Components of managed grazing and complexity of conducting grazing studies

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Outline

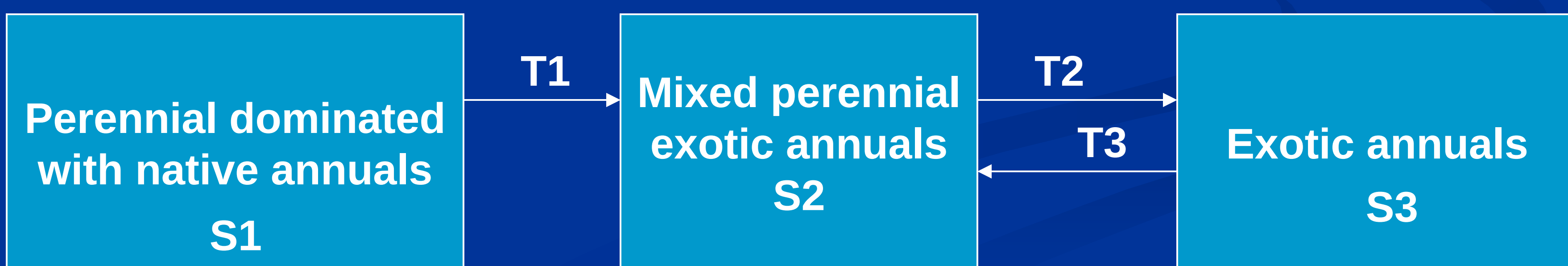
1. Developing reliable knowledge
2. Descriptive models
3. Ecosystem models
4. Predictive models
5. Controlling and monitoring system response
6. Conclusions and recommendations

Outline

1. **Developing reliable knowledge**
   - Description, Understanding, Prediction, Control
   - Experiments and Observations
2. **Descriptive models**
   - States and Transitions
3. Ecosystem models
   - Components of grazing management
   - Plant response to grazing
4. Predictive models
   - Non-equilibrium systems
5. Controlling and monitoring system response
6. Conclusions and recommendations

Hypothetical States and Transitions in Valley Grassland

- State 1: Native perennial dominated pristine grassland
- State 2: Mixed perennials and annuals
- State 3: Exotic annual dominance
- Transition 1: Introduction of livestock beginning in 1769 and exotic annuals
- Transition 2: Elimination of native perennials due to cultivation, competition with exotic annuals and overgrazing
- Transition 3: Reverses T2 through better grazing management but there is no reversal for T1.



Lolium multiflorum dominated annual grassland north of Livermore

Cultivated grain replaced natives

Introduction of livestock changed grazing influences on the grassland

Decades without livestock, no native perennials, only Avena spp.

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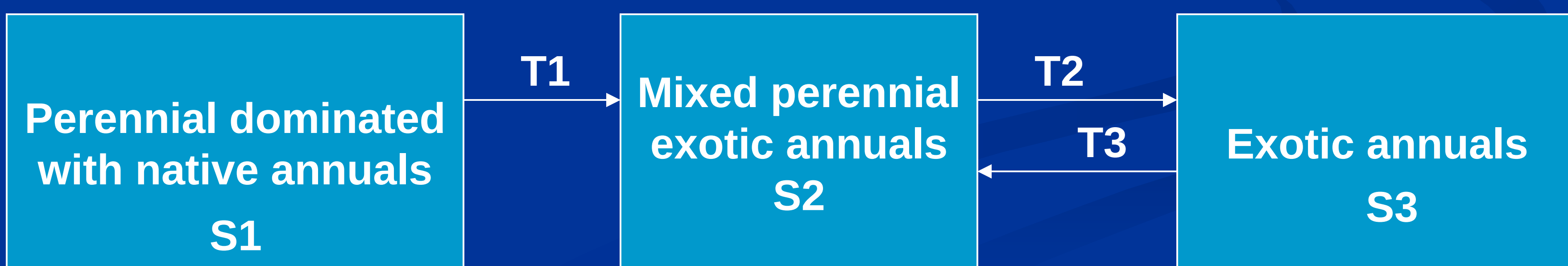

