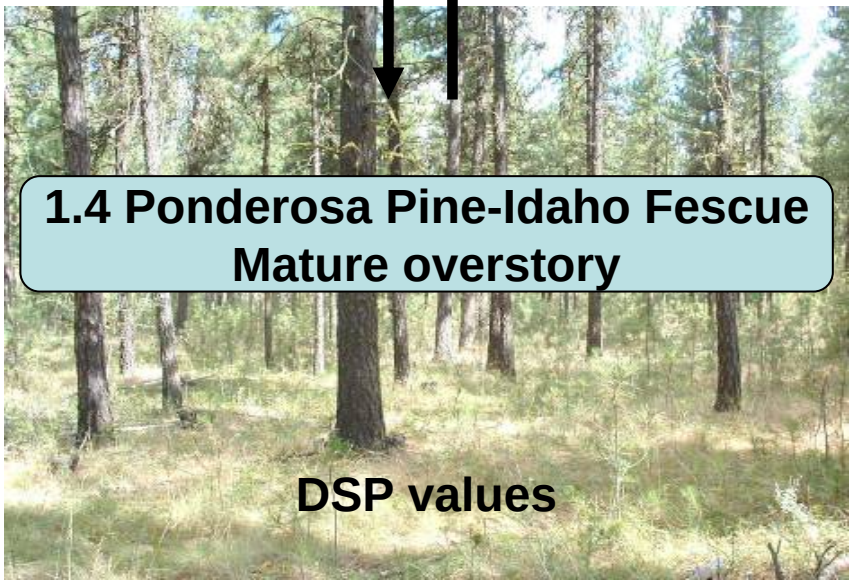
Legend: CC=clearcut harvest; FE=fire exclusion; GR=growth; HCPC=Historic Climax Plant Community; ISSS=invasive species seed source; NUR=native understory restoration; PG=prescribed grazing; SF=surface fire (recurring); SP=site preparation; spa=stems per acre; STH=seed-tree harvest; TH=thinning (prescribed); TMCF=total mortality crown fire; TSS=tree seed source present; UG=uncontrolled grazing. Symbols: **"/"** = and/or; **","** = and; **"-"** = or.

Community pathway
Restoration pathway
Transition pathway

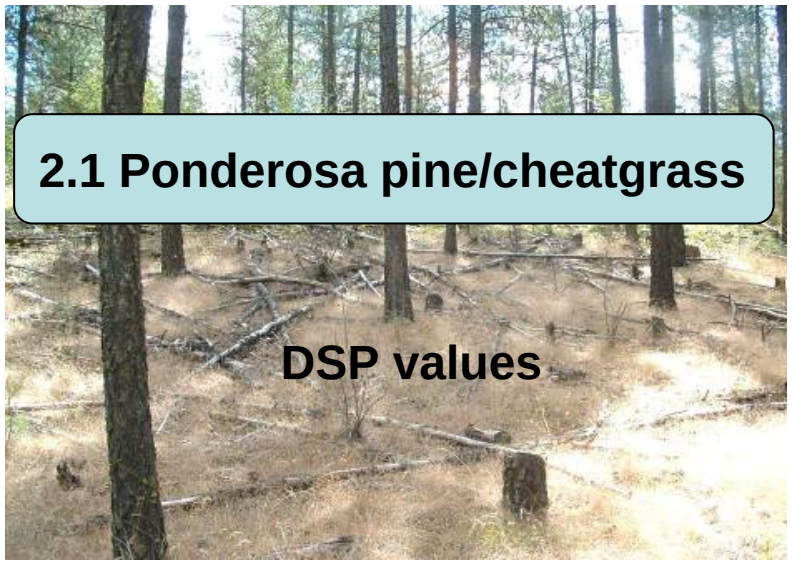
(Pinus ponderosa/Idaho fescue; Rev. 1May2007) from L Townsend, NRCS

