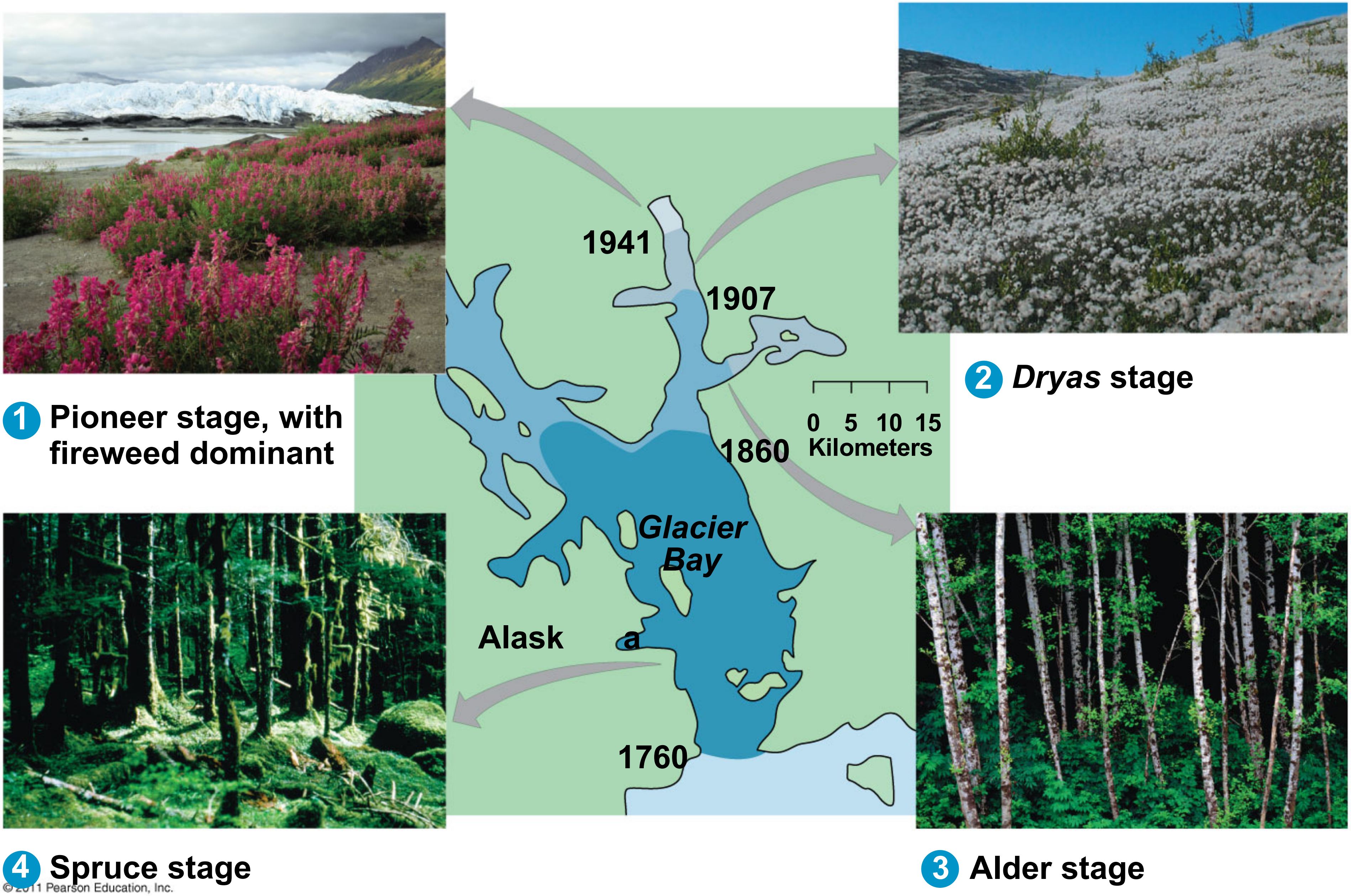
Succession and Community Assembly:

Primary succession: Glacial retreat in Glacier Bay, Alaska



Retreat documented since 1760

space = time → chronosequence

Secondary succession. Douglas fir forest clearcuts

Phases
Establishment/initiation
Competitive exclusion
Maturation/diversification
Dynamic climax

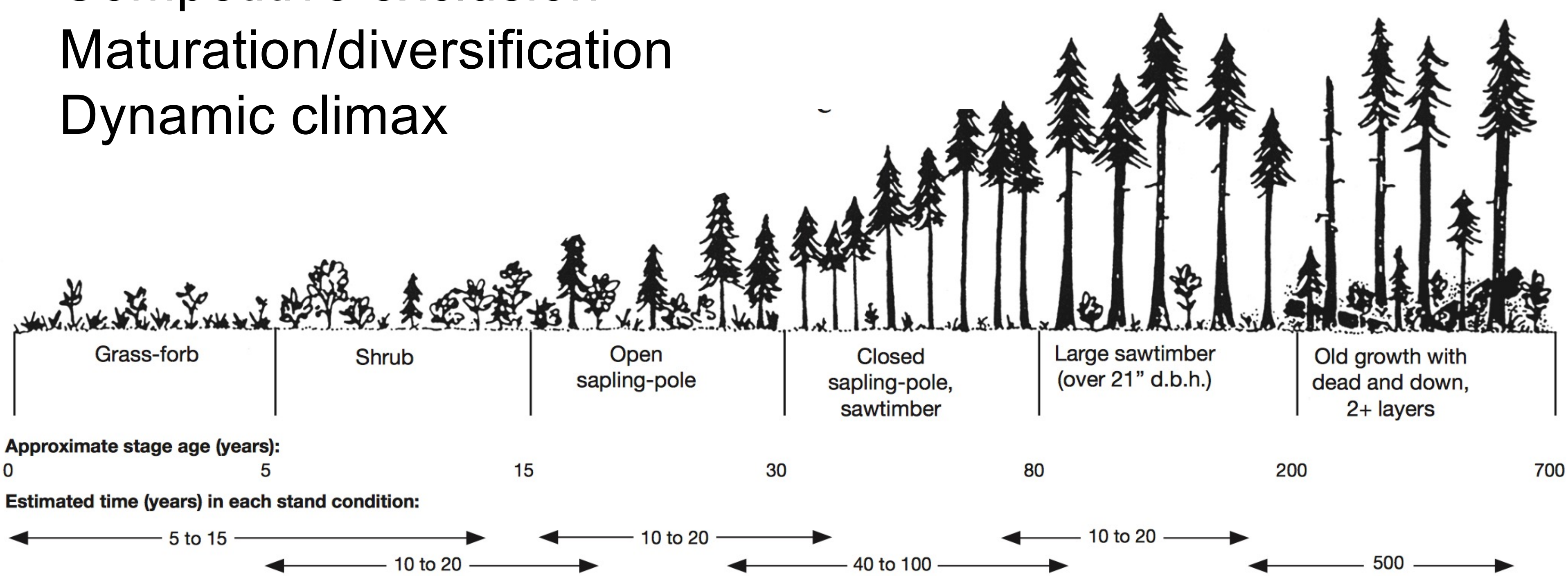


Figure 1. Stand conditions in Douglas-fir forests after even-aged harvesting. ***From Brown (1985).***

Franklin et al. 2002. Forest Ecology & Management 155:399-423

Mechanisms and Models of Succession:

Early ideas: Clements and Gleason

Mechanisms: Connell and Slatyer

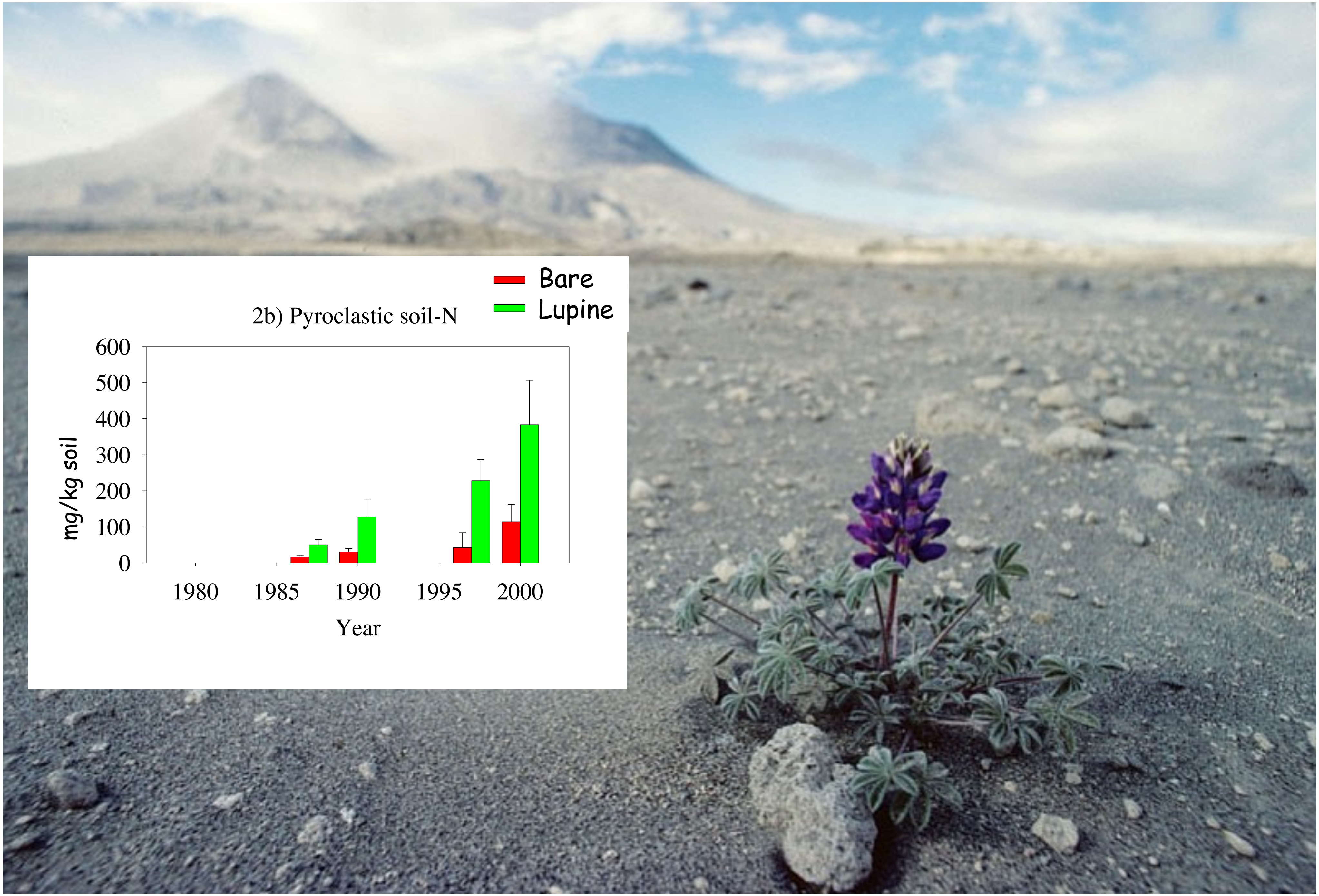
Models: Egler, Grime, Tilman,
Westoby and Philips

Mechanisms

Facilitation

early successional species modify the physical environment making it more conducive for later species

Facilitation. Mt. St. Helens May 18, 1980



Mechanisms/processes

Connell and Slatyer 1977

Facilitation

early successional species modify the physical environment making it more conducive for later species

Tolerance

any species that arrives can establish
r-selected species are gradually outcompeted by K-selected species

Inhibition

any species that arrives can establish
early species inhibit later species slowing succession