Nassella pulchra dominated Grassland at Vasco Caves

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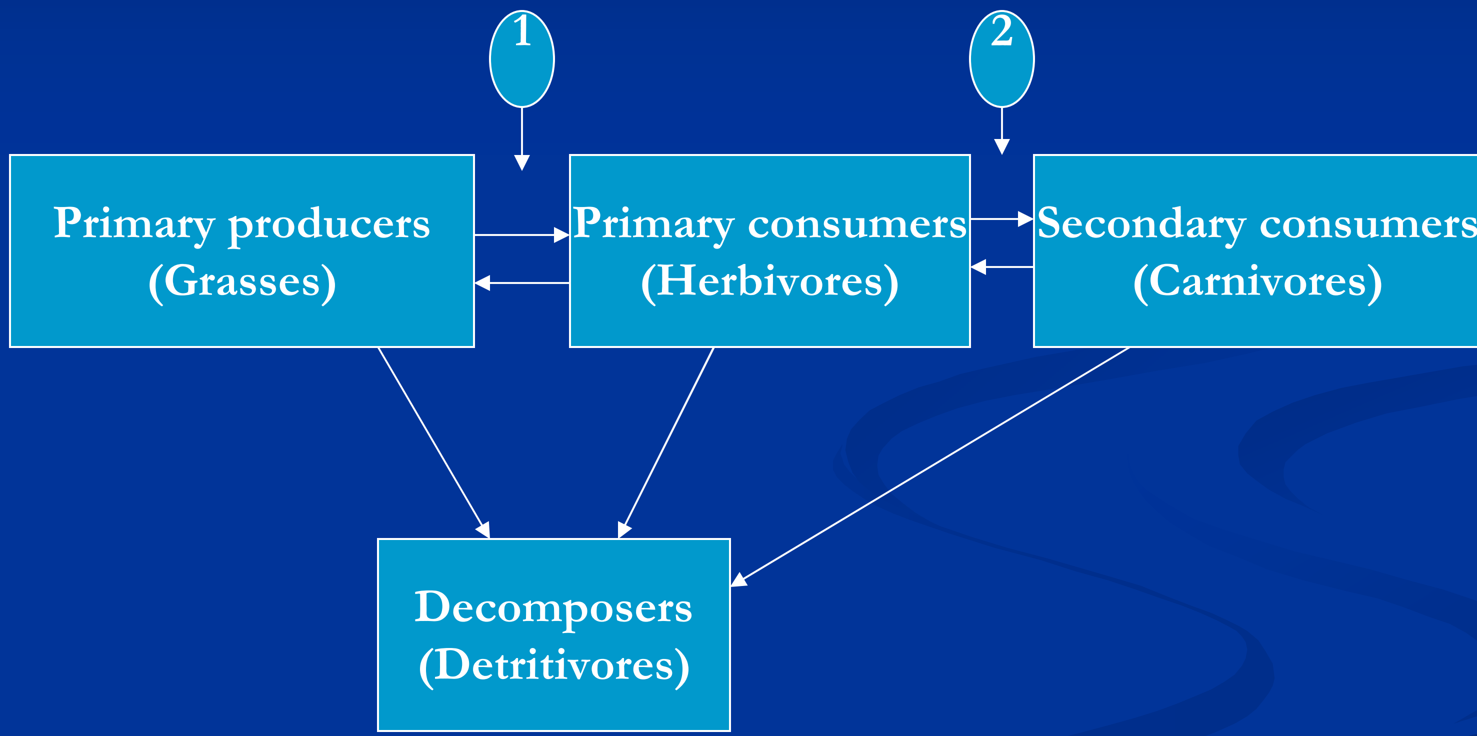
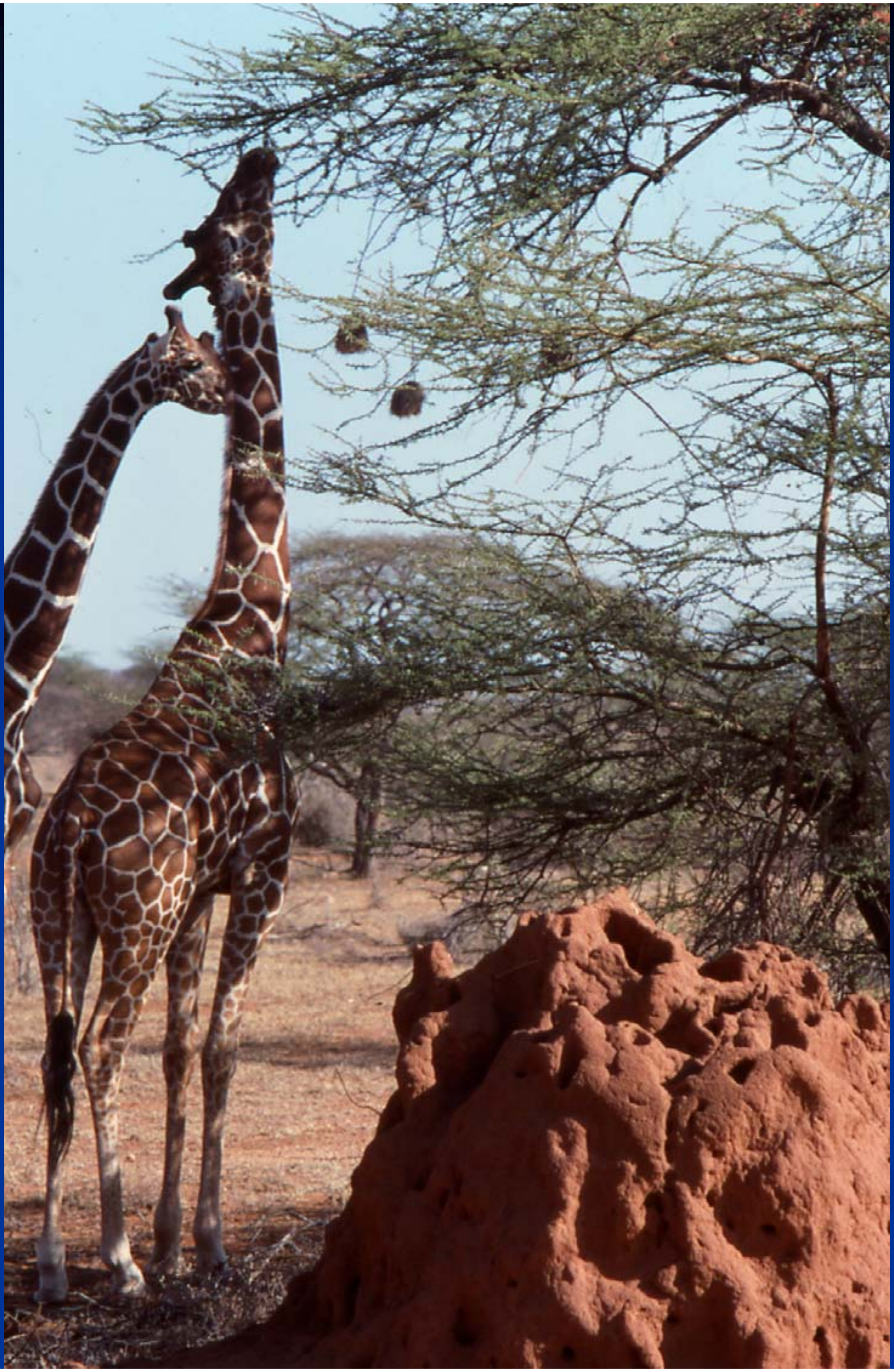
Grassland ecosystem





