

# Indirect controls on resource availability: when does community change matter?

Katharine Suding University of California Berkeley USA Sandra Lavorel, Sandra Diaz, Terry Chapin, David Hooper, Hans Cornelissen, Eric Garnier



## Major Challenge

• How do we incorporate mechanistic understanding of the *response of communities* and *linkages to ecosystem function* in models?

How do we incorporate mechanistic understanding of the *response of communities* and *linkages to ecosystem function* in models?

What aspects are important?
*Consequences of changing biodiversity* (Chapin et al 2000)



How do we incorporate mechanistic understanding of the *response of communities* and *linkages to ecosystem function* in models?

 Can we ignore it?
Carbon responses to N fertilization
(Lu et al. 2011)



## Key Questions

- Mechanisms of response to global change factors?
- Mechanisms linking community dynamics to ecosystem function?





### Two important components: Response and Effect



## Species traits as one translator



Wardle et al. 2011 Science

 (a) Difference in traits of response groups that strongly affect ecosystem processes
(b) Difference in traits of response groups have little affect on ecosystem function

## Grime (1979) Plant strategies



## How do species response traits relate to effect traits?

1. Response FTG = Effect FTG



## Response group = Effect group



Walker et al 2006; Cornelissen et al 2007

## How do species response traits relate to effect traits?

- 1. Response = Effect
- 2. Feedback: Effect accelerates Response



### 2) Positive feedbacks

Compared to paired native grasslands, exotic grasses:

- Higher nitrate pools
- Faster net N mineralization (4X)
- Faster C mineralization
- Greater N-acquiring microbial extracellular enzyme activity (LAP)
- Lower light levels (80% lower)



L. Larios, dissertation, Suding et al 2008

# How do species response traits relate to effect traits?

- 1. Response = Effect
- 2. Feedback: effect accelerates response
- Resilience: response and effect overlap



#### 3) Overlapping: effect and response



**Response: invaders have** high N litter

Kurokawa et al 2009

Effect: no difference among response groups Effect: C:P and phenolics

1000

10000

## Dynamics

#### 1. Gradual Change: R=E



## Dynamics

- 1. Gradual Change: R=E
- 2. Resilience: overlapping
- 3. Rapid shifts, thresholds: positive feedback



## Key Questions

- Mechanisms of response to global change factors?
- Mechanisms linking community dynamics to ecosystem function?
- Priorities to address gaps in understanding?

#### Measuring Response, Response Traits



#### KNZ LTER, J. Klein

#### **Response: Nitrogen Fertilization Experiments**



#### **Response: Increased Nitrogen**

• Diversity declined in most experiments



#### **Response: Increased Nitrogen**



### Measuring Effect, Effect Traits

#### This might be harder...



### Measuring Effect, Effect Traits



N. Sanders, D. Timan

#### Effect: C<sub>4</sub> grasses related to ANPP increase



Clark et al 2007

## How important are diversity effects? Combination of species traits matter



## How important are diversity effects? Combination of species traits matter



Fornara and Tilman, 2008

- C4 grasses: high NUE
- Legumes: Fix N
- C4 + Legumes: greater root biomass

#### Positive feedback:

 $C_4$  grasses – low soil N levels – legumes fix more N – increase  $C_4$  growth

## Role of dispersal?

- Timeframe of Response
- Transient Dynamics, Disturbance



## Role of dispersal?



## How important are effectresponse feedbacks?



#### **Response and Effect Trait Framework**

Environments Change

RESPONSE

Communities Respond (diversity, species composition)

#### EFFECT

Ecosystem Function Effects

### **Possible Experimental Approaches**

Change manipulations along trait gradients Biodiversity manipulations x global change



Ecosystem Process

 $+CO_{2}$ 

Gradient in Community Trait X



**Environmental Change** 

## Summary

Mechanisms of community response to global change can differ from mechanisms link communities to ecosystem function:

- Response and Effect
- Feedbacks and Resilience
- Diversity effects

These relationships can affect system dynamics A functional trait approach may help resolve issue with complexity.