Models of management-soil-plant dynamics



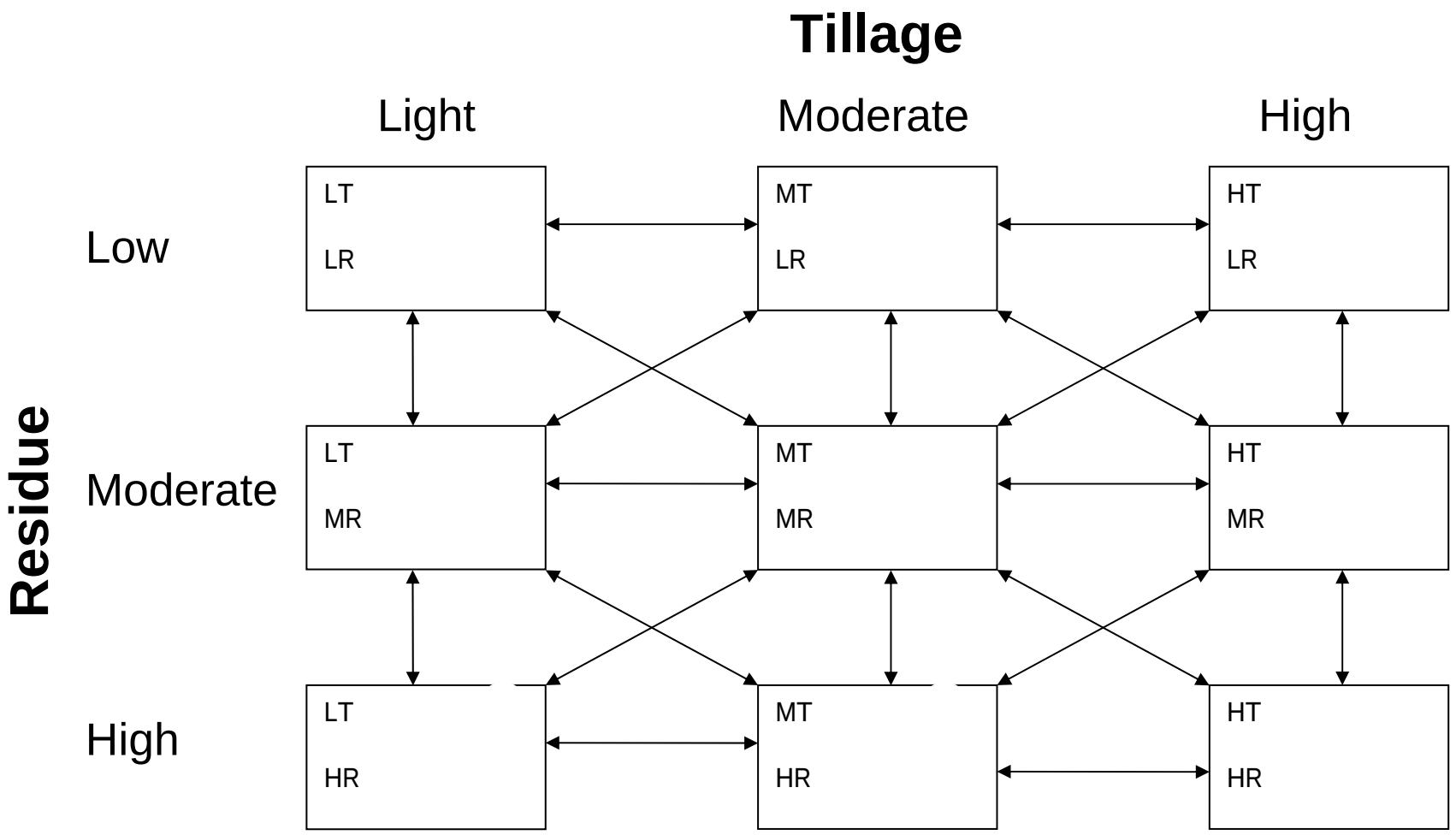


Uncontrolled grazing,
Invasive species seed source
? Soil degradation?



Surface fire (recurring)
Native understory restoration

Cropland model



Soil survey applications: models as a tool to document human impacts

1. Stratify a soil map unit component (phase) based on land use and management systems to guide sampling of dynamic soil properties.
2. Extend data and relationships to other similar soils (e.g. similar Ecological Site or crop management zone).
3. Develop hypotheses of mechanisms of management effects for testing (research) and development of interpretations.

4. Provide a framework to design integrated databases (soil + management + vegetation).
5. Communicate dynamic processes and management effects on soil to technical and non-technical audiences.

Gross, John E. 2003. Developing Conceptual Models for Monitoring Programs, NPS Inventory and Monitoring Program, http://science.nature.nps.gov/im/monitor/docs/Conceptual_Modelling.pdf

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