Life history traits

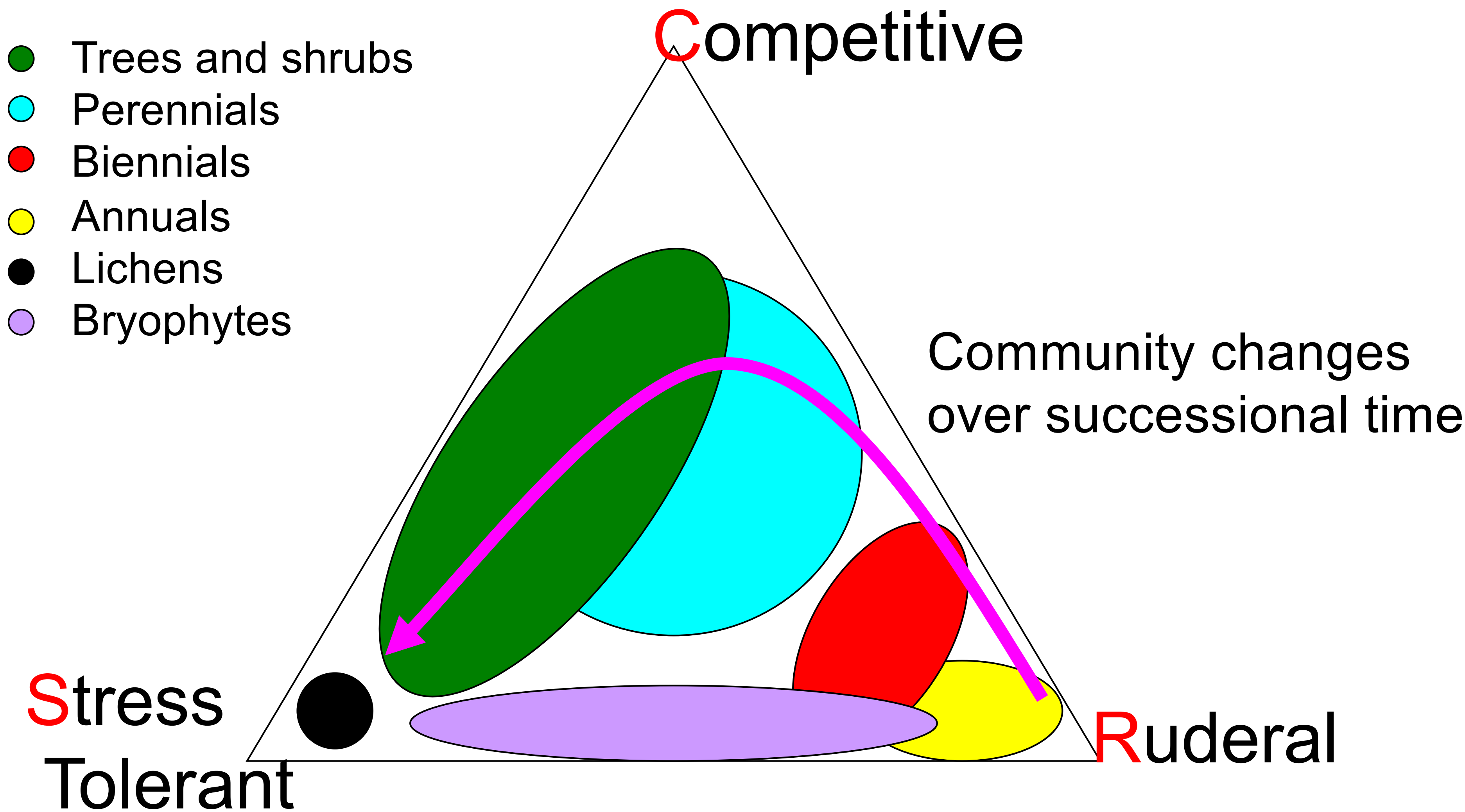
Faster dispersal

early species arrive sooner
colonization-competition trade-off

Relative growth rates

arrive at the same time
early successional species mature faster

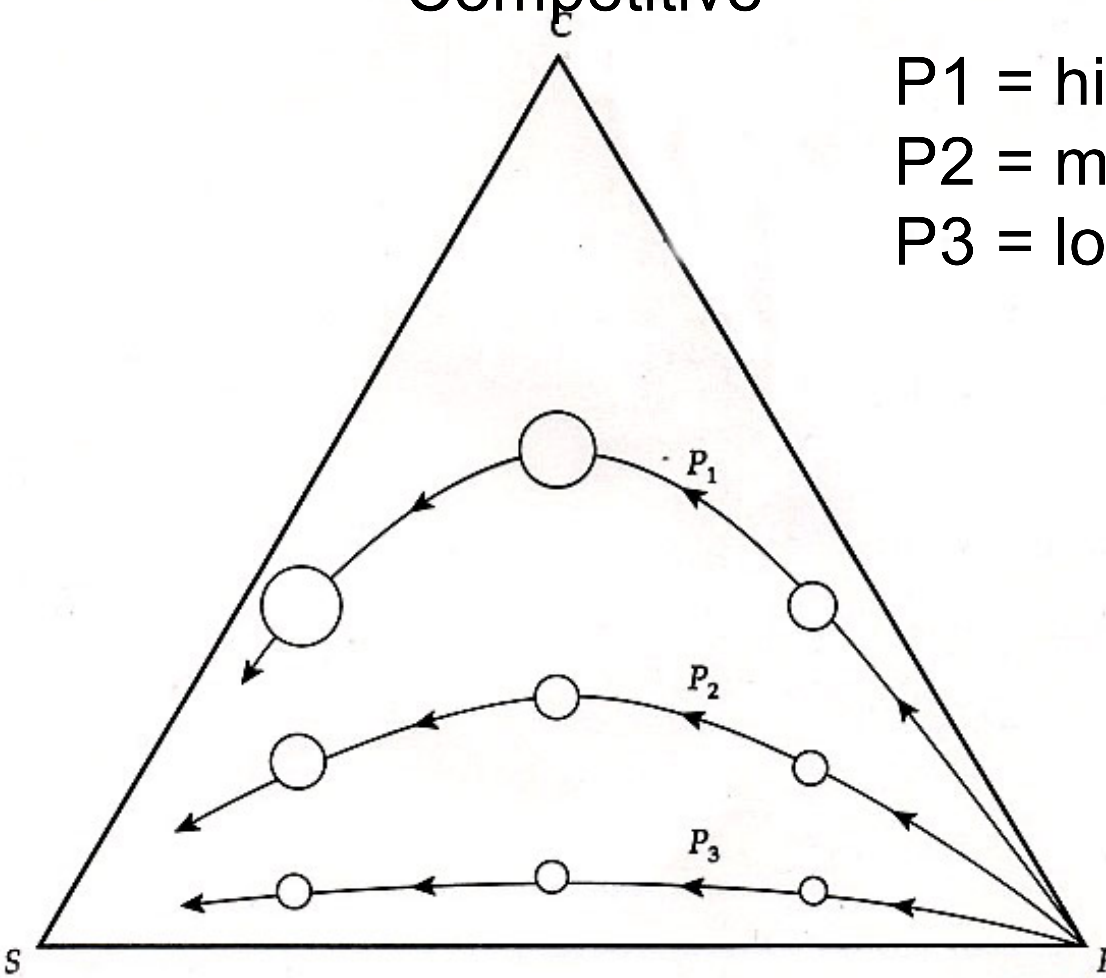
Models: Grime (1977, 1979)



Models: Grime (1977, 1979)

Competitive

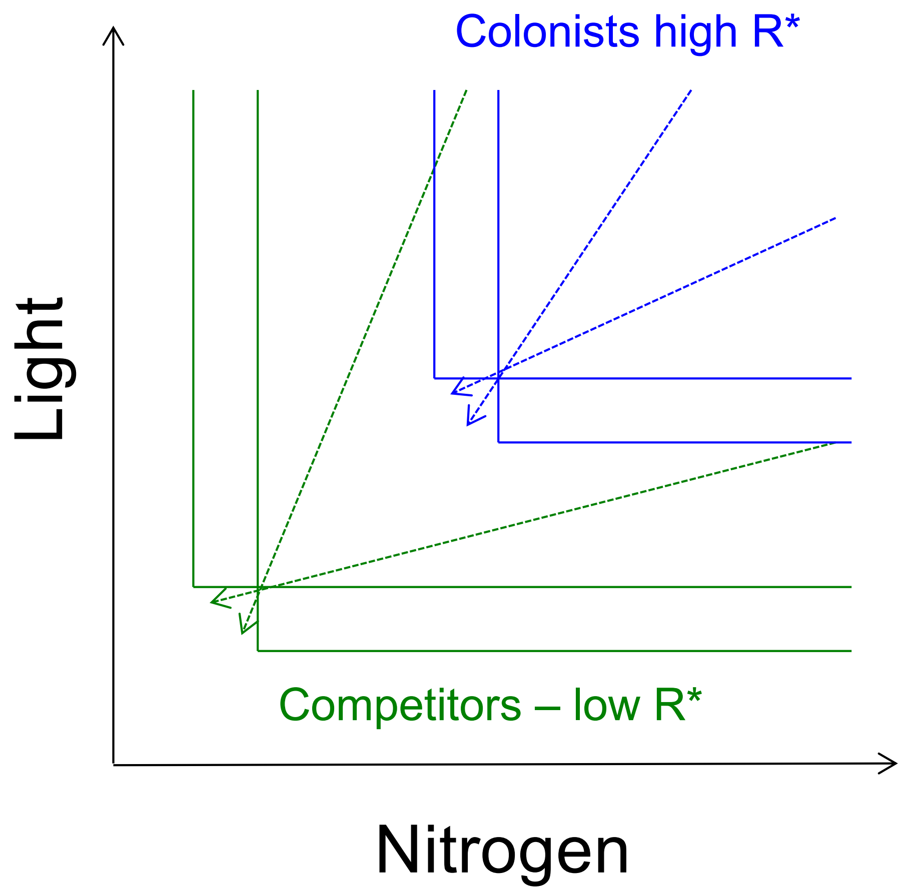
P1 = high productivity
P2 = moderate
P3 = low

