Proposed Workshop on

Resource Pulse Utilization in Arid and Semi-Arid Ecosystems

Time and place:

August, 2 & 3, 2002 (Friday and Saturday) at the University of Arizona. This is in advance of the Annual Meeting of the Ecological Society of America (August 4-8, 2002) held at the Tucson Convention Center.

Summary and objectives:

The resource availability of arid and semi-arid ecosystems may be described as one of constant drought, with occasional drought relieve from rainfall (Noy-Meir, 1973). These rainfall events cause short pulses of water availability in the soil, which are utilized by plants, animals and soil microbes alike. On the whole, ecosystem processes are highly dependent on these moisture pulses, as is evidenced by the positive and linear statistical relationship between ecosystem productivity and annual precipitation (Houérou, 1984; Noy-Meir, 1985; Sala et al., 1988). However, at a smaller scale, the effects of rainwater input on ecosystem function are more complex and not readily scaleable. As changes in global circulation patterns modify not just the total amount of precipitation into arid and semi-arid regions around the world, but also the timing and magnitudes of rainfall events (IPCC 1996), studies focusing on the effects of rainfall patterns on ecosystems become imperative to predicting the likely future of these ecosystems.

Initial studies indicate that there are large differences among plant species in their ability to utilize moisture pulses, with grasses and annuals being best adapted for utilizing even small rainfall events (Sala and Lauenroth, 1982), and some woody shrubs and trees being least able to do so (Ehleringer et al., 1991). Brown et al. (1997) observed that a recent shrub expansion in the Chihuahua region was linked to unusually high winter precipitation, suggesting that the seasonal distribution of precipitation, more than the total annual precipitation, affect community structure. This view is supported by a recent model, which predicts sweeping changes in the morphological and physiological characteristics of the optimal plant phenotype with shifts in the precipitation regime (Schwinning and Ehleringer, in press). Little is known, currently, about soil microbial responses to soil moisture pulses, but it has been speculated that the size of a rain event may determine its net effect on ecosystem carbon and nitrogen balance. For example, rainfall events smaller than 3 mm may have no significant effect on stimulating primary productivity, but may still allow a burst of microbial respiration, leading to a net loss of carbon. Similarly, small events may promote nitrogen losses through geochemical reactions, but may not provide moisture long enough to initiate biological N-fixation.

Several research groups are presently conducting research to investigate the effects of single rainfall events, or patterns of events, on ecosystem components, but these studies have been conducted largely independently and without the benefits of a forum to share research findings and expertise. We propose to offer such an opportunity in the form of a 2-day workshop in advance of the Annual Meeting of the Ecological Society in Tucson, Arizona.

We propose the following questions as the main focal points of the workshop:

- How does plant diversity affect rainfall utilization in primary production?
- How do rainfall events affect the soil nutrient cycle and soil respiration?
- What are the relationships between event size, primary productivity and soil metabolic processes?
- How does season modify ecosystem responses to rainfall?
- How does the history of previous events modify ecosystem responses to a given event?

- Can changes in the seasonality, timing and sizes of events cause changes in biodiversity, functional type composition, and ecosystem function?

Our goal is to examine these questions both from a conceptual and an experimental perspective, to establish the current state of knowledge on these questions, and to achieve a synthesis that resolves current conflicts in data interpretation and suggests future research directions.

References

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Ehleringer, JR, Phillips, SL, Schuster, WSF, Sandquist, DR (1991) Differential utilization of summer rains by desert plants, implications for competition and climate change. Oecologia 88: 430-434

Houérou, HNL (1984) Rain use efficiency: a unifying concept in arid-land ecology. Journal of Arid Environments 7: 213-247

IPCC (1996) Climate Change 1995. In: Contribution of Working group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Noy-Meir, I (1973) Desert Ecosystems: Environment and Producers. Annual Review of Ecology and Systematics 4: 25-51

Noy-Meir, I (1985) Desert ecosystem structure and function. In: M Evenari, I Noy-Meir , DW Goodall (eds) Ecosystems of the World. Elsevier, Amsterdam, pp 92-103

Sala, OE, Lauenroth, WK (1982) Small rainfall events: an ecological role in semiarid regions. Oecology 53: 301-304

Sala, OE, Parton, WJ, Joyce, LA, Lauenroth, WK (1988) Primary production of the central grassland region of the United States. Ecology 69: 40-45

Schwinning, S., Ehleringer, J.R. (2001) Water use trade-offs and optimal adaptations to pulse-driven arid ecosystems. Journal of Ecology 89: in press

Workshop format

Day 1:

9:00-12:00	Seven (20 min) presentations and a coffee break
12:00-13:30	Lunch Break
13:30-17:00	Seven (20 min) presentations and a coffee break

Day 2:

9:00-12:00	Seven (20 min) presentations and a coffee break
12:00-13:30	Lunch Break
13:30-17:00	General discussion and summary of conclusions
evening	Social dinner

Tentative participants	**Tentative presentation topic**s
(USA)	
"Steve Archer" (Texas A&M)	Causes and consequences of woody invasion
Jayne Belnap (USGS and NPS)	Responses of biological crusts to pulse
"Jim Brown" (University of New Mexico)	Granivore responses
Ingrid Burke (Colorado State University)	The role of nutrient pulses in ecosystems
Martyn Caldwell (Utah State University)	Utilization of nutrient pulses
Peter Chesson (UC Davis)	Competition in a stochastic environment
Jim Ehleringer (University of Utah)	Stable isotope applications
David Evans (University of Arkansas)	Soil nitrogen fluxes in response to pulse
"Roberto Fernandez" (Duke University)	Ecophysiological responses of plants
Renate Gebauer (Keene State)	Competition for resource pulses
Deborah Goldberg (University of Michigan)	Competition intensity and pulse frequency
Bill Lauenroth (Colorado State University)	Characterizing the pulse nature of precipitation
Vicente Lopes (University of Arizona)	Event-scale dryland hydrology
Guy McPherson (University of Arizona)	Causes and consequences of woody invasion
Jim Reynolds (Duke University)	Modeling plant water and nutrient use
Susan Schwinning (University of Arizona & Utah)	Life form adaptations for resource pulse use
Anna Sher (University of New Mexico)	Plant responses to resource pulse patterns
Keirith Snyder (University of Georgia)	Water use in arid riparian ecosystems
(International)	
Martin Aguiar (University of Buenos Aires, Argentina)	Population responses to pulse frequency
Amy Austin (University of Buenos Aires, Argentina)	Nutrient responses to water pulses
Ariel Novoplansky (Ben-Gurion University of the Negev)	Developmental plasticity under pulsed conditions
José Paruelo (University of Buenos Aires, Argentina)	Modeling pulse use
Osvaldo Sala (University of Buenos Aires, Argentina)	Water-nutrient interactions as modified by pulse frequency
"Francisco Squeo" (University of La Serena, Chile)	Ecophysiology of desert plants
Thorsten Wiegand (UFZ Leipzig-Halle)	Vegetation dynamics in the Karoo