giraffes
acacia
weavers
termites

Components of herbivory

- Intensity
- Timing
- Frequency
- Distribution
- Kind and class of animal

Selective grazing by livestock should affect plant abundance

Some Important Grasses in California Valley Grassland

NATIVES

Achnatherum parishii
Achnatherum coronatum
Aristida spp.
Elymus glaucus
Koeleria macrantha
Leymus triticoides
Melica imperfecta
Muhlenberghia rigens
Poa secunda
Nassella pulchra
Nassella cernua

EXOTICS

Aegilops triuncialis
Avena barbata
Avena fatua
Brachypodium distachyon
Bromus hordeacous
Bromus diandrus
Bromus madritensis
Hordeum spp.
Lolium multiflorum
Taeniatherum caput-medusae
Vulpia spp.

Grazing prescription information for enhancing *Nassella pulchra* in Valley Grassland

- Where – **valley grassland, low fertility sites**
- Growth form -- **perennial**
- Reproductive strategy -- **seed**
- Invasiveness – **low/moderate**
- Seed bank longevity -- **0**
- Seed volume -- **moderate**
- Resistant season and growth stage for grazing – **early vegetative, dormant**
- Frequency -- **low**
- Intensity -- **high**
- Kind and class of livestock -- **sheep, maybe cattle**
- Stocking density -- **high**
- Demonstrated success with prescription grazing? -- **no**
- Citation – Bartolome et al 2004

Grazing prescription information for Aegilops triuncialis

- Where a problem -- **range**
- Growth form -- **annual**
- Reproductive strategy -- **seed**
- Invasiveness -- **high**
- Seed bank longevity -- **2+ yr**
- Seed volume -- **low**
- Season and growth stage for grazing -- **vegetative**
- Frequency -- **low**
- Intensity -- **high**
- Kind and class of livestock -- **cattle**
- Stocking density -- **high**
- Demonstrated success with prescription grazing? -- **no**
- Citation – **Betts 2002**