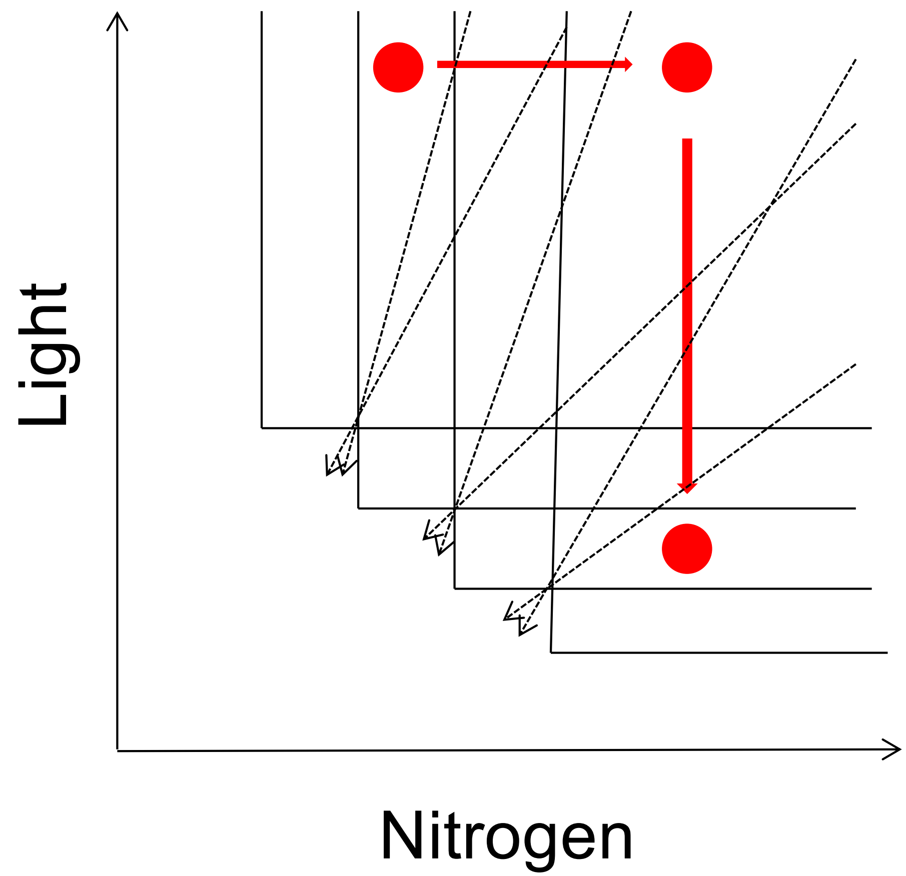


Stress tolerant

Ruderal

Tilman (1985, 1988) Resource-ratio theory





Succession- outcome of a Competition-colonisation trade-off

Facilitation and shade alter the resource supply points and outcome of competition

Central Questions in Studies of (Plant) Succession

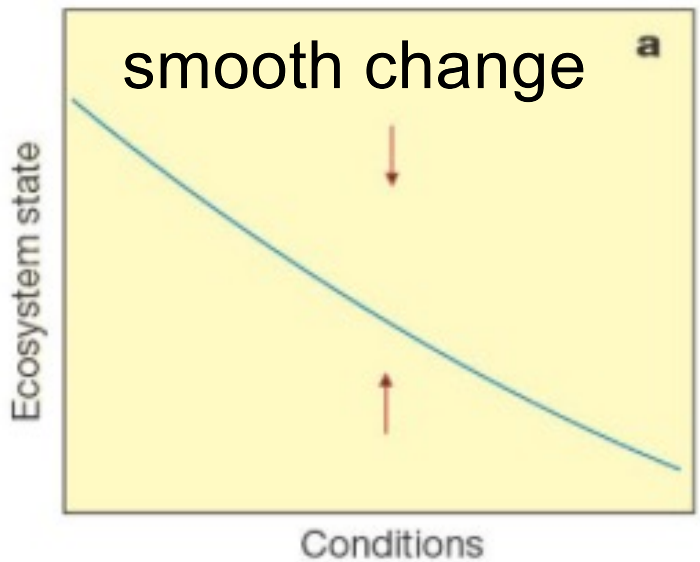
How predictable is succession?

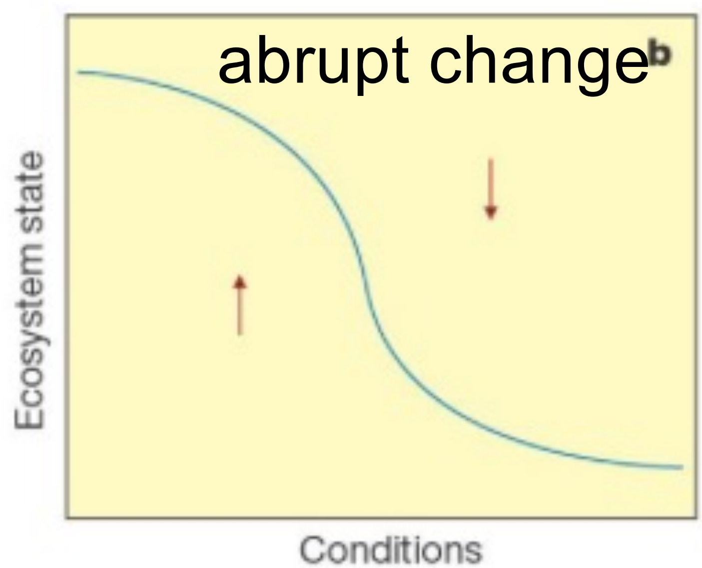
Does succession produce a climax community?

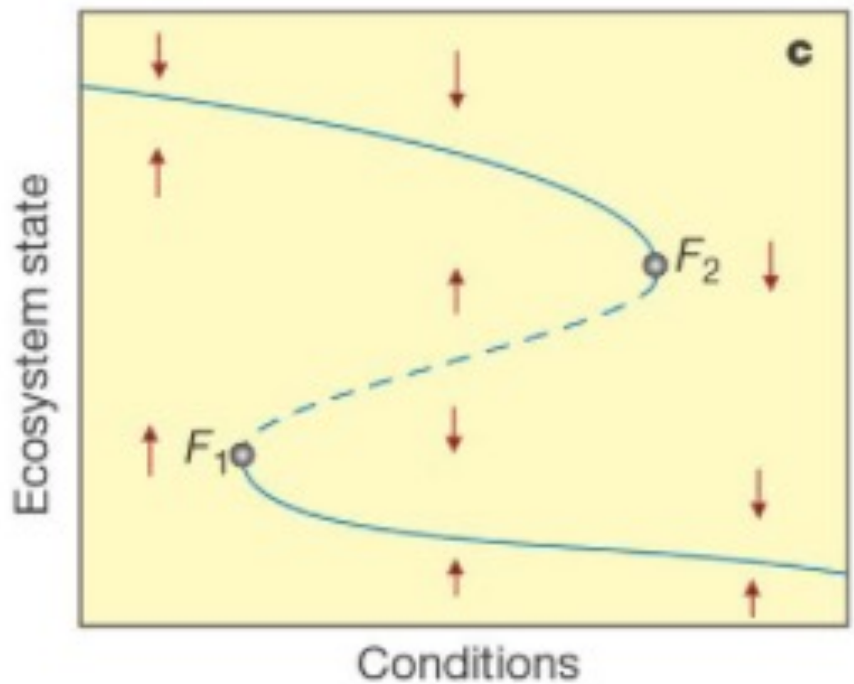
What mechanisms/processes are operating during succession?

What role do additional disturbance/pathogens/specialist herbivores play?

Disturbance/condition effects on the ecosystem state

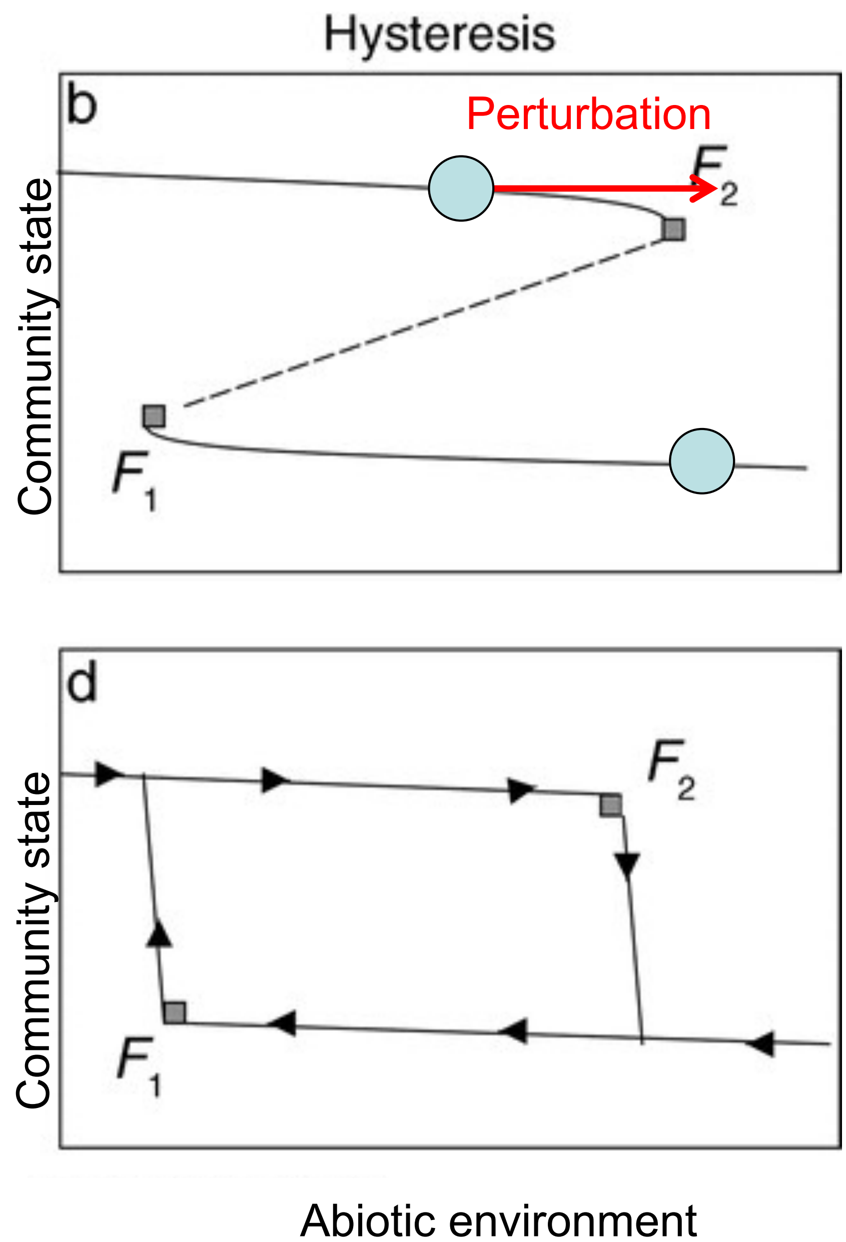






abrupt change with
alternative stable states

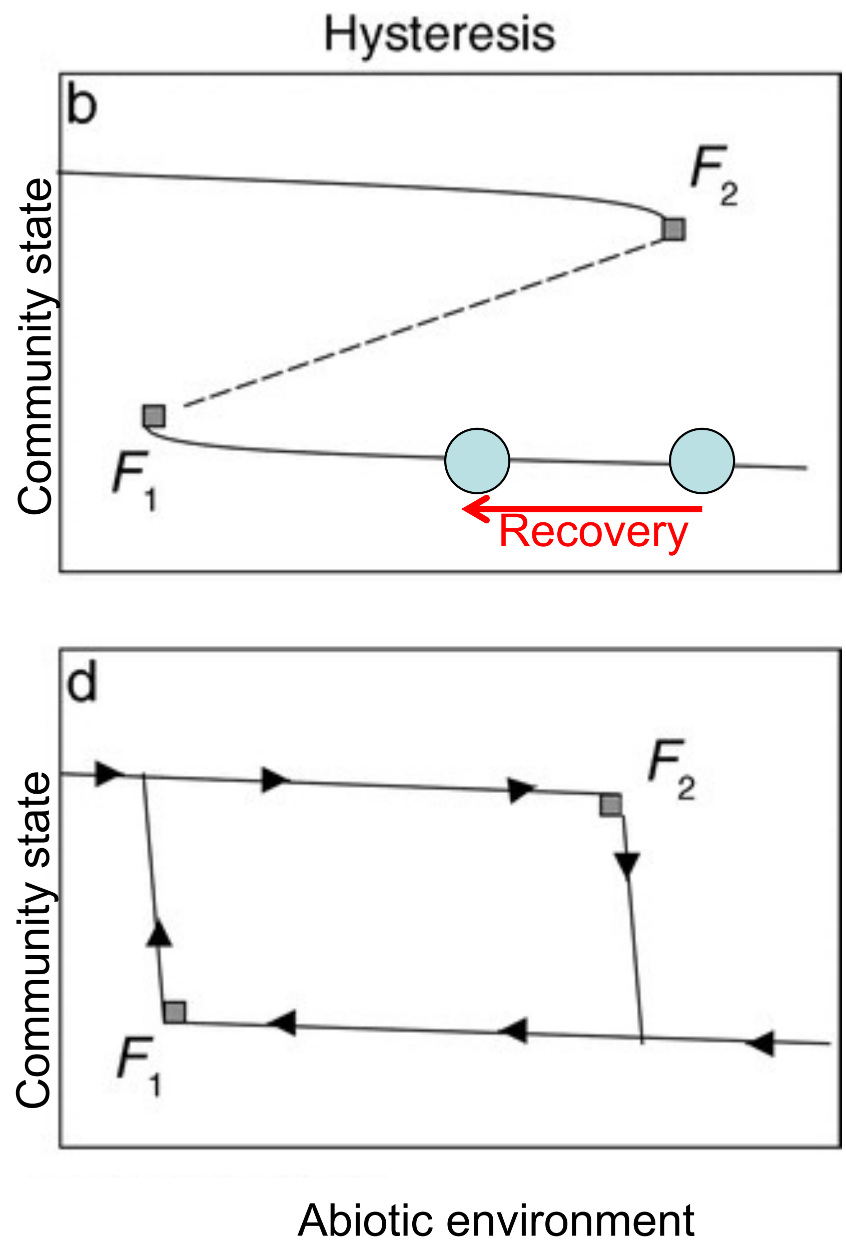
1. Perturbation beyond a tipping point → shift from State 1 to 2

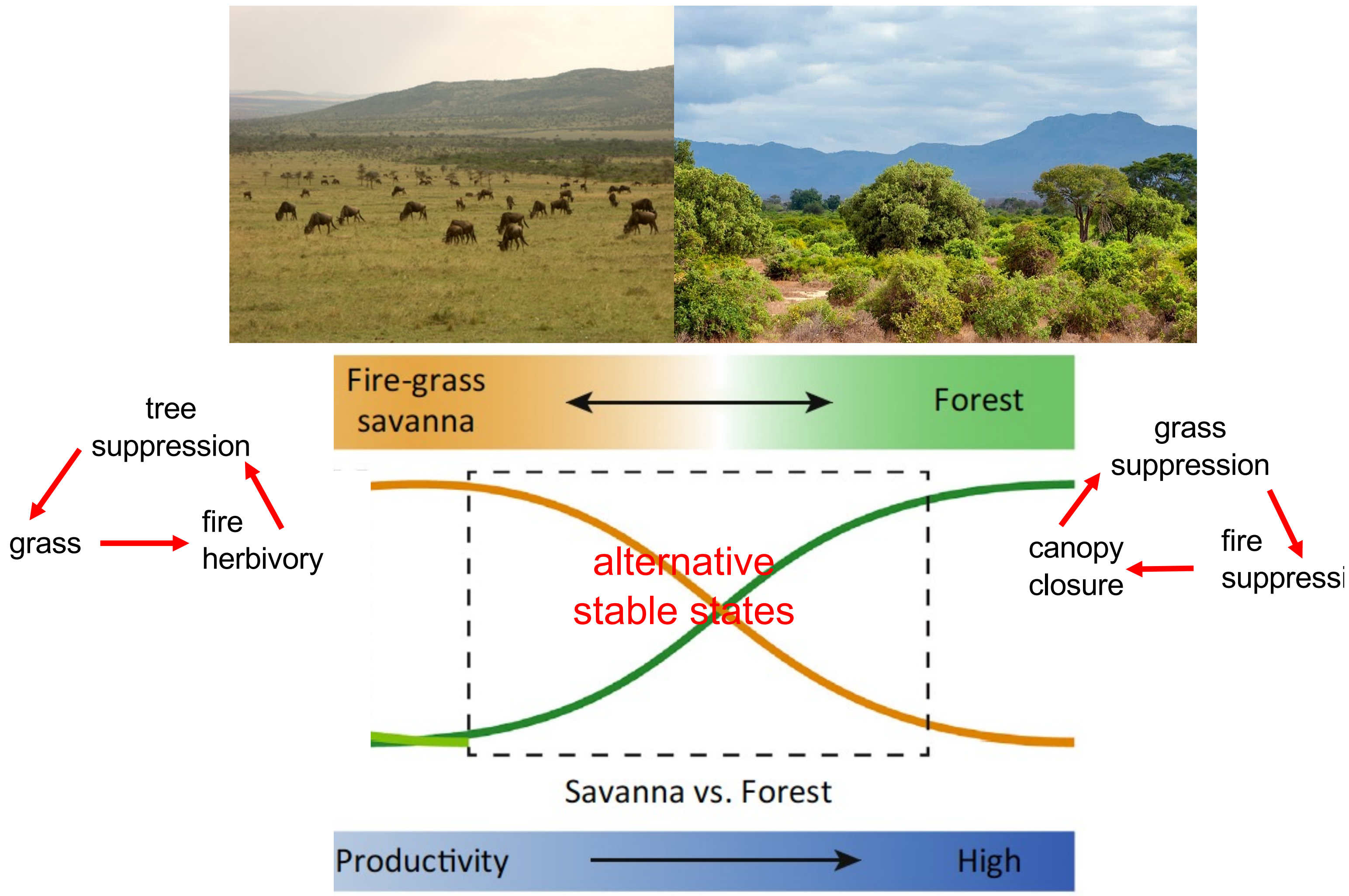


Recovery of abiotic environment to the original condition

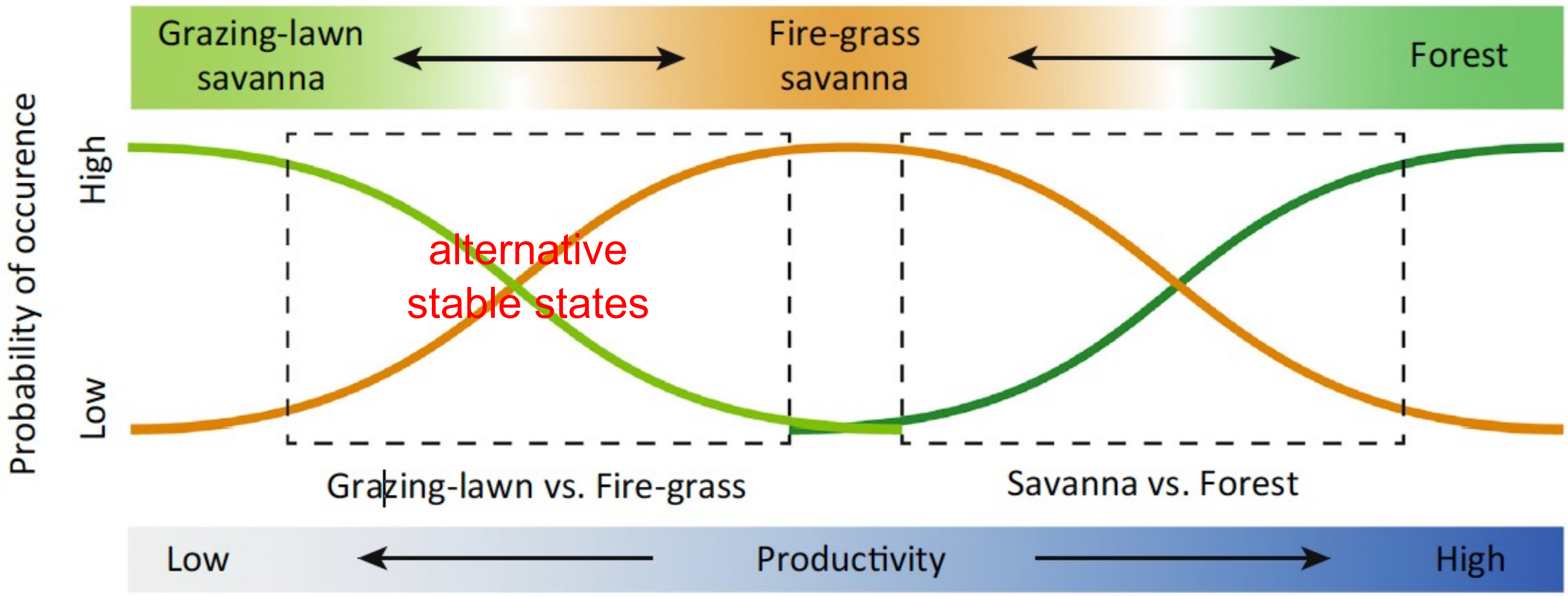
but
ecosystem remains in the alternative state

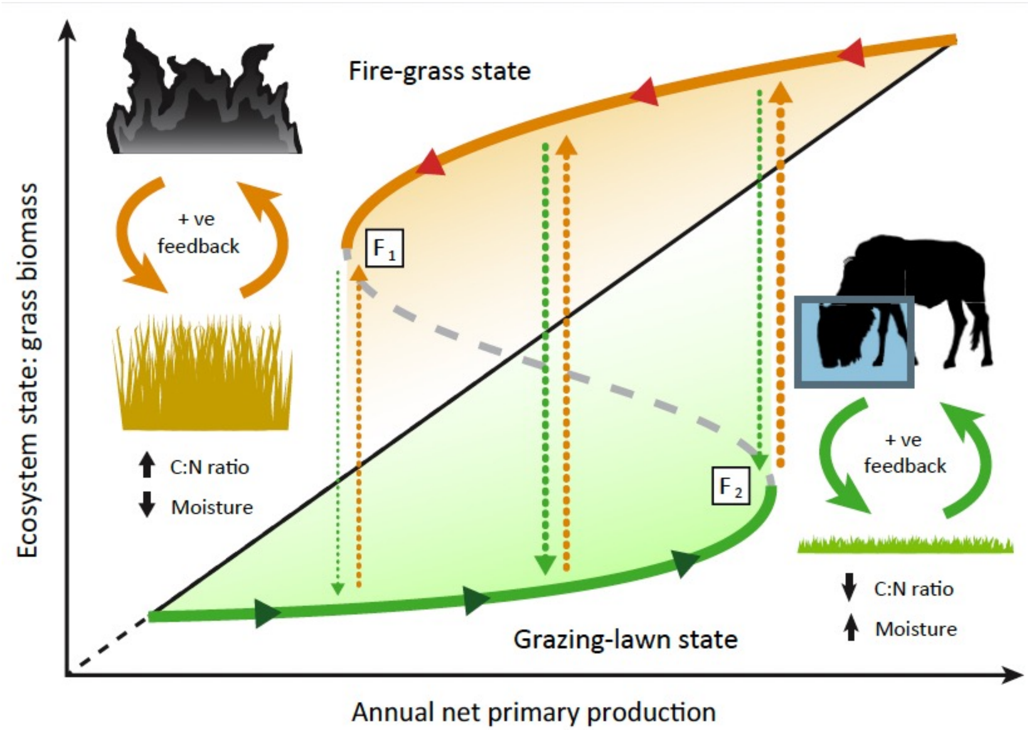
A shift from State 2 to 1 requires abiotic environment is pushed past a second tipping point F1





Dublin et al. 1990 J Anim Ecol 59: 1147-1164
Oliveras &Malhi 2016 Phil. Trans. R. Soc. B 371: 20150308.