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   Non-equilibrium systems
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Characteristics of equilibrium and non-equilibrium systems (Wiens 1984)

Equilibrium

- Biotic interactions
- Resource limitation
- Density dependence

- Processes primarily shaped by biotic interactions (plant-plant and plant-animal)

Non-Equilibrium

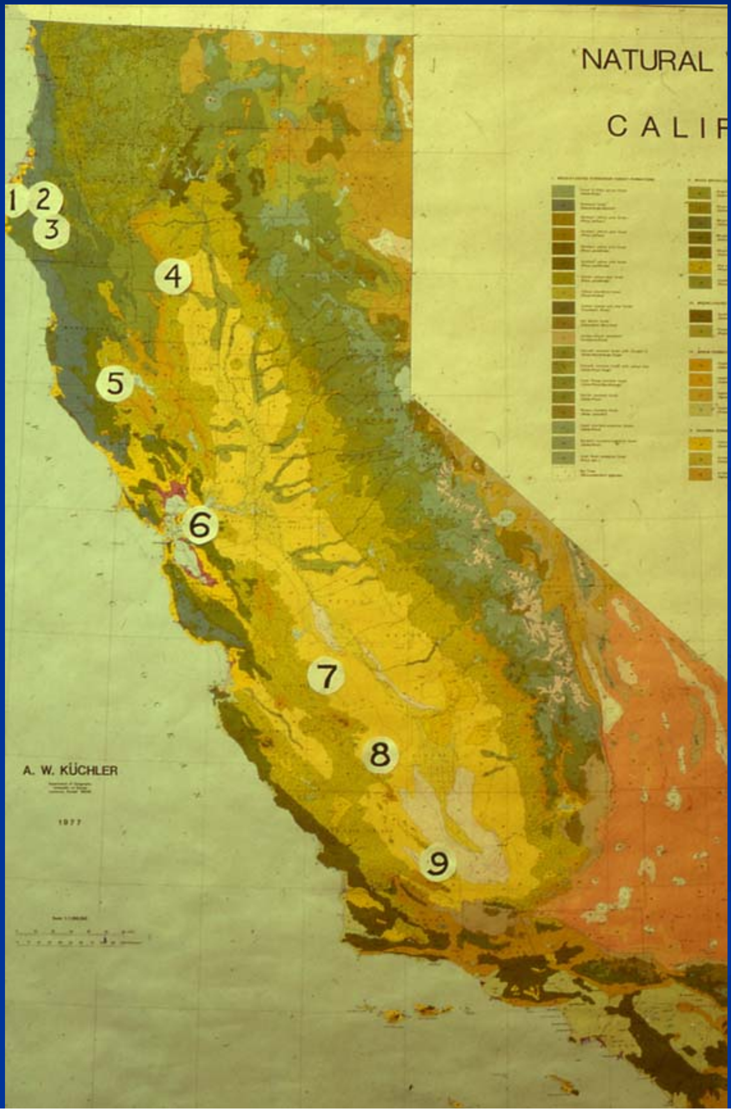
- Biotic decoupling
- Abiotic limitation
- Density independence

- Processes dominated by environmental factors like weather

Using State and Transition Models to understand community structure and its controls