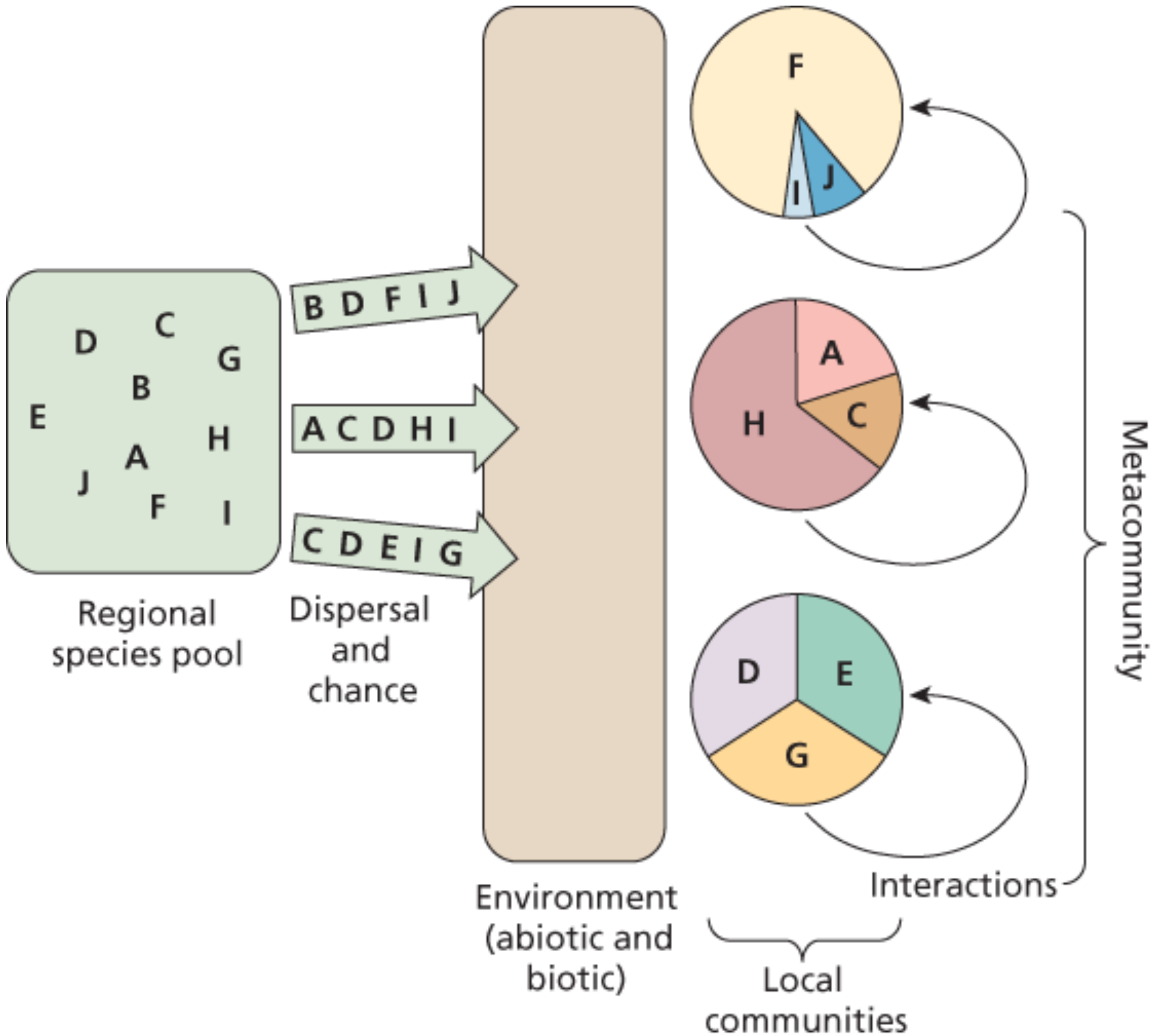




Hempson et al. 2019 TREE

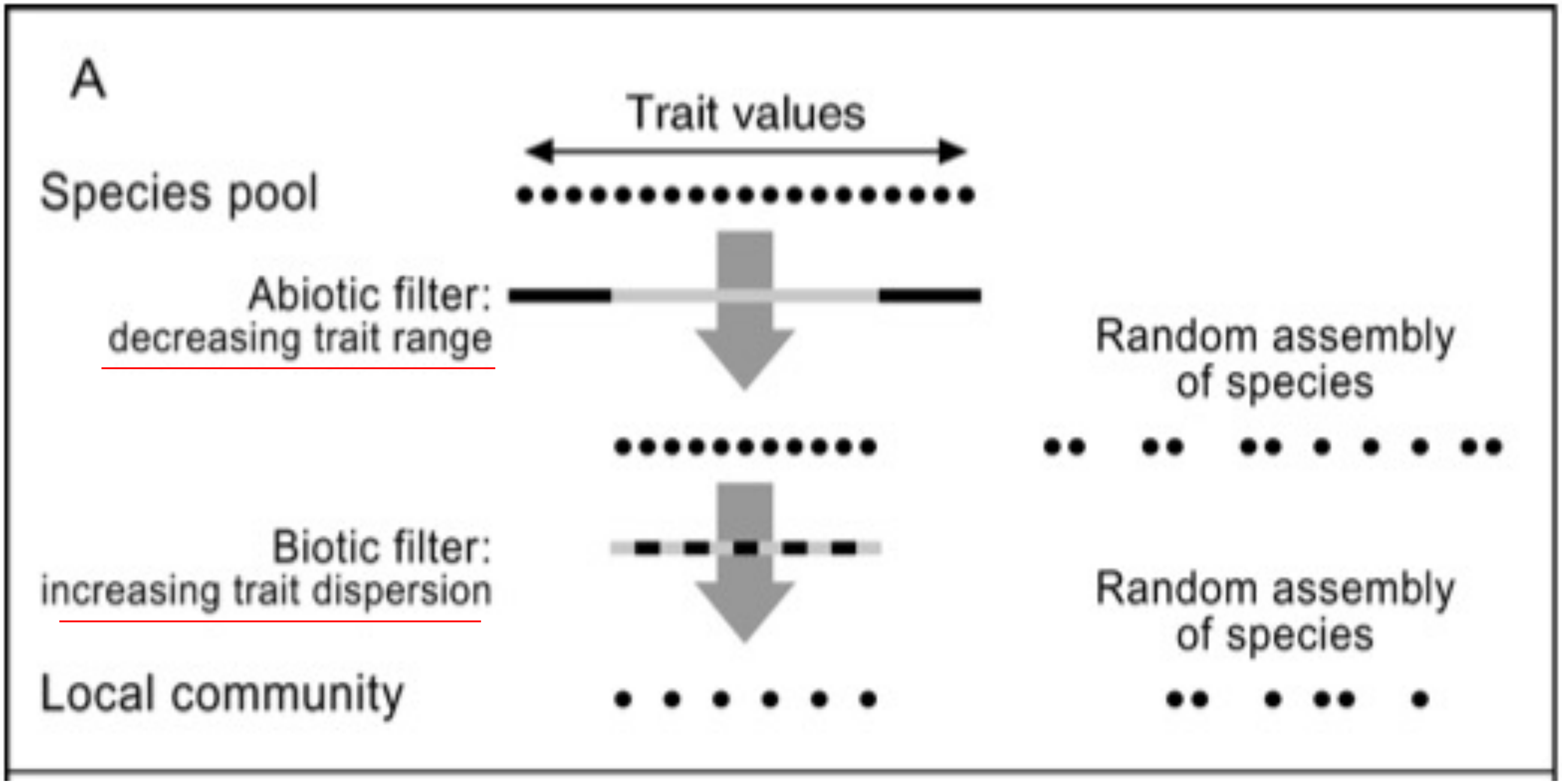
Community assembly

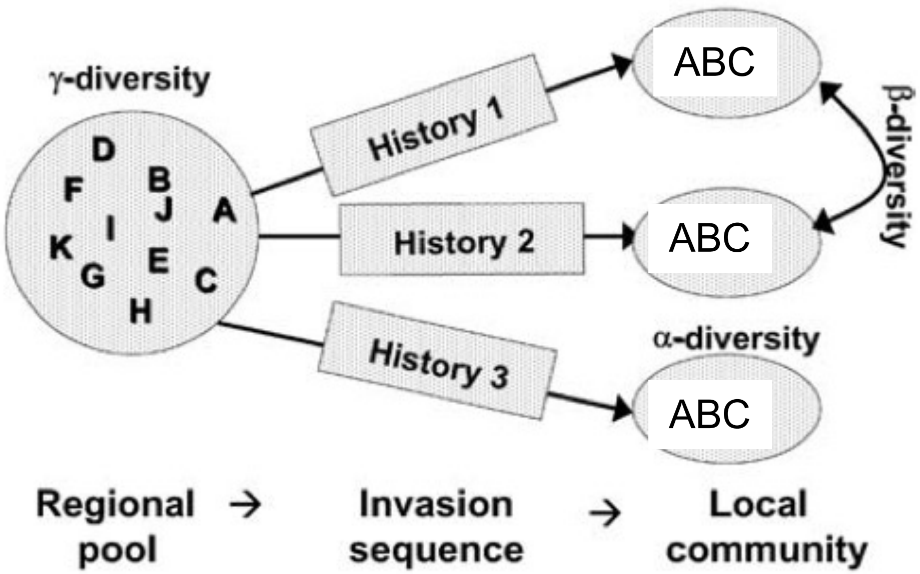
Community assembly



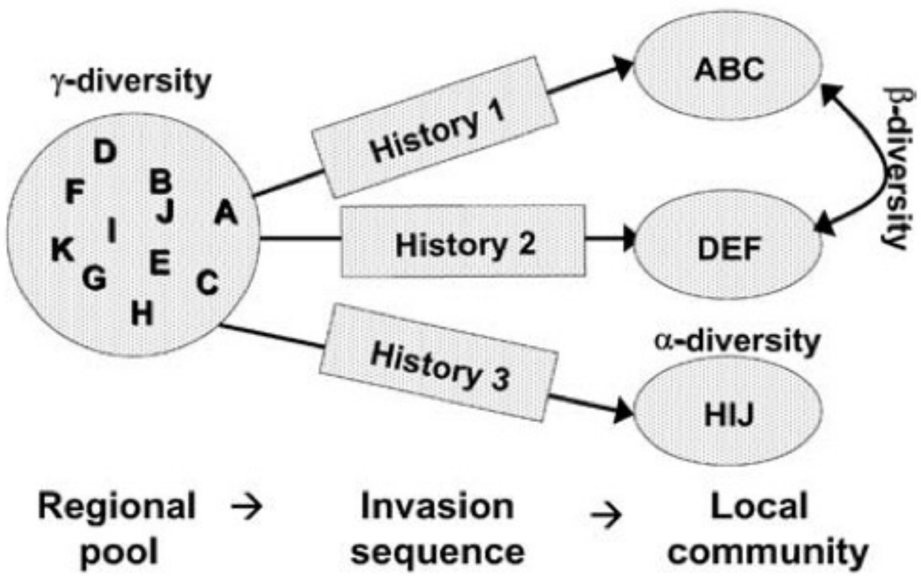
Mittelbach and McGill Fig 12.1, after MittelbacH and Schemske 2015

Community assembly





History varies but → one single stable state



History varies → multiple stable states

Chase 2003 Community assembly: when should history matter?

Chase 2003 Community assembly: when should history matter?

Predictions regarding dissimilarity = beta diversity

1 Size of the regional pool

2 Rate of dispersal / connectedness

3 Primary productivity

4 Disturbance

Chase 2003 Community assembly: when should history matter?

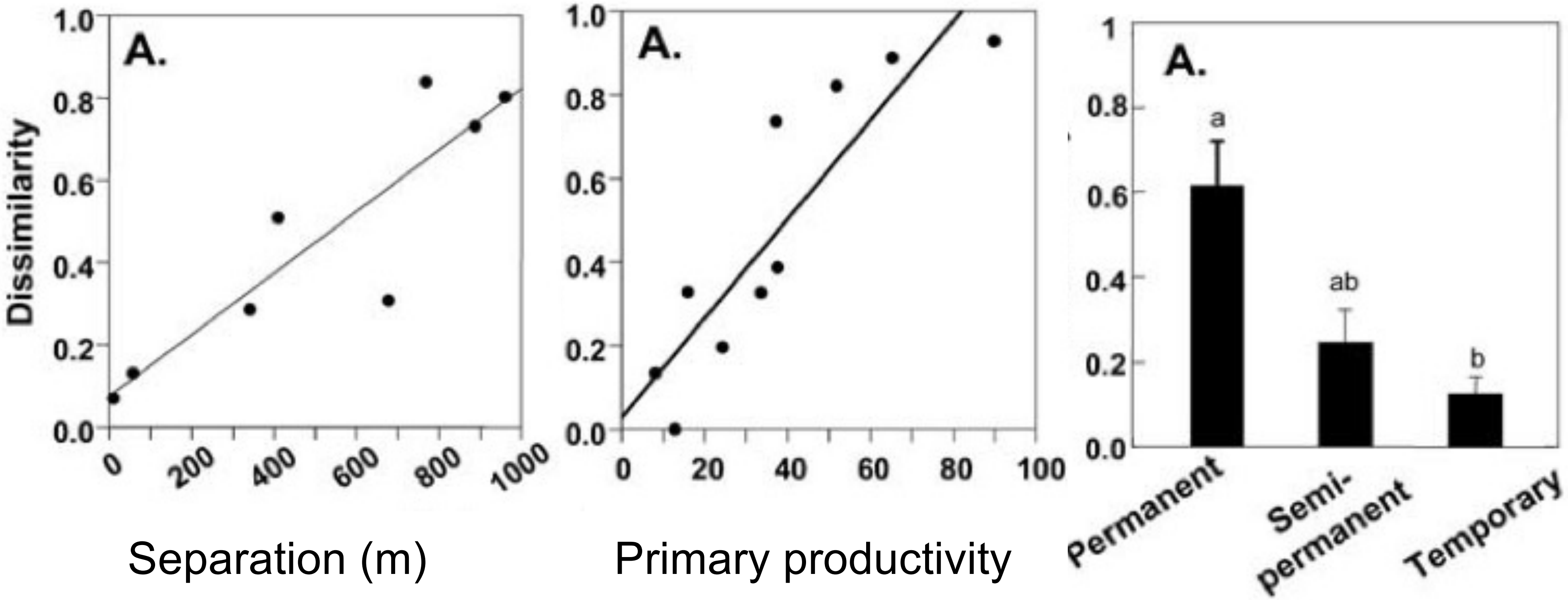
Empirical tests in 72 ponds

Benthic inverts
Benthic and free-swimming insects
Amphibians
Small fish

local scale = pond (alpha diversity)
regional scale = three local ponds in watershed (gamma)

Inter-pond dissimilarity – 1 no species shared
- 0 all species shared

Chase 2003 Community assembly: when should history matter?



Summary

The study of community assembly focusses on three processes – dispersal, abiotic and biotic filters

Pattern-based assembly rules (checkerboard, Hutchinsonian ratios, guild limits) have been foundational

Assembly rules have limited ability to predict communities

History (sequence and chance effects) can influence the community

History is more important when the species pool is large, dispersal is high, primary productivity is high, disturbance is low

Central Questions in the Study of Community Assembly

What structures the regional pool?

Can we predict when dispersal, abiotic and biotic filters are the primary driver of community assembly?

How do functional traits (rather than species) limit community membership?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Succession and Community Assembly
Implications for Restoration

Primary/Secondary succession – historical view
community composition moves along a traditional pathway to a pre-determined endpoint
→Restoration may be accomplished using natural processes

Community assembly - theory and experiments
the final community is often dependent on invasion sequence
→Restoration should manage sequence