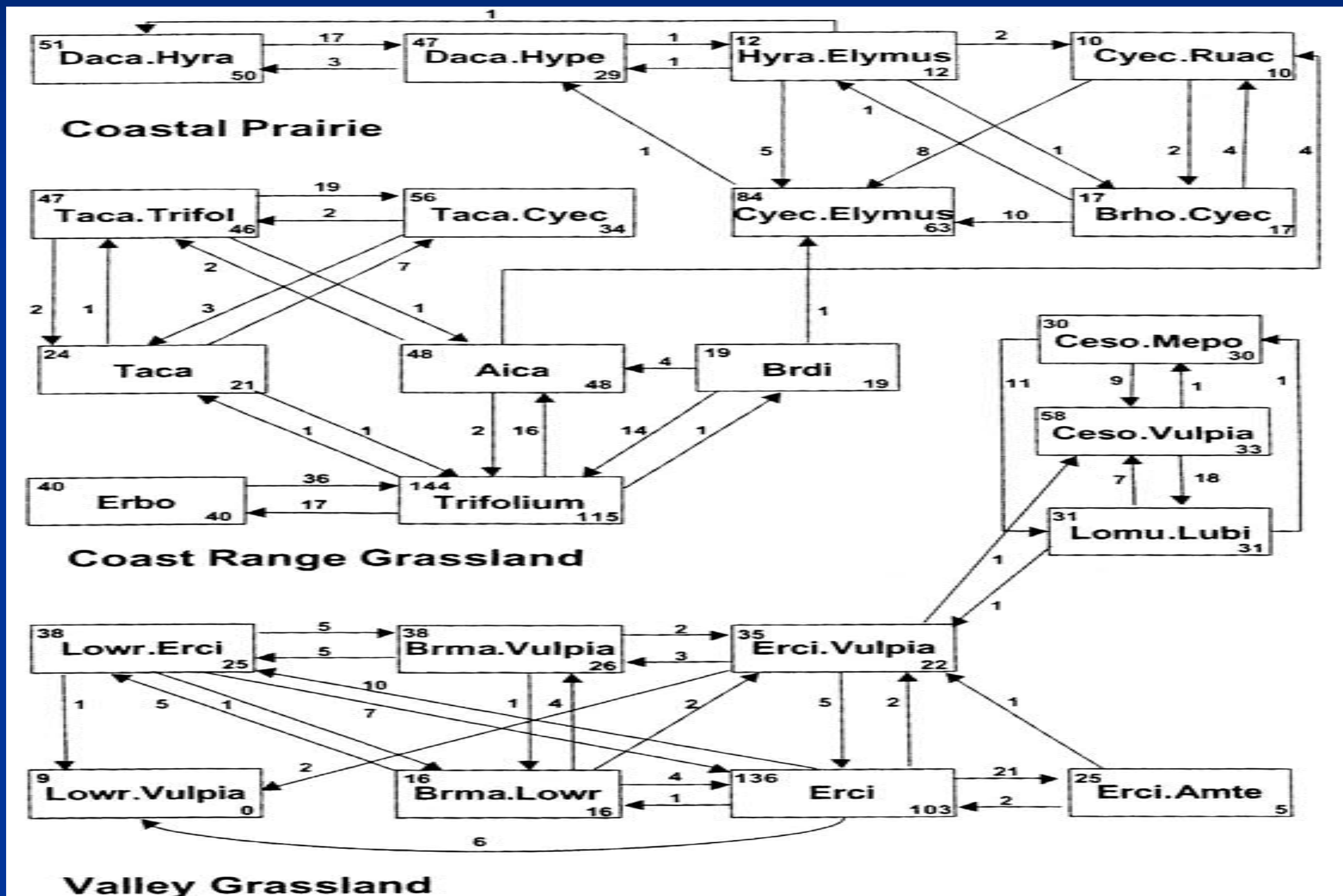
- Jackson, R.D. and J.W. Bartolome. 2002. A state-transition approach to understanding nonequilibrium plant community dynamics of California grasslands. Plant Ecology. 162:49-65.

Location of RDM Study plots



RDM treatments simulate heavy to moderate grazing intensity

Data-based State and Transition Grassland Model



Summary of results from ST/CART analysis

- Site was the most important factor separating states, native perennials increased with higher average rainfall
- Inter-annual variations in rainfall and temperature explained most transitions among states
- Weather variables did not produce the anticipated "grass, legume, filaree" years or changes in biomass
- RDM (grazing surrogate) only explained a small number of transitions, and then only at the driest sites
- System dynamics exhibit a strong site and time dependency at multiple scales.

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Summary of meta-analysis of fire and grazing literature

- A review of of 45 studies (19 fire, 17 grazing, 9 fire and grazing) showed highly variable effects on native plant species, strongly influenced by site and annual weather.
- Weather had much more of an effect on native perennial grasses than did fire or grazing.
- Management effects are poorly predicted by the existing literature

Carrizo Plain, native perennials with few annuals in a drought year

6. Conclusions

1. Most rangelands are non-equilibrium type systems with limited response to biotic interactions including grazing.
2. Rangeland systems exhibit small-scale spatial variability which, coupled with a site-time dependency, makes predictions about system response to environment and management very unpredictable under current levels of knowledge.
3. There are severe and largely intractable limitations on current experimental and observational approaches for predicting rangeland response to grazing management.

Conclusions

4. Effective grazing management requires understanding of the components of herbivory and an ability to deal with complex interactions at multiple spatial and temporal scales. More experimental work on grazing effects would be helpful.
5. Efficient methods for objectively evaluating and measuring grazing impacts on resources